Interdisciplinary Multimodal Pain Therapy for chronic musculoskeletal pain in a day clinic setting: Examining patient-reported and performance-based correlates of treatment outcomes

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Abstract

Objectives

The aim of this single-arm pre-post intervention study was to evaluate an interdisciplinary multimodal pain therapy (IMPT) in a day clinic for people with chronic musculoskeletal pain under routine care conditions. Primary objectives included assessing changes in pain intensity and pain-related disability and examining theory- and evidence-based correlates of these treatment outcomes, such as parameters of mental and physical health.

Methods

A cohort of *n* = 308 patients underwent a four-week IMPT, which included exercise, manual therapy, and cognitive behavioural therapy. Pain intensity and disability (CPG), well-being (FW-7), mental and physical health (VR-12), depressive symptoms, anxiety, and stress (DASS) were assessed using self-report questionnaires before and six months after the IMPT was completed. Physical function was assessed using performance-based measures including the stair climb test, the MFT-S3-Check and the prone bridge test before and after treatment. Data were analysed using dependent samples *t*-tests and multiple linear regressions.

Results

Six months post-treatment, patients showed reductions in pain intensity (*d* = .95) and disability (*d* = .75). Reductions in depression, anxiety, and stress,well-being, mental and physical health, and physical function were also observed, with small to large effect sizes. Regression analysis showed that improvements in self-reported well-being and physical health were associated with changes in pain. However, this was not the case for changes in performance-based physical function or changes psychological risk factors (i.e., depressive symptoms, anxiety, stress).

Discussion

The results indicate that individuals with chronic pain experienced sustained benefits from IMPT for up to six months following treatment completon. The findings highlight the role of changes in self-reported well-being and physical health in reducing pain. The investigation of psychosocial and behavioural mechanisms is an important avenue for future studies.

Introduction

The long-term effectiveness of interdisciplinary multimodal pain therapy (IMPT) in treating chronic pain has been demonstrated repeatedly[1,2]. IMPT is a complex intervention incorporating different treatment components provided by a multidsiciplinary team[3] and has been shown to lead to reductions in pain, improvements in functional ability, a faster return to work, and appears to be cost-effective [1,4–7]. The primary treatment outcomes of IMPT usually include self-reported, pain-related outcomes. However, to optimise IMPT, evaluations need to consider not only whether individuals benefit from the intervention (e.i. is the intervention effective?), but also why they benefit from it. The first step in answering the latter question is to a) assess potential mediators of treatment effects and b) analyse whether changes in these mediators are associated with changes in treatment outcomes (i.e. pain intensity, pain-related disability). Prior research has indicated that patients with high pain intensity levels benefit from IMPT[8,9]. Furthermore, sociodemographic factors such as gender, age, and work status have been shown to correlate with treatment outcomes. For example being younger[10], being male[9], and having a shorter duration of sick leave[11,12] were associated with greater improvements in pain. With regard to psychological variables, changes in pain intensity measures after IMPT have been shown to correlate with improvements in risk factors, such as depression and catastrophizing[13] and to be associated with positive treatment expectations[13] and higher acceptance of one's condition[14].

Daenen et al.[15] describe exercise therapy as a fundamental part of the conservative treatment of chronic musculoskeletal pain and most IMPTs also specifically aim to improve patients' physical functioning in order to reduce pain[16]. Guidelines for managing chronic pain recommend exercise as an important treatment modality[17] and performance-based measured of physical function have been shown to improve following IMPT[18,19]. However, previous research into the relationship between pain-related treatment outcomes and performance-based measures of physical function, has produced incosistent results. While some studies have shown that changes in physical function, such as strength and endurance, correlate with changes in pain following treatment[20], other studies have shown that performance-based measures of physical function are unrelated to improvements in pain intensity and disability[21].

This study therefore uses routine care data from an established IMST in a day clinic setting to a) evaluate the IMPT in terms of pain-related primary treatment outcomes (i.e. pain intensity, pain-related disability), b) evaluate the IMPT in terms of potential patient-reported and performance-based mediators of treatment effects, and c) examine the extent to which patient-reported and performance-based variables are associated with changes in pain-related treatment outcomes. It was hypothesised that reductions in pain intensity and pain-related disability, as well as improvements in self-reported measures of mental and physical health, would be observed six months after the IMPT program.We also hypothesized that there would be an improvement in objective, performance-based measures of physical function following IMPT. Secondly, we hypothesized that both changes in mental and physical health, as well as parameters of physical function would be associated with changes in pain intensity and pain-related disability.

Materials and Methods

Ethical approval, trial registration

The Ethics Committee of the MSB Medical School Berlin approved the study on 05/05/2025 (approval number MSB-2025/246). The study was registered retrospectively in the German Clinical Trials Register (DRKS00036855), which is also available on the International Clinical Trials Registry Platform.

