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ORIGINAL RESEARCH

Communication Skills Training for Practitioners to Increase Patient Adherence to Home-Based Rehabilitation for Chronic Low Back Pain: Results of a Cluster Randomized Controlled Trial

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Abstract

Objective: To assess the effect of an intervention designed to enhance physiotherapists' communication skills on patients' adherence to recommendations regarding home-based rehabilitation for chronic low back pain.

Design: Cluster randomized controlled trial.

Setting: Publicly funded physiotherapy clinics.

Participants: A sample (N=308) of physiotherapists (n=53) and patients with chronic low back pain (n=255; 54% female patients; mean age, 45.3y).

Interventions: Patients received publicly funded individual physiotherapy care. In the control arm, care was delivered by a physiotherapist who had completed a 1-hour workshop on evidence-based chronic low back pain management. Patients in the experimental arm received care from physiotherapists who had also completed 8 hours of communication skills training.

Main Outcome Measures: (1) Patient-reported adherence to their physiotherapists' recommendations regarding home-based rehabilitation measured at 1, 4, 12, and 24 weeks after the initial treatment session. (2) Pain and pain-related function measured at baseline and at 4, 12, and 24 weeks.

Results: A linear mixed model analysis revealed that the experimental arm patients' ratings of adherence were higher than those of controls (overall mean difference, .41; 95% confidence interval, .10−.72; $d=.28$; $P=.01$). Moderation analyses revealed that men, regardless of the intervention, showed improvements in pain-related function over time. Only women in the experimental arm showed functional improvements; female controls showed little change in function over time. The Communication Style and Exercise Compliance in Physiotherapy intervention did not influence patients' pain, regardless of their sex.

Conclusions: Communication skills training for physiotherapists had short-term positive effects on patient adherence. This training may provide a motivational basis for behavior change and could be a useful component in complex interventions to promote adherence. Communication skills training may also improve some clinical outcomes for women, but not for men.

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Patient adherence to interventions based on self-management principles is often poor.[1] For example, patients with chronic musculoskeletal conditions often do not complete their home-based exercise programs as recommended by their health care practitioners.[2,3] Poor adherence to treatment recommendations is problematic for both clinicians and patients, because it can limit the potential for positive treatment outcomes.[4,5] Despite acknowledgment that interventions targeting patient behavior should be grounded in relevant behavior change theory,[6] there is limited evidence regarding the effect of theory-based interventions to promote adherence in populations with chronic pain.[7-9]

According to self-determination theory,[10] people have psychological needs for autonomy (feeling free to engage in an activity), competence (feeling effective and capable), and relatedness (feeling connected to and cared for by others). When health care practitioners support their patients' psychological needs, patients are more likely to be autonomously motivated (ie, empowered), which results in more enduring behavior change.[11] In contrast, a controlling health care climate involves disregarding patients' views, pressuring patients, and making decisions on patients' behalf without consultation, leading to more controlled motivation and poorer long-term adherence. Unfortunately, health care practitioners often adopt the latter model of patient care.[12-14]

We designed a self-determination theory-based communication skills training intervention, called Communication Style and Exercise Compliance in Physiotherapy (CONNECT), for physiotherapists working with people seeking treatment for chronic low back pain. Communication skills training can increase patient adherence across a range of conditions,[15] but there is limited evidence regarding its effect on adherence to chronic pain self-management[14] or clinical outcomes.[16]

Aims

The aim of this cluster randomized controlled trial was to assess the effect of an intervention designed to enhance physiotherapists' need-supportive communication skills on patients' adherence to recommendations regarding home-based rehabilitation for chronic low back pain. We also sought to examine effects on hypothesized determinants (eg, motivation) and clinical outcomes (eg, pain) of increased adherence. Finally, in response to increasing calls for a gendered approach to health research,[17-19] we explored the possibility that CONNECT may have differential effects on pain and function for male and female patients.

Hypotheses

Compared with patients in the wait-list control arm, patients in the experimental arm will show

1. greater self-rated adherence to physiotherapists' recommendations regarding home-based rehabilitation, greater increases in physical activity, and greater adherence during physiotherapy sessions;
2. greater decreases in pain, along with greater increases in function, well-being, and perceived global improvement after treatment; and
3. greater increases in perceived competence and autonomous motivation, as well as greater decreases in fear-avoidance beliefs, controlled motivation, and amotivation (ie, lack of motivation).

We did not formulate a priori hypotheses for our exploratory sex moderation analyses.

List of abbreviations:

CONNECT **Communication Style and Exercise Compliance in Physiotherapy**

Methods

Design

This study was a patient and assessor-blinded cluster randomized controlled trial (Clinical Trial Registration No.: ISRCTN63723433). A methodological description has been published previously.[20]

Participant recruitment, consent, and allocation

Centers

Managers at 13 publicly funded outpatient clinics providing general physiotherapy services in Dublin, Ireland, were invited to participate. These clinics included all 9 community care clinics and 4 of the 6 outpatient hospital clinics in the region. These 4 hospitals were purposively sampled to provide a cross section of socioeconomic levels and geographical locations. Research ethics committees responsible for each site granted approval, and the study conformed to the Declaration of Helsinki. Centers were assigned to the experimental or control arm (1:1) after their physiotherapists agreed to participate in the study. A person blinded to the purposes of the study used a computerized random number generator algorithm to assign centers.