Participants and procedure

The present study is a single-arm pre-post intervention study. Participants were patients at a day clinic for manual medicine at the Sana Hospital Lichtenberg between November 2019 to August 2022. To be eligible for the IMPT program, patients had to have experienced chronic pain (at least three months) in the musculoskeletal system. This could include conditions such as back pain, joint pain, and headaches. The aetiology of the pain had to be multifactorial, involving a combination of complex functional musculoskeletal findings, pathomorphological changes, and psychosocial factors. Further details on the inclusion and exclusion criteria can be found in the supplementary material S1. Eligibility for the IMPT programme was assessed during an outpatient diagnostic appointment, consisting of one-hour medical and psychological examinations. This included an evaluation of the patient's pain characteristics, physical function and psychosocial health. Between November 2019 and August 2022, 422 patients attended the diagnostic assessment, and 308 of these received a recommendation for IMPT at the day clinic. The remaining 114 patients were advised to pursue alternative treatment, such as inpatient IMPT or psychosomatic treatment. On average, patients had to wait two months after the diagnostic assessment before starting IMPT. All participants gave written informed consent for their data to be used to assess treatment quality. As part of this evaluation participants completed paper-pencil questionnaires at the time of their diagnostic appointment (T0), underwent physical performance tests to measure physical function at the start (T1) and end (T2) of IMPT, and were reassessed with questionnaires six months after treatment (T3). The study design is shown in Fig. 1.

Interdisciplinary multimodal pain therapy (IMPT)

The patients were enrolled in an IMPT program, which was provided by a team of healthcare professionals with expertise in the treatment of pain. This complex treatment is understood as a conservative orthopaedic pain therapy approach that incorporates manual medicine-oriented diagnostics and therapy, physical training and cognitive behavioral psychotherapy. The program aims to restore and improve physical functioning and reduce pain-related disability and pain intensity. Patients participate in a four-week therapy program comprising 100 hours in total. The treatment plan was standardized for all patients and included strength training, endurance training, relaxation training and medical and psychological education on pain and pain management, among other things. An example of a weekly schedule can be found in the supplementary material 2. In addition to the group program (closed groups of up to eight), patients had weekly individual sessions with their reference therapists (physician, physiotherapist/sports therapist, psychologist). A daily one-hour team meeting was held to facilitate interdisciplinary communication between team members. A more detailed description of the IMPT, following the TIDieR-Rehab checklist (Signal et al., 2024), can be found in the supplementary material (see S1).

Coding intervention content in pain therapy in behaviour change techniques

As previous research has often lacked clarity regarding the exact implementation of the IMPT[22], the IMPT content was coded post-hoc using a German version of the standard behaviour change taxonomy[23,24]. The purpose of the coding was to make IMPT more replicable and comparable. This taxonomy aims to systematically and reliably identify the content of behaviour change interventions using a list of 93 different behaviour change techniques (BCTs[23]). BCT refers to a measurable and irreducible element of an intervention that is designed to modify or influence the underlying processes regulating behavior[25]. Treatment content was categorized into BCTs independently by two raters (JM, LF), then compared and adjusted in a consensus process. An overview of the BCTs used in the treatment is provided in Table 1.

Table 1
Content, form of delivery and behavior change techniques (BCTs) of the intervention

Content	Method	Profession	Organization / Setting	Material	BCT	Target behavior	Aim of the intervention component
Definition of individual behavioral goals (incl. context, frequency, duration and/ or intensity)	Frontal teaching, group discussion, one-on-one	Physicians, psychologists, physiotherapists, sports therapists	Conference room, treatment room	Presentation, writing material, printed individualized instructions	Action planning (1.4), goal setting (behavior) (1.1)	Physical activity, nutrition, relaxation, sleep	Facilitate behavior change
Analysis of barriers for behavior change & development of strategies to overcome those	Frontal teaching, group discussion, one-on-one	Psychologists, physicians, physiotherapists, sports therapists	Conference room, treatment room	Presentation	Problem solving (1.2), social support (practical) (3.2), social support (emotional) (3.3)	Physical activity, sleep, relaxation, nutrition, stress management	Facilitate behavior change
Feedback on change in physical performance	One-on-one	Physicians, physiotherapists, sports therapists	Treatment room	Visual presentation of outcome	Feedback on outcomes of behavior (2.7)	Physical activity	Help patients build motivation
Exploration of perceived causes of behavior & development of an explanatory model	Frontal teaching, group discussion, one-on-one, physician's round	Physicians, psychologists, physiotherapists, sports therapists	Conference room, treatment room	Presentation, writing material, flipchart	Re-attribution (4.3)	Adaptive Coping (instead of catastrophizing)	Reduce insecurity and increase self-efficacy for suitable behavior in patients
Information on consequences of a variety of behaviors on physical & mental health & emotional well-being	Frontal teaching, group discussion, one-on-one, physician's round	Physicians, psychologists, physiotherapists, sports therapists	Conference room, treatment room	Presentation, *flipchart, work sheets*	Information about health consequences (5.1), emotional consequences (5.6), credible source (9.1)	Physical activity, sleep, relaxation, nutrition, stress management	Increase self-responsibility and motivation to implement health behavior
Instruction, demonstration and instigation of rehearsal of behavior	Frontal teaching, modeling, one-on-one	Physicians, psychologists, physiotherapists, sports therapists	Conference room, treatment room, training room, outside	Presentation, *video recordings*	Instruction on how to perform behavior (4.1), demonstration of the behavior (6.1), behavioral practice / rehearsal (8.1), credible source (9.1) *habit formation (8.3), habit reversal (8.4), generalization of a target behavior (8.6), graded tasks (8.7)*	Physical activity, sleep, relaxation, nutrition, stress management, communication and decision-making skills	Improve patients' well-being and self-efficacy, reduce pain
Encouragement of adherence to the use of drugs if necessary	Frontal teaching, one-on-one, physician's round	Physicians psychologists	Conference room, treatment room	Presentation	Credible source (9.1), pharmacological support (11.1)	Use of medication	Improve patients' well-being, reduce pain
Working out ways to reduce unpleasant feelings	Frontal teaching, group discussion, one-on-one	Psychologists	Conference room, treatment room	Presentation, *flipchart, work sheets*	Reduce negative emotions (11.2)	Emotion regulation	Improve patients' well-being, reduce anxiety and stress

Content	Method	Profession	Organization / Setting	Material	BCT	Target behavior	Aim of the intervention component
Working out ways to redirect attention from unwanted bodily sensations	Frontal teaching, group discussion, one-on-one	Psychologists	Conference room, treatment room	Presentation	Distraction (12.4)	Adaptive coping with pain	Reduce anxiety and pain intensity, increase self-efficacy
Training, manual therapy, *assistive aids (e.g. lumbar support), passive treatment methods (e.g. taping)*	Frontal teaching, modeling, one-on-one	Physicians, psychologists, physiotherapists, sports therapists	Treatment room, training room, outside	Written instructions, *audio- and video recordings*	Feedback on behavior (2.2), body changes (12.6)	Physical activity and relaxation	Improve patients' well-being and self-efficacy, reduce pain
Cognitive (re-) structuring (e.g. change of view on disability)	Frontal teaching, group discussion, one-on-one	Psychologists	Conference room, treatment room	*work sheets*	Framing / Reframing (13.2), *behavioral experiments (4.4), monitoring of emotional consequences (5.4), exposure (7.7), incompatible beliefs (13.3)*	Adaptive Coping (instead of catastrophizing)	Reduce anxiety and pain intensity, increase self-efficacy
Motivation and support of self-esteem	Frontal teaching, group discussion, one-on-one	Physicians, psychologists, physiotherapists, sports therapists	Conference room, treatment room, training room, outside	Presentation	Verbal persuasion about capability (15.1), *mental rehearsal of successful performance (15.2), focus on past success (15.3), self-talk (15.4)*	Physical activity, sleep, relaxation, nutrition, stress management	Help patients build motivation and self-efficacy
Italics: This BCT, content or material is included in the treatment if necessary.							

Self-report treatment outcomes

At baseline (T0), demographic data were collected and patients were asked about the duration of their pain. Answers were given on a 6-point response scale (1 = < *1 month*, 2 = *1 month - ½ year*, 3 = *½ year – 1 year*, 4 = *1 year – 2 years*, 5 = *2 years – 5 years, 6 = > 5 years)*. At follow-up assessment (T3), patients were asked to rate the perceived success of the treatment on a 6-point scale (1 = *very good*, 2 = *good*, 3 = *satisfactory*, 4 = *adequate*, 5 = *inadequate*, 6 = *insufficient*).

The "pain questionnaire" of the German Pain Society, which encompasses several of the following measures, was used to collect data[26].

Primary outcome measure: pain intensity and pain-related disability

The degree of pain intensity and pain-related disability were assessed using the validated German version of the Chronic Pain Grade questionnaire (CPG[27,28]). Patients were asked to rate their pain intensity (current pain intensity; maximum and average pain intensity within the past four weeks) and their pain-related disability within the past three months (with regard to daily activities, leisure activities, and ability to work) using six 11-point numeric rating scales. The response scales ranged from 0 (*no pain/no impairment)* to 10 (*most severe pain/no activity possible*). An additional item asked about the number of days in the past three months (six months in the original publication) during which the patient was unable to perform usual activities due to pain. The primary outcome variables were pain intensity (i.e., mean of current, average and maximum pain intensity multiplied by 10; ranging 0-100) and pain-related disability (i.e., mean of impairment in daily activities, leisure activities and ability to work multiplied by ten; ranging 0-100). The CPG allows the consctruction of a total score for grading the pain severity (i.e., Pain Severity Grade; four-step grading of pain intensity and disability; ranging 0–3). As it is often used to guide the selection of pain treatments and could provide an assessment of qualitative change, changes in pain severity grade were also evaluated. The German version has been shown to be reliable and valid[28], although only the Brazilian Portuguese translation of the questionnaire has been tested for test-retest reliability, demonstrating moderate agreement[29].

Physical and mental health

Self-reported physical and mental health were measured using the German version of the Veterans RAND 12-Item Health Survey (VR-12[30,31]). The response format of this instrument alternates between three (1 = *yes, limited a lot* to 3 = *no, not limited at all*), five (1 = *never* to 5 = *always* or 1 = *excellent* to 5 = *poor*) and six (1 = *always* to 6 = n*ever*) response options. The items are divided into two component scores: physical and mental health. All 12 items are included in the calculation of each subscale and weighted according to their relevance to its content. Higher subscores indicate a more positive self-assessment of health. The VR-2 has been validated with patients with chronic pain[31].