Patients

Because randomization was by center, all participants in a given center belonged to the experimental arm or the control arm. We contacted each patient referred by a medical practitioner for physiotherapy for chronic low back pain to 1 of the 12 centers. Patients who met the inclusion criteria (table 1) and provided informed consent were invited to complete baseline assessment.

Interventions

Training for physiotherapists

In both arms, physiotherapists participated in a 1-hour refresher workshop on evidence-based physiotherapy care for chronic low back pain.[21,22] In addition, physiotherapists in the experimental arm completed 8 hours of communication skills training, details of which have been published previously.[20,23]

Treatment for patients

Patients in both trial arms received publicly funded physiotherapy care. We placed no restrictions on the number of sessions each patient could receive or the type of treatment the physiotherapist administered. As such, all patients received usual care, but in the experimental arm this care was delivered by a physiotherapist who had completed CONNECT training.

Table 1 Patient inclusion and exclusion criteria

Inclusion Criteria	
Age	18–70y
Diagnosis	Low back pain of mechanical origin with/without radiation to the lower limb
Pain duration	Chronic (≥3mo) or recurrent (≥3 episodes in the previous year)
Language	English speaking and English literate
Contact status	Access to a telephone
Exclusion Criteria	
Disease/disorder	Suspected or confirmed serious spinal condition (fracture, metastatic, inflammatory, or infective diseases of the spine, cauda equina syndrome/widespread neurological disorder)
	Nerve root compromise (2 of strength, reflex, or sensation affected for the same nerve root)
Medical history	Spinal surgery or history of systemic/inflammatory disease
Current medical status	Scheduled for major surgery during treatment
Treatment status	Currently or having received treatment for chronic low back pain within previous 3mo
Pregnancy	Suspected or confirmed pregnancy
Contraindications	Unstable angina/uncontrolled cardiac dysrhythmias/severe aortic stenosis/acute systemic infection accompanied by fever. No confounding conditions, such as a neurological disorder or an intellectual disorder

Outcomes

We conducted participant assessments at baseline, 1 week, 4 weeks, 12 weeks, and 24 weeks after each participant's first physiotherapy appointment. Patients self-reported their overall adherence to their physiotherapists' recommendations by using 7-point rating scales (eg, 1=completed none; 5=completed all).[24] They also reported the proportion of specific rehabilitation exercise they completed during the previous week (ie, sessions completed/sessions prescribed)[3] and their leisure time physical activity[25] (ie, sessions completed/sessions prescribed). Physiotherapists rated patients' in-clinic adherence by using 5-point rating scales.[26] Table 2 presents a complete list of outcomes.[3,24-35]

Statistical methods

Using SPSS version 23,[a] we analyzed participants' data according to their assigned trial arm (ie, intention-to-treat principle). We tested the baseline demographic and outcome differences across the trial arms by using multivariate analysis of variance for continuous variables and chi-square tests for categorical variables.

We tested the main study hypotheses by using linear mixed modeling with measurement occasions, patients, physiotherapists, and clinics as levels of analysis. In our main analyses, we tested differences in the rates of change in outcome variables. In sensitivity analyses, we tested differences in mean levels. The primary endpoint of the analysis was data collected at week 24, except for in-clinic adherence, which was measured only up to 12 weeks—few patients were provided treatment after this point.

In sex moderation analyses, we studied cross-level interactions to determine the interrelations between experimental arms and sex with time (control arm coded as −1, experimental arm coded as +1). Time-invariant predictors were mean centered.

Sample size calculations

The sample size of the study was calculated on the basis of an anticipated effect size of $d=.4$ for adherence.[7,36] With an estimated ICC of .03, we required 254 participants to achieve 80% power.

Intervention fidelity

A convenience subsample of 24 physiotherapists (12 in each arm) audio recorded one of their initial (week 1) treatment sessions with a participant. Blinded expert raters assessed the support provided using the Health Care Climate Questionnaire.[37] As we previously reported,[23] CONNECT had a large positive effect ($d=2.27$) on physiotherapists' support.

Deviations from the protocol

We decided to discontinue our planned use of sealed pedometers to monitor physical activity.[20] Many participants in the initial month of the trial found the monitor burdensome.

Results

Data were collected between March 31, 2011 and December 12, 2012. Figure 1 shows the participant flow through the trial. Physiotherapists at 12 clinics (4 hospitals, 8 community clinics) agreed to participate. The 6 clinic clusters in the experimental arm ranged in size from 5 to 34 participants (mean, 20.67±6.86 participants). The clinic clusters in the control arm ranged in size from 10 to 28 participants (mean, 21.83±10.51 participants). In total, 255 participants entered the study (45% recruitment rate) and 207 (81%) provided follow-up data at week 24. No adverse effects were reported.