Well-being

The Marburg Questionnaire on Habitual Well-being (FW-7[32]) was used to measure general well-being as a unidimensional factor. Respondents were asked to rate their level of satisfaction with their everyday and job performance despite their pain on a scale of 0 to 5, with 0 indicating strong disagreement and 5 indicating strong agreement. They were also asked to rate their level of comfort in various situations. Higher FW-7 total scores indicate higher levels of well-being. Basler[32] reports high internal consistency, test-retest reliability, and external validity with measures of pain chronification.

Depressive symptoms, anxiety, and stress

The short version of the Depression Anxiety Stress Scale (DASS) was used as a screening instrument to measure the subscales of depression, anxiety and stress, each with seven items (German version: Nilges & Essau[33]). Items were rated on a 4-point scale (0 = *did not apply to me at all* to 3 = *applied to me very much or most of the time*). Cut-off values of ≥ 10 for depression, ≥ 6 for anxiety, and ≥ 10 for stress indicate an increased likelihood for the respective psychological condition. The internal consistency and construct validity of the depression and anxiety subscales were good in the study conducted by Nilges and Essau[33].

Performance-based measures of physical function

Balance and body stability

The stability, sensorimotor regulation and symmetry test from Multifunktionale Trainingsgeräte GmbH (MFT-S3-Check[34]; MFT Bodyteamwork GmbH, Vienna, Austria) was used. The measurement device consisted of a uniaxially mounted, unstable standing plate with an integrated sensor-controlled transducer and associated evaluation software. Participants were tasked with keeping the platform horizontal for 30 seconds. Normative values are available for men and women in different age groups so that the results of the test can be classified within a standardized reference system.The stability index can range from 1 (*very good*) to 9 (*very poor*). Scores below 5 are considered below average compared to the normative sample for all age groups. Raschner et al.[34] report high test-retest reliability and objectivity for the stability index.

Physical fitness

For the stair climb test (SCT), which assesses physical fitness, patients were asked to climb the stairs to the fourth floor as quickly as possible[35]. The time taken to climb the stairs was measured by physiotherapists or sports therapists using a stopwatch. The number of steps was based on local conditions (72 steps), so no comparisons can be made with other populations. Test-retest reliability was high in previous studies and there is evidence of good construct and criterion validity[36].

Trunk muscle endurance

The prone bridge test was used to assess trunk muscle endurance[37]. Patients were positioned in a prone position with their elbows flexed at 90°, their legs extended, and their whole body aligned. They were then asked to lift their body off the floor (except for the arms and feet) and to hold this position for as long as possible. The test ended when the position was disturbed or the patient fell. The duration was recorded in seconds. This test has been shown to validly measure trunk muscle endurance, with high test-retest reliability[38,39].

Statistical analysis

The mean and standard deviation of all variables were calculated, with the significance level set at alpha = .05 for each statistical analysis. Listwise deletion was used to adress missing data. For the dropout analyses, t-tests were used for interval-scaled variables and chi-squared tests were used for non-interval-scaled variables to compare values between participants who took part in the follow-up survey and those who did not. Changes in the self-reported measures of pain intensity and pain-related disability, well-being, physical and mental health, depression, anxiety and stress were evaluated by comparing baseline (T0) and follow-up (T3) measures using a series of dependent samples t-tests. Treatment outcomes for physical function (balance and stability, physical fitness and trunk muscle endurance) were assessed by comparing test scores at the beginning (T1) and end (T2) of the intervention. The subgroup of participants who took part in the physical performance tests at T1 and T2 was larger than the group who also completed the questionnaire at T3. This is why the sample size differs in these analyses. Effect

sizes were calculated using Cohen's *d* and interpreted as small (.2), medium (.5) or large (.8)[40]. Pearson correlation coefficients were used to assess the correlation between the primary outcome measures, and the other factors at the different time points. The results were then used to select the variables for the regression analysis. Hierarchical linear regressions were performed to examine the extent to which changes in well-being, physical health, depression, stress, and physical function were associated with changes in pain intensity and pain-related disability at follow-up (T3). As previous studies have found correlations between pain duration, gender, age, and work status and treatment outcomes, these were included as control variables in the analyses. There was no difference in the results when 'pain duration' was included as either dummy variables (with five dummy variables representing the six categories, with '>5 years' as the reference category, as this category occurred most frequently) or as a pseudo-metric variable. Therefore, we included it in the final model as a pseudo-metric variable.An additional outcome variable was calculated based on the pain severity grade. By comparing pain severity grades at T0 and T3, a dichotomous variable was created to indicate whether there had been “improvement by at least one grade” (= 1) or “no change/worsened” (= reference category). Binary logistic regression was used to examine the extend to which well-being, physical health, depression, stress, and physical function were associated with pain grade progression vs. pain grade maintenance/regression. Complete case analysis was used. All analyses were performed using SPSS (version 28).