Table 3 contains mean values for participants' characteristics, participants' baseline outcomes, and physiotherapists' characteristics. There were no differences in demographic or clinical characteristics between the 2 arms at baseline (Wilks $\Lambda=.98$; $F=.93$; $P=.43$; all χ^2 tests, $P>.05$). There were no overall differences in outcome variables between the experimental and control arms at baseline (Wilks $\Lambda=.85$; $F=.52$; $P=.94$). There were no differences in physiotherapists' age ($t=2.35$; $P=.81$), sex ($\chi^2=.51$; $P=.48$), or baseline motivational orientations (Wilks $\Lambda=.78$; $F=2.09$; $P=.07$).[38]

Fifty-three physiotherapists were recruited, and 50 delivered treatment to study participants. There was no significant difference ($t=.47$; $P=.64$) in the number of treatment sessions attended by participants in the experimental arm (mean, 3.08±1.88 sessions) and the control arm (mean, 3.20±1.45 sessions). The mean length of time between the first treatment session and the final treatment session was 7.457.96 weeks across both arms. All

Table 2 Primary and secondary outcomes

Outcome	Measure	Baseline	First session	1wk	4wk	12wk	24wk
Primary outcomes							
Home-based adherence	[24]			✓	✓	✓	✓
Clinic-based adherence	SIRAS [26]			✓	✓	✓	
Specific adherence to back exercises at home, patient report of percentage of prescribed sessions completed per week	[3]			✓	✓	✓	✓
Physical activity (total METs)	IPAQ [25]	✓		✓	✓	✓	✓
Pain intensity	NRS [27]	✓			✓	✓	✓
Pain bothersomeness	[27]	✓			✓	✓	✓
Interference with work	[27]	✓			✓	✓	✓
Satisfaction with symptoms	[27]	✓			✓	✓	✓
Perception of recovery	[28]	✓			✓	✓	✓
Pain-related function, Disability	RMDQ [29, 30]	✓			✓	✓	✓
Pain-related function	PSFS [31]	✓			✓	✓	✓
Quality of life	EurQoL[32]	✓			✓	✓	✓
Secondary outcomes							
Fear-avoidance beliefs, Physical Activity subscale	FABQ [33]	✓			✓	✓	✓
Perceived competence to follow recommendations	[34]	✓	✓		✓	✓	✓
Autonomous motivation to follow recommendations	TSRQ [35]	✓	✓		✓	✓	✓
Controlled motivation to follow recommendations	TSRQ [35]	✓	✓		✓	✓	✓
Amotivation regarding recommendations	TSRQ [35]	✓	✓		✓	✓	✓

Abbreviations: EurQoL, European Quality of Life Questionnaire; FABQ, Fear-Avoidance Beliefs Questionnaire; First session, assessment conducted immediately after the first treatment session; IPAQ, International Physical Activity Questionnaire – Short Form; MET, metabolic equivalent; NRS, numerical rating scale; PSFS, Patient-Specific Functional Scale; RMDQ, Roland-Morris Disability Questionnaire; SIRAS, Sports Injury Rehabilitation Adherence Scale; TSRQ, Treatment Self-Regulation Questionnaire.

except 19 patients had completed all their clinic-based treatment before week 12. As shown in supplemental table S1 (available online only at http://www.archives-pmr.org/), the content of advice that physiotherapists provided to patients regarding specific back exercises and advice directed at reducing fear avoidance was largely similar across arms, except physiotherapists in the experimental arm provided more advice than did those in the control arm.

Intervention effects on outcomes

Supplemental table S2 (available online only at http://www.archives-pmr.org/) contains unadjusted mean values. Table 4 presents the results of analyses related to the effects of the CONNECT intervention on outcomes.

Overall, CONNECT training for physiotherapists had a weak positive effect on patients' self-reported home-based adherence ($d=.28$; $P=.01$), with significant effects found at week 1 ($d=.32$; $P<.01$), week 4 ($d=.30$; $P<.01$), and week 12 ($d=.27$; $P=.03$). These differences were not maintained at week 24 ($d=.25$; $P=.14$), but effect sizes at week 12 and week 24 were not statistically different ($P>.05$).

The CONNECT intervention had no significant effect on physiotherapists' ratings of in-clinic adherence or on the proportion of specific back exercises that participants reported completing at home. There was also no significant effect on physical activity.

CONNECT did not have a significant effect on any of the clinical outcomes (eg, pain, function, and satisfaction with treatment) or quality of life.

CONNECT training had a moderately significant positive effect on patients' perceptions of competence to follow their physiotherapists' recommendations ($d=.66$; $P<.01$). This effect was not observed immediately after the treatment ($d=.36$; $P=.16$), but was found at week 4, week 12, and week 24 ($d=.56$ to $d=.97$; $P<.01$).

The CONNECT intervention also had a significant overall positive effect on patients' amotivation ($d=-.42$; $P=.01$). Once again, this effect was not observed immediately after the treatment ($d=-.25$; $P=.19$), but was found at week 4, week 12, and week 24 ($d=-.37$ to $d=-.59$; $P<.01$).

The effects of the CONNECT intervention on autonomous motivation were not observed, perhaps because of ceiling effects (ie, patients reported high scores at baseline on a 7-point scale; mean score, 6.64±0.58 in the experimental arm and 6.60±0.54 in the control arm). CONNECT training for physiotherapists also did not influence controlled motivation ($P=.71$) or fear-avoidance beliefs ($P=.36$). Similarly, patients' ratings of their physiotherapists' need-supportive behavior were not influenced by the CONNECT intervention, because both arms had scores that were near the scale maximum of 7 immediately after their first treatment session (mean score, 6.70±0.68 in the experimental arm and 6.55±0.77 in the control arm).