Results

Descriptive analyses

Of the 308 patients who started treatment, seven (2.3%) discontinued it. In six cases, this was due to the onset of another illness (e.g., Covid infection) which prevented participation. In one case, it was due to an increase in depressive symptomss following the abrupt cessation of antidepressant medication shortly before the start of treatment. Patients had various and sometimes multiple diagnoses with lumboischialgia (25.5%), chronic pain disorder with somatic and psychological factors (17.8%), low back pain (12.5%), and cervicobrachial syndrome (11.2%) being the most common. As shown in the flowchart (Fig. 2), the follow-up survey six months after the end of treatment (T3) was completed by 137 participants (44.5%).There was no significant difference in most variables between participants who completed only the initial questionnaire (= drop-out participants) and those who completed both the initial and follow-up questionnaire (= completers). However, completers had lower mean scores on the anxiety subscale of the DASS at baseline ($M = 3.20$) compared to drop-out participants (M = 4.20), $t(290) = 2.39$, $p = .017$, $d = .28$. In the drop-out group, fewer participants were working compared to the completers, $\chi^2(1, N = 290) = 4.15$, $p = .042$. The following descriptive data refer to participants who completed the questionnaires both at T0 and T3 ($n = 137$). However, completers had lower mean anxiety subscale scroes on the DASS at baseline ($M = 3.20$) than drop-out participants (M = 4.20), $t(290) = 2.39$, $p = .017$, $d = .28$. Fewer participants in the drop-out groupwere working compared to the completers, $\chi^2(1, N = 290) = 4.15$, $p = .042$. The following descriptive data refer to participants who completed the questionnaires at both T0 and T3 ($n = 137$). The mean age of the participants was 50 ± 11 years and 69% ($n = 95$) were women. At baseline (T0), 62% ($n = 75$) of participants were working. The remaining participants were either on sick leave, retired, unemployed, or in education. The mean body mass index (BMI) was 25.96 ± 4.83 kg/m^2. At baseline (T0), 43 participants (34%) categorized the duration of their pain as > 5 years, 24 (19%) as 2–5 years, 22 (18%) as 1–2 years and 36 (29%) as 6 months – 1 year. The mean current pain intensity as measured by the first item of the CPG, was 5.74 ± 1.72 (0–10). At follow-up (T3) participants rated the program as follows: very good (32%), good (29%), satisfactory (20%), adequate (11%), inadequate (8%) and insufficient (0%). Correlations between the primary outcome measures, and the other factors at the different time points can be seen in Table 2.

Content of the intervention

Table 1 summarizes how the intervention content aligned with the identified BCTs. Of the 93 BCTs, 27 techniques were identified within the intervention at least once. The majority of the identified BCTs belonged to the clusters repetition and substitution ($n = 5$), self-belief ($n = 4$), goals and planning ($n = 3$), and shaping knowledge ($n = 3$; see Table 1).

Changes in the variables across time

Table 3 shows changes in pain intensity, pain-related disability, well-being, physical and mental health, depression, anxiety, stress between baseline (T0) and follow-up (T3). Significant changes in the hypothesized direction were observed for all variables, with effect sizes ranging from small (d=-.24 for mental health and $d = .25$ for anxiety)) to large ($d = .90$ for physical health, $d = .95$ for pain intensity). Table 3 also shows a comparison of physical function parameters at the start (T1) and end (T2) of treatment. Significant improvements were observed in all three measures, with the largest effect size (-1.12) seen in the change in trunk muscle endurance. Examining the distribution of CPG pain severity grades at baseline (T0) and follow-up (T3), it was found that 77 participants (65%) improved by at least one grade, 30 participants (25%) experienced no change, and 12 participants (10%) reported an increase in pain severity by at least one grade (see Table 4).

Table 3
Change in the variables over time

Questionnaire	T0		T3					
	M	*SD*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Pain intensity (CPG)	62.24	15.41	40.05	24.21	10.39	*118*	*< .001*	.95
Pain-related disability (CPG)	54.80	23.15	31.65	25.38	8.19	*117*	< .001	.75
Physical health (VR-12)	33.31	9.63	43.53	10.78	-9.64	*115*	< .001	− .90
Mental health (VR-12)	35.48	6.54	37.54	6.85	-2.57	*115*	.006	− .24
Well-being (FW-7)	14.23	7.74	21.47	8.42	-8.30	*121*	< .001	− .75
Depression (DASS)	6.68	4.63	4.26	4.28	6.25	*119*	< .001	.57
Anxiety (DASS)	3.10	3.09	2.44	3.00	2.70	*119*	.004	.25
Stress (DASS)	8.48	4.95	6.19	4.74	5.39	*119*	< .001	.49
Physical performance tests	T1		T2					
	M	SD	M	SD	t	df	p	Cohen's d
Balance & Stability (MFT-S3-Check)	5.37	1.02	5.05	1.06	7.06	*256*	< .001	.44
Physical fitness (SCT)	40	15.70	35.45	13.27	9.80	*251*	< .001	.62
Trunk muscle endurance (prone bridge test)	37.76	21.86	65.84	29.80	-16.89	*224*	< .001	-1.12

Note: CPG indicates Chronic Pain Grade; VR-12, Veterans RAND 12-Item Health Survey; FW-7, Marburg Questionnaire on Habitual Well-being; DASS, Depression Anxiety Stress Scale; SCT, stair climb test; 116 ≤ n ≤ 257 due to missing values.