Supplemental table S3 (available online only at http://www.archives-pmr.org/) presents the results of sensitivity analyses examining the effects of the CONNECT intervention on mean levels. The results were similar to those of the analyses examining rates of change.

Sex moderation

There was a significant effect of time ($P<.01$) on all 3 pain variables (pain intensity, bothersomeness, satisfaction), indicating a decrease in pain for men and women in both arms, but no differential sex

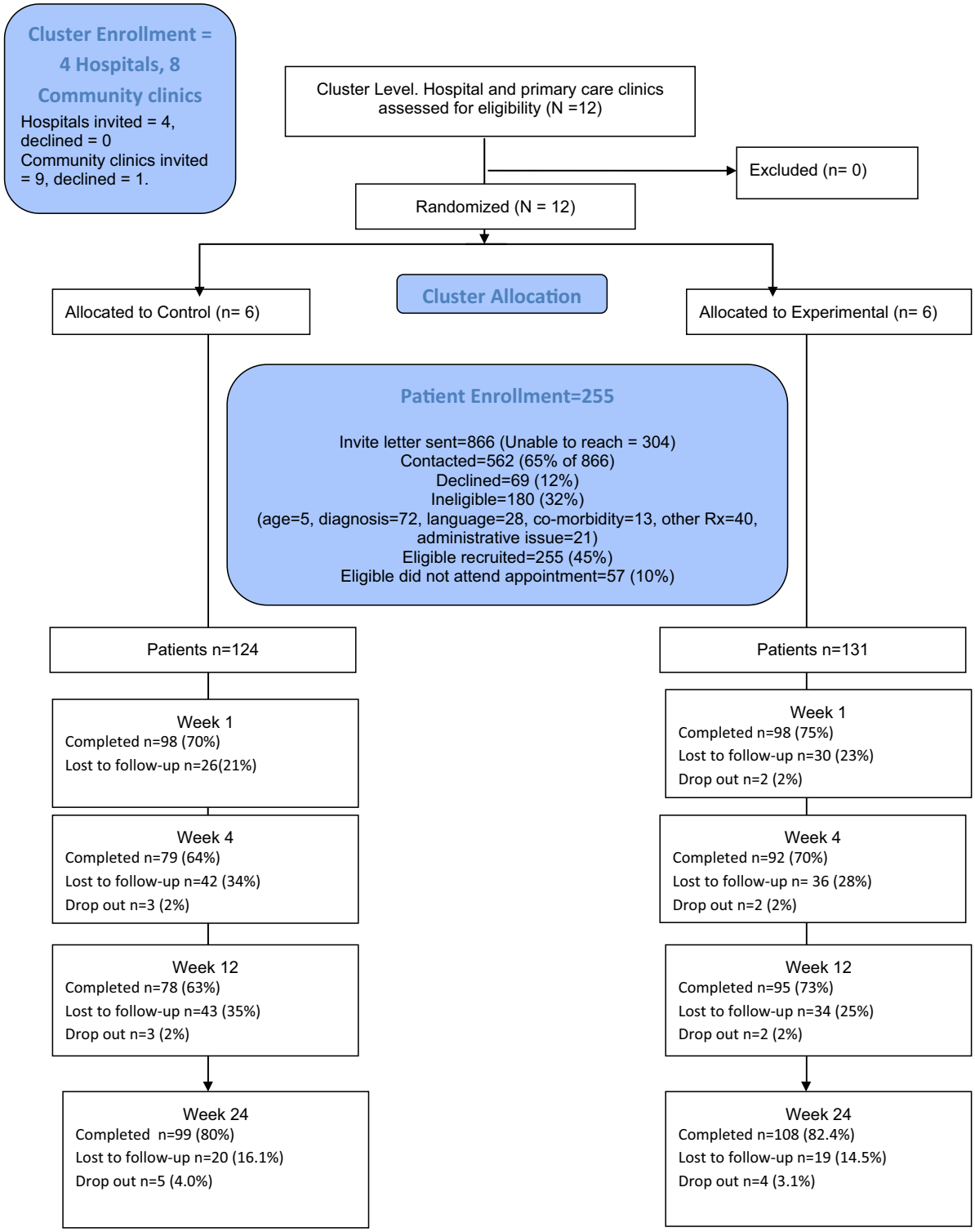

Fig 1 CONSORT 2010 flow diagram. Abbreviation: Rx, reaction.

effects. In contrast, sex moderated the effects of the CONNECT intervention on all 3 pain-related function variables: Roland-Morris Disability Questionnaire ($P<.01$), Patient-Specific Function Scale ($P<.05$), and interference with work ($P=.06$). As shown in supplemental table S4 and supplemental figures S1 to S3 (available online only at http://www.archives-pmr.org/), higher-order interactions (arm × time × sex) indicated a differential trajectory for men and women across time and between experimental arms for these 3 variables. Men, regardless of the intervention, showed improvements in pain-related function over time. In contrast, only women in the experimental arm showed improvements that were similar to those shown by men, whereas female controls showed