Table 4
Number of patients per pain severity grades based on von Korff28 at T1 and T3

		Pain severity grade (T3)				Total
		I	II	III	IV	
Pain severity grade (T0)	**I** low intensity & low disability	9	3	0	0	12
	II high intensity & low disability	29	12	0	7	48
	III high disability & moderately limiting	11	6	1	2	20
	IV high disability & severely limiting	18	10	3	8	39
Total		67	31	4	17	119

Note. Grey background indicates improvement.

Correlates of changes in pain intensity and pain-related disability

Multiple regression analysis was used to test for significant associations between changes in self-reported psychological and performance-based physical parameters and changes in participants' pain intensity.. The results of the regression analysis, which controlled for pain duration, gender, age and work status, are shown in Table 5. These results indicate that two variables explained 44.1% of the variance, $F(6,96) = 12.60$, $p < .001$. Specifically,changes in both self-reported physical health (VR-12) and change in well-being (FW7) were significantly associated with changes in pain intensity (B = 1.11, $p < .001$, and B = 0.73, $p < .001$, respectively). Table 5 also shows the results of the regression analysis in which change in reported pain-related disability was used as the dependent variable. Consistent with previous pattern, changes in physical health (B = 1.65, $p < .001$) and change in well-being (B = 1.48, $p < .001$) were significantly associated with changes in pain-related disability. Changes in depressive symptoms, stress and in the physical function parameters were not significantly related to the changes in pain intensity or pain-related disability.

Table 5
Prediction of change in pain intensity

	Change in pain intensity					Change in pain-related disability				
Predictors	**B**	**SE**	**R**	**R^2**	**ΔR^2**	**B**	**SE**	**R**	**R^2**	**ΔR^2**
Step 1:			.27	.07	.03			.28	.08	.65
Duration	-3.84	1.65				-5.96	2.17			
Age	.18	.21				.05	.27			
Gender	− .69	4.90				-2.96	6.11			
Work-status	-8.08	4.93				2.13	6.47			
Step 2:			.61	.37***	.33			.67	.45***	.42
Change in physical health	1.11	.17				1.65	.20			
Step 3:			.66	.44***	.41			.79	.63***	.60
Change in well-being	.73	.21				1.48	.22			
Step 4:			.66	.44	.39			.79	.63	.60
Change in depression	.05	.57				.59	.61			
Change in stress	− .11	.49				− .44	.53			
Step 5:			.67	.46	.39			.79	.63	.59
Change in balance and body stability	2.52	2.47				-1.01	2.70			
Change in physical fitness	.31	.09				.17	.31			
Change in trunk muscle endurance	.04	.08				− .05	.09			
* p < .05 ** p < .01 *** p < .001; *N* = 108										

Logistic regression was used to analyse the association between changes in psychological and physical parameters and the likelihood of an improvement of at least one pain grade on the CPG (reference category 0 = “no change / worsened”). Together, the variables accounted for a significant amount of variance in the outcome; the likelihood ratio test comparing a full model with a reduced model resulted in a chi-squared value of 50.25, with a p-value of less than .001. Again, only change in physical health, *OR* = 1.11 95% CI [1.03, 1.19], *p* = .006, and change in well-being *OR* = 1.13, 95% CI [1.04, 1.23], *p* = .003, were independently associated with changes in the graduation of pain. The odds of a reduction in the CPG by at least one grade, compared to no change or worsening, increased by 11% for each one-point increase in self-reported physical health and by 13% for each one-point increase in self-reported well-being, when holding the other variables constant.

Discussion

The overall aim of the present pre-post analysis was to evaluate an IMPT for individuals with chronic musculoskeletal pain in the context of routine day clinic care. This evaluation considered changes in patient-reported variables and performance-based measures (e.g., prone bridge test, SCT, MFT-S3-Check) after the intervention. As well as analysing changes in the primary treatment outcomes (i.e., pain intensity, pain-related disability), the study examined changes in potential mediators of the treatment effects, and their associations with the pain-related outcomes. Six months after treatment, reductions in pain intensity (CPG) and pain-related disability (CPG) were observed, with large and medium effect sizes, respectively.These findings align with previous research demonstrating the effectiveness of IMPT in reducing musculoskeletal pain [1, 41–45], further supporting its robustness as a therapeutic intervention for chronic pain. Regarding potential mediators, self-reported measures showed improvements in physical health (VR-12) with a large effect size, reductions in depressive symptoms (DASS) and improvements in general well-being (FW-7) with medium effect sizes, and reductions in stress, anxiety (DASS) and mental health (VR-12) with small effect sizes. Furthermore, performance-based measures showed improvements from the start to the end of treatment, with small to large effect sizes, suggesting that IMPT is associated with objectively measurable changes in physical function. Few participants (2.3%) dropped out of the treatment program, and satisfaction with the treatment remained high.

In terms of intervention content, healthcare professionals in the interdisciplinary treatment team most frequently used BCTs that focused on coping strategies (e.g., reattribution), advising patients on how to perform recommended health behaviours correctly (e.g., behavioural rehearsal of specific exercises), and motivating patients to engage in specific health behaviours (e.g., behavioural instruction, verbal persuasion of ability).

BCTs that empower patients to regulate their own health behaviours in daily life (e.g., habit formation, action planning) were used less frequently, but would be a valuable addition to current IMPT programmes in order to support the sustainability of treatment effects.

Rather than objective measures of physical function, changes in self-reported well-being and physical health were associated with changes in pain intensity, pain-related disability and pain grade classification. Contrary to other studies[9,10,11,12], age was not associated with a reduction in pain intensity or disability and neither was pain duration, gender or work status. It is possible that there are bidirectional relationships between well-being, physical health and pain. For example, pain could negatively impact subjective health and well-being. A large study by Ritchie et al[46] found that persistent pain in older adults was associated with a decline in self-reported physical function and well-being over a seven years. However, a review examining prognostic factors for self-reported physical functioning (as measured by the VR-12) after an IMPT found that pain intensity was unrelated to physical functioning[47]. Karayannis et al.[48] used a parallel process latent growth curve modelling to study the relationship between pain interference and self-reported physical functioning. They found a weak one-way relationship between physical functioning and pain interference over 90 days. This suggests that changes in physical functioning are associated with changes in pain interference, rather than the other way around. Future studies should further examine whether improvements in self-reported parameters of physical health lead to pain reduction via specific pathways, such as increased mobility,enhanced mental health or improved well-being.

Contrary to our hypotheses, changes in objective physical function parameters were not associated with improvements in pain intensity and disability. This is consistent with previous studies, in which pain correlated with self-reported disability, rather than performance-based measures[49], and in which physical variables showed little prognostic value for outcome parameters[19,50–52]. In contrast to our hypotheses and unlike previous studies, where reductions in depressive symptoms coincided with reductions in pain[53,54]reductions in anxiety, depressive symptoms and stress did not correspond with pain reductions. Additionally, the effect size for changes in mental health and anxiety at follow-up compared to baseline scores was smaller than for the other variables. These differing results may be due to differences in the study population, methodology or types of intervention used. This suggests that the relationship between mental health and pain may not be universal across all contexts.The mean scores for depression, anxiety and stress (DASS) by the sample in this study were lower than in a population with chronic low back pain using the same questionnaire[55], which limits the potential for improvement after the intervention. Compared to other multimodal outpatient treatment programs this treatment was relatively short but intensive[56]. In a systematic review, Scascighini et al.[56] did, however, not find a significant relationship between the treatment duration and success. Present findings should be replicated using additional patient-reported measures to assess depressive symptoms, as recent studies have suggested that the psychometric properties of the DASS may be limited. [57]. When comparing the questionnaires used in this study to assess different aspects of mental health (DASS, VR-12, FW-7), the DASS and VR-12 are more deficit-oriented than the FW-7. This distinction is particularly relevant given that one of the stigmas feared by people with chronic pain is psychologisation[58], which may lead to a reluctance to respond positively to items that address mental health problems specifically. At a content level, the associations between changes in well-being (FW-7) and changes in pain intensity and pain-related disability found in this study, may also support a greater focus on potential protective resources that help individuals to become and /or remain healthy[58,59,60]. As well as targeting mental health outcomes such as depression, IMPT should specifically target resources and theory-based, psychological risk factors of pain chronification[61,62]. At the behavioural level, researchers may also consider measuring the extent to which individuals adhere to health behaviours relevant to pain management (e.g. physical activity, relaxation techniques). As such, IMPT can be understood as a multiple behaviour intervention[63] and it is likely that multiple behaviour changes contribute to treatment success. Factors that potentially contribute to this but were not assessed in this study include catastrophizing, fear-avoidance behaviour, self-efficacy, expectations, and perceived social support[13,64–66]. In a study done by Furrer et al.[67], pain catastrophizing mediated the effect of subjective well-being on pain intensity and pain interference. Optimism is one of factor that has been shown to be associated with self-reported physical functioning[68]. Exercise training and subsequent improvements in physical function may influence pain intensity and disability through changes in pain processing, self-efficacy, motivation and mood[21].

The study design of the present study has some limitations. The data of the current study were collected in a naturalistic setting of a day clinic. A major limitation of this study is the lack of randomized control groups (e.g. alternative pain treatment or no intervention). Additionally, there was an asymmetric timing of the assessments: unlike the physical performance tests, the questionnaire data were collected at the six-month follow-up, rather than post-treatment due to clinic logistics. So while the external validity of our results is high, we cannot make any causal inferences about the observed changes following the treatment. The response rate to the follow-up survey was low, and those who participated in the follow-up survey differed from those who dropped out in terms of anxiety levels and work status. This leaves room for non-response bias and limits generalizability. The initial questionnaire survey was conducted approximately two months prior to the start of IMPT, during which time symptoms may have changed, for example, due to expectations of treatment[69]. In other studies, a decrease in pain and passive pain coping strategies was observed during the waiting period[70,71]. As the patient group was diverse, with pain in various musculoskeletal areas, results may vary by subgroup andthe standardized nature of the program may not fully address patients' diverse needs. Future evaluations should include longer follow-up periods to examine IMPT sustainability and assess patient adherence, since long-term adherence to exercise programs has been demonstrated to be challenging for patients[16].