Table 3 Baseline characteristics

Characteristic	Control	Experimental
Participant characteristic		
Age (y)	46.71±13.48	44.11±12.96
Female sex	64/122 (52)	73/131 (56)
Irish birth	80/93 (86)	87/101 (86)
Married or partner	47/78 (60)	54/85 (64)
Weight (kg)	77.09±15.48	76.18±17.47
Height (cm)	167.52±9.52	167.73±10.19
Smoker	27/87 (31)	25/102 (25)
Sick leave for low back pain	50/91 (55)	41/97 (42)
Previous treatment	38/93 (41)	46/100 (46)
Paid employment	32/90 (36)	44/101 (44)
Participant outcome		
Physical activity (total METs)	1849.06±3525.31	2356.84±5650.21
Pain intensity	5.84±2.42	5.53±1.94
Pain bothersomeness	3.31±1.15	3.28±0.99
Interference	3.05±1.14	3.14±1.15
Satisfaction with symptoms	1.45±0.77	1.63±0.95
Perception of recovery	−0.72±2.17	−0.27±2.20
Pain-related function (Roland-Morris Disability Questionnaire)	12.44±4.70	11.51±4.82
Pain-related function (Patient-Specific Function Scale)	3.85±2.02	4.03±2.01
Quality of life	0.51±0.22	0.57±0.20
Fear-avoidance beliefs	16.95±6.96	17.39±7.85
Perceived competence to follow recommendations	6.67±0.57	6.46±0.77
Autonomous motivation to follow recommendations	6.64±.54	6.60±0.58
Controlled motivation to follow recommendations	2.75±1.29	2.94±1.45
Amotivation	2.21±0.98	2.27±1.15
Depression	9.07±8.28	7.32±8.48
Physiotherapist characteristic		
Female sex	23/29 (79.31)	17/24 (70.83)
Age (y)	32.24±5.26	31.92±4.70
Clinical experience (y)	9.90±5.16	9.75±4.33
Autonomous orientation	100.10±6.77	94.05±8.01
Controlling orientation	57.21±15.28	58.61±10.71
Impersonal orientation	46.62±9.03	50.65±12.03

NOTE. Values are group mean ± SD or n/N (%). Physiotherapists' motivational orientation personality styles were measured using the General Causality Orientations Scale.[38]
Abbreviation: MET, metabolic equivalent.

little change in function over time. There was no significant arm × time × sex interaction for any of the hypothesized mediators ($P>.05$).

Discussion

The trial provided mixed support for our hypotheses. When considering overall self-rated adherence to their physiotherapists' recommendations, patient adherence showed a general decrease over time, but communication skills training designed to increase support for patients appeared to slow this rate of decline. This generally positive conclusion should be tempered by the nonsignificant intervention effects on adherence to specific exercises and levels of physical activity. Thus, it appears that CONNECT had a positive effect on home-based adherence, but it is not clear which specific aspects of the physiotherapists' advice patients followed.

Previous interventions have sought to increase adherence to home-based rehabilitation for musculoskeletal conditions by adding components to usual care treatment (eg, motivational counseling in addition to exercise prescription[39]). In contrast, the CONNECT intervention was designed to change the way treatment is provided, rather than add extra interventions. Helping physiotherapists to learn skills that will improve their patients' adherence is a model that might be scaled up more readily than models requiring additional personnel.

Future research is required to determine methods that can enhance the effect of CONNECT on adherence. Indeed, training had a large positive effect on physiotherapists' communication skills,[23] but independent observers still rated the support of physiotherapists in the experimental group well below the ideal (mean rating of 4.57 on a 7-point scale). Efforts to enhance the effect of CONNECT training could include individualized audit, and feedback techniques are effective in promoting higher quality clinical practice.[40] We recently implemented this type of training for physiotherapists who had completed CONNECT training and found that it was a feasible addition.[41] Research is required to determine the effect of this extra training on their patient adherence. Additional implementation strategies could include more extended continuing professional development provided via an online platform,[42] implementation and self-reflection prompts from a mobile phone,[43] and continued support from mentors.[44,45]

Contrary to our hypotheses, intervention effects on clinical outcomes were not significant. Sex, however, appeared to moderate the effect of the CONNECT intervention on function, but not pain. Overall, men improved their function regardless of whether their physiotherapist had completed the CONNECT training. In contrast, only women in the experimental condition showed improvements that were similar to those shown by men, whereas female controls showed little change in function over time. At week 24, women in the experimental arm had scores that were 4.94 points lower than those of controls on the Roland-Morris Disability Questionnaire and 1.43 points higher than those of controls on the Patient-Specific Function Scale. These effects exceed the minimum clinically important difference of 3.5 for the Roland-Morris Disability Questionnaire[46] and 1.3 for the Patient-Specific Function Scale,[47] suggesting a meaningful effect of CONNECT training on function, but only for women. These findings raise a number of questions, including why do women appear to require physiotherapy delivered using supportive communication but men do not? None of the proposed mechanisms (eg, fear-avoidance differences) showed a significant arm × time × sex interaction and, therefore, do not explain differences in function between men and women in our sample. It is also unknown why sex differences appeared for function but not for pain.

In line with our hypotheses, CONNECT training had a moderate positive effect on selected motivational variables, including

Table 4 Effects of the CONNECT intervention: between-arm differences in outcome variables over time

	Effects of Intervention											
	Clinic Cluster Adjusted				Therapist Cluster Adjusted				Not Cluster Adjusted			
Outcome	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	*d*	
Adherence outcomes												
Home-based adherence												
Week 1	0.46 (0.15 to 0.77)	.00		.32	0.50 (0.17 to 0.82)	.00		.35	0.46 (0.16 to 0.77)	.00	.32	
Week 4	0.43 (0.14 to 0.71)	.00		.30	0.46 (0.16 to 0.76)	.00		.32	0.43 (0.15 to 0.71)	.00	.30	
Week 12	0.39 (0.04 to 0.74)	.03		.27	0.43 (0.06 to 0.81)	.02		.30	0.39 (0.04 to 0.74)	.03	.27	
Week 24	0.35 (−0.13 to 0.83)	.15		.24	0.40 (−0.11 to 0.91)	.12		.28	0.36 (−0.12 to 0.83)	.14	.25	
Overall	0.41 (0.10 to 0.71)	.01	<.01	.28	0.45 (0.12 to 0.78)	.01	<.01	.31	0.41 (0.10 to 0.72)	.01	.28	
Clinic-based adherence												
Week 1	0.10 (−0.14 to 0.34)	.43		.15	0.09 (−0.16 to 0.33)	.48		.13	0.09 (−0.16 to 0.33)	.48	.13	
Week 4	0.09 (−0.13 to 0.31)	.44		.13	0.08 (−0.14 to 0.30)	.48		.12	0.08 (−0.14 to 0.30)	.48	.12	
Week 12	0.07 (−0.19 to 0.34)	.58		.10	0.07 (−0.19 to 0.34)	.58		.10	0.07 (−0.19 to 0.34)	.58	.10	
Overall	0.09 (−0.13 to 0.31)	.44	.08	.13	0.08 (−0.14 to 0.30)	.48	.10	.12	0.08 (−0.14 to 0.30)	.48	.12	
Specific adherence to back exercises at home												
Week 1	4.44 (−1.72 to 10.60)	.16		.03	4.71 (−1.39 to 10.81)	.13		.04	4.47 (−1.70 to 10.64)	.16	.03	
Week 4	3.82 (−1.02 to 8.66)	.12		.04	4.54 (−0.58 to 9.66)	.08		.05	3.90 (−0.95 to 8.76)	.11	.04	
Week 12	3.20 (−2.77 to 9.16)	.29		.05	4.37 (−2.09 to 10.84)	.18		.07	3.34 (−2.64 to 9.32)	.28	.05	
Week 24	2.57 (−6.05 to 11.19)	.56		.06	4.20 (−4.96 to 13.36)	.37		.08	2.77 (−5.87 to 11.42)	.53	.06	
Overall	3.51 (−1.61 to 8.62)	.18	<.01	.05	4.46 (−1.09 to 10.00)	.11	<.01	.06	3.62 (−1.51 to 8.75)	.17	.05	
Physical activity (METs/total)												
Week 1	−711.67 (−2135.22 to 711.88)	.33		−.20	−680.43 (−2187.02 to 826.16)	.37		−.19	−735.22 (−2166.30 to 695.85)	.31	−.21	
Week 4	−709.64 (−2016.55 to 597.28)	.29		−.20	−687.88 (−2070.55 to 694.79)	.33		−.20	−729.57 (−2043.57 to 584.42)	.28	−.21	
Week 12	−707.60 (−1967.17 to 551.98)	.27		−.20	−695.33 (−2029.48 to 638.81)	.31		−.20	−723.93 (−1989.77 to 541.91)	.26	−.21	
Week 24	−705.56 (−1994.75 to 583.63)	.28		−.20	−702.79 (−2071.85 to 666.27)	.31		−.20	−718.28 (−2012.61 to 576.05)	.28	−.20	
Overall	−708.62 (−1982.45 to 565.22)	.28	.02	−.20	−691.61 (−2039.79 to 656.57)	.31	<.01	−.20	−726.75 (−2007.31 to 553.80)	.27	−.21	
Pain, function, and quality of life												
Pain intensity												
Week 4	−0.38 (−1.16 to 0.40)	.34		−.16	−0.31 (−1.14 to −0.65)	.46		−.13	−0.38 (−1.16 to 0.40)	.34	−.16	
Week 12	−0.10 (−0.71 to 0.51)	.75		−.04	−0.01 (−0.65 to 0.64)	.98		.00	−0.10 (−0.71 to 0.51)	.75	−.04	
Week 24	0.18 (−0.48 to 0.83)	.60		.07	0.30 (−0.38 to 0.98)	.38		.13	0.18 (−0.48 to 0.83)	.60	.07	
Overall	−0.10 (−0.71 to 0.51)	.75	.03	−.04	−0.01 (−0.65 to 0.64)	.98	<.01	.00	−0.10 (−0.71 to 0.51)	.75	−.04	
Pain bothersomeness												
Week 4	−0.09 (−0.48 to 0.30)	.64		−.08	−0.20 (−0.61 to 0.21)	.35		−.17	−0.11 (−0.50 to 0.28)	.58	−.10	
Week 12	−0.07 (−0.40 to 0.24)	.65		−.06	−0.16 (−0.50 to 0.19)	.37		−.14	−0.09 (−0.42 to 0.23)	.58	−.08	
Week 24	−0.05 (−0.39 to 0.29)	.76		−.05	−0.11 (−0.47 to 0.25)	.54		−.10	−0.07 (−0.41 to 0.27)	.68	−.06	
Overall	−0.07 (−0.40 to 0.25)	.65	.01	−.06	−0.16 (−0.50 to 0.19)	.37	.01	−.14	−0.09 (−0.42 to 0.23)	.58	−.08	
Interference with work												
Week 4	−0.43 (−0.83 to −0.04)	.03		−.38	−0.45 (−0.87 to −0.04)	.03		−.40	−0.43 (−0.83 to −0.04)	.03	−.38	