In conclusion, the results of this study suggest that individuals with chronic musculoskeletal pain can benefit from IMPT in routine caresettings. This improvement was evident in both pain-specific outcomes (i.e. pain intensity and disability) and physical function, well-being, and mental and physical health. However, it was changes in self-reported well-being and physical health rather than in performance-based measures of physical function that were associated with changes in treatment outcomes. This emphasises the importance and value of assessing and adressing psychosocial factors, such as risk factors and resources, alongside performance-based measures in IMPT. Although challenging in naturalistic settings, future research should aim to implement research designs (e.g. randomized controlled designs) that allow for a better understanding of why changes occur following IMPT. Such insights would help further optimize pain management strategies in clinical practice.

Declarations

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Data availability statement:

The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data can not be shared publicly.

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Table 2

Table 2 is available in the Supplementary Files section.

Figures

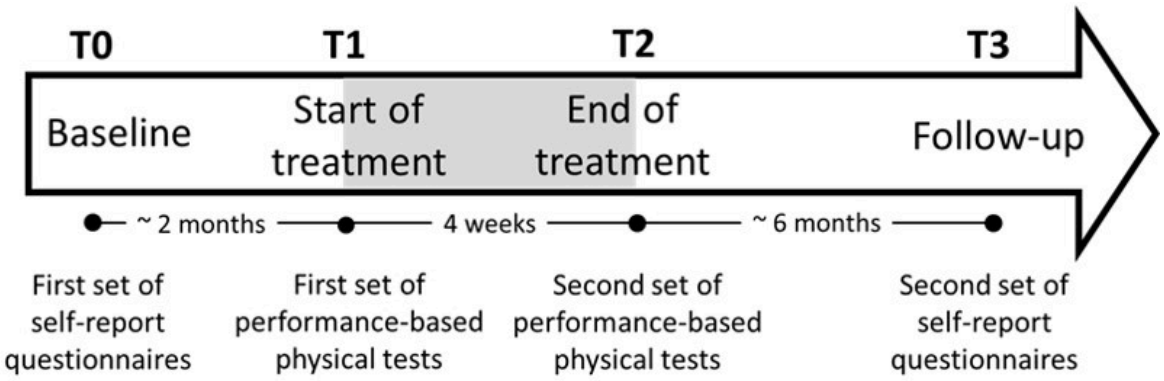

Figure 1

Measurement points of the longitudinal study to evaluate the interdisciplinary multimodal pain therapy. *Note*. T = Time

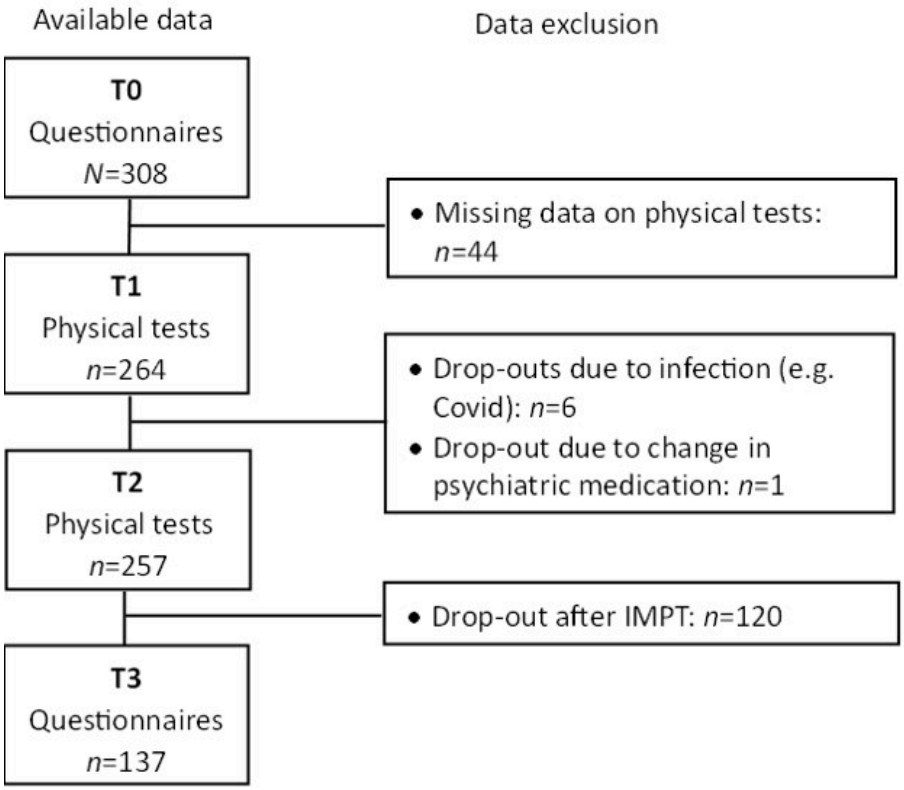

Figure 2

Flowchart of the study.

Supplementary Files

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- SupplementaryMaterial.docx
- TABLE2.docx