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Table 4 (*continued*)

Outcome	Effects of Intervention										
	Clinic Cluster Adjusted				Therapist Cluster Adjusted				Not Cluster Adjusted		
	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	*d*
Week 12	−0.31 (−0.65 to 0.02)	.07		−.28	−0.28 (−0.63 to 0.07)	.12		−.25	−0.31 (−0.65 to 0.02)	.07	−.28
Week 24	−0.19 (−0.56 to 0.18)	.30		−.17	−0.11 (−0.49 to 0.27)	.58		−.10	−0.19 (−0.56 to 0.18)	.30	−.17
Overall	−0.31 (−0.65 to 0.02)	.07	.01	−.28	−0.28 (−0.63 to 0.07)	.12	.02	−.25	−0.31 (−0.65 to 0.02)	.07	−.28
Satisfaction with current symptoms											
Week 4	−0.18 (−0.62 to 0.26)	.41		−.56	−0.07 (−0.53 to 0.39)	.76		−.09	−0.17 (−0.61 to 0.27)	.46	−.22
Week 12	−0.12 (−0.44 to 0.20)	.48		−.41	−0.05 (−0.38 to 0.29)	.79		−.06	−0.10 (−0.42 to 0.22)	.55	−.13
Week 24	−0.05 (−0.38 to 0.28)	.77		−.25	−0.02 (−0.37 to 0.33)	.91		−.03	−0.03 (−0.37 to 0.31)	.87	−.04
Overall	−0.12 (−0.44 to 0.20)	.48	<.01	−.41	−0.05 (−0.38 to 0.29)	.79	.01	−.06	−0.10 (−0.42 to 0.22)	.55	−.13
Treatment satisfaction											
Week 4	0.10 (−0.18 to 0.39)	.47		−.22	0.18 (−0.13 to 0.49)	.25		.22	0.10 (−0.20 to 0.41)	.51	.12
Week 12	0.05 (−0.15 to 0.26)	.62		−.14	0.13 (−0.10 to 0.36)	.26		.15	0.05 (−0.17 to 0.28)	.65	.06
Week 24	0.00 (−0.24 to 0.24)	1.00		−.06	0.08 (−0.18 to 0.33)	.55		.09	0.00 (−0.25 to 0.25)	1.00	.00
Overall	0.05 (−0.15 to 0.26)	.62	.002	−.14	0.13 (−0.10 to 0.36)	.26	.01	.15	0.05 (−0.17 to 0.28)	.65	.06
Perception of recovery											
Week 4	0.58 (−0.03 to 1.20)	.06		.27	0.50 (−0.14 to 1.13)	.13		.23	0.60 (−0.02 to 1.21)	.06	.27
Week 12	0.51 (−0.01 to 1.02)	.05		.23	0.44 (−0.10 to 0.98)	.11		.20	0.52 (0.01 to 1.04)	.05	.24
Week 24	0.44 (−0.19 to 1.07)	.17		.20	0.38 (−0.27 to 1.03)	.25		.17	0.45 (−0.18 to 1.08)	.16	.21
Overall	0.51 (−0.01 to 1.02)	.05	.03	.23	0.44 (−0.10 to 0.98)	.11	.03	.20	0.52 (0.01 to 1.04)	.05	.24
Pain-related function, Roland-Morris Disability Questionnaire											
Week 4	−0.80 (−1.38 to 0.77)	.32		−.17	−0.82 (−2.48 to 0.85)	.34		−.17	−0.94 (−2.53 to 0.65)	.25	−.20
Week 12	−0.36 (−1.68 to 0.96)	.60		−.08	−0.50 (−1.90 to 0.90)	.48		−.11	−0.49 (−1.83 to 0.85)	.47	−.11
Week 24	0.09 (−1.43 to 1.60)	.91		.02	−0.19 (−1.78 to 1.41)	.82		−.04	−0.05 (−1.58 to 1.49)	.95	−.01
Overall	−0.36 (−1.68 to 0.96)	.60	.01	−.08	−0.50 (−1.90 to 0.90)	.48	.02	−.11	−0.49 (−1.83 to 0.85)	.47	−.11
Pain-related function, Patient-Specific Function Scale											
Week 4	0.33 (−0.28 to 0.93)	.29		.16	0.44 (−0.21 to 1.08)	.18		.22	0.40 (−0.22 to 1.01)	.21	.20
Week 12	0.38 (−0.20 to 0.95)	.20		.19	0.44 (−0.18 to 1.06)	.16		.22	0.45 (−0.14 to 1.04)	.14	.22
Week 24	0.43 (−0.34 to 1.20)	.27		.21	0.44 (−0.37 to 1.25)	.28		.22	0.50 (−0.28 to 1.28)	.21	.25
Overall	0.38 (−0.20 to 0.95)	.20	.07	.19	0.44 (−0.18 to 1.06)	.16	.16	.22	0.45 (−0.14 to 1.04)	.14	.22
Quality of life											
Week 4	−0.05 (−0.12 to 0.01)	.09		−.25	−0.06 (−0.13 to 0.01)	.08		−.27	−0.05 (−0.12 to 0.01)	.12	−.25
Week 12	−0.04 (−0.10 to 0.01)	.13		−.19	−0.04 (−0.10 to 0.02)	.19		−.17	−0.04 (−0.10 to 0.01)	.13	−.19
Week 24	−0.03 (−0.09 to 0.03)	.35		−.14	−0.02 (−0.08 to 0.05)	.65		−.07	−0.03 (−0.09 to 0.03)	.32	−.14
Overall	−0.04 (−0.10 to 0.01)	.13	<.01	−.19	−0.04 (−0.10 to 0.02)	.19	<.01	−.17	−0.04 (−0.10 to 1.52)	.13	−.19

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Table 4 (*continued*)

Outcome	Effects of Intervention										
	Clinic Cluster Adjusted				Therapist Cluster Adjusted				Not Cluster Adjusted		
	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	*d*
Motivational outcomes											
Fear avoidance											
Week 4	−0.99 (−3.40 to 1.42)	.42		−.14	−0.86 (−3.31 to 1.60)	.50		−.12	−1.09 (−3.50 to 1.32)	.38	−.16
Week 12	−0.90 (−3.07 to 1.28)	.42		−.13	−0.77 (−3.04 to 1.50)	.51		−.11	−1.01 (−3.20 to 1.17)	.36	−.15
Week 24	−0.81 (−3.73 to 2.12)	.59		−.12	−0.68 (−3.82 to 2.46)	.67		−.10	−.94 (−3.87 to 2.00)	.53	−.13
Overall	−0.90 (−3.07 to 1.28)	.42	<.01	−.13	−0.77 (−3.04 to 1.50)	.51	.01	−.11	−1.01 (−3.20 to 1.17)	.36	−.15
Perceived competence to follow recommendations											
Immediately after the initial treatment	0.21 (−0.08 to 0.50)	.15		.37	0.27 (−0.04 to 0.57)	.08		.47	0.21 (−0.08 to 0.49)	.16	.36
Week 4	0.33 (0.09 to 0.56)	.01		.57	0.38 (0.13 to 0.64)	.00		.67	0.32 (0.09 to 0.56)	.01	.56
Week 12	0.44 (0.19 to 0.69)	.00		.78	0.50 (0.23 to 0.77)	.00		.87	0.44 (0.19 to 0.69)	.00	.77
Week 24	0.56 (0.24 to 0.88)	.00		.99	0.61 (0.28 to 0.95)	.00		1.08	0.55 (0.23 to 0.87)	.00	.97
Overall	0.39 (0.15 to 0.62)	.00	<.01	.68	0.44 (0.19 to 0.69)	.00	<.01	.77	0.38 (0.14 to 0.61)	.00	.66
Autonomous motivation to follow recommendations											
Immediately after the initial treatment	0.18 (−0.04 to 0.41)	.11		.34	0.21 (−0.02 to 0.45)	.08		.39	0.19 (−0.04 to 0.42)	.10	.35
Week 4	0.09 (−0.08 to 0.26)	.28		.17	0.12 (−0.06 to 0.30)	.18		.22	0.10 (−0.07 to 0.27)	.26	.18
Week 12	0.00 (−0.13 to 0.14)	.96		.01	0.03 (−0.11 to 0.17)	.67		.06	0.01 (−0.13 to 0.14)	.93	.01
Week 24	−0.09 (−0.23 to 0.05)	.23		−.16	−0.06 (−0.21 to 0.09)	.44		−.11	−0.08 (−0.23 to 0.06)	.24	−.16
Overall	0.05 (−0.10 to 0.20)	.53	<.01	.09	0.08 (−0.08 to 0.23)	.34	<.01	.14	0.05 (−0.10 to 0.20)	.50	.10
Controlled motivation to follow recommendations											
Immediately after the initial treatment	−0.10 (−0.41 to 0.21)	.53		−.08	−0.19 (−0.51 to 0.13)	.24		−.15	−0.10 (−0.41 to 0.21)	.52	−.08
Week 4	−0.08 (−0.38 to 0.22)	.61		−.06	−0.14 (−0.46 to 0.18)	.40		−.11	−0.08 (−0.39 to 0.22)	.60	−.06
Week 12	−0.06 (−0.43 to 0.31)	.76		−.05	−0.08 (−0.47 to 0.31)	.68		−.06	−0.06 (−0.44 to 0.31)	.73	−.05
Week 24	−0.04 (−0.52 to 0.45)	.88		−.03	−0.03 (−0.54 to 0.48)	.92		−.02	−0.05 (−0.53 to 0.44)	.85	−.04
Overall	−0.07 (−0.40 to 0.26)	.68	<.01	−.05	−0.11 (−0.46 to 0.24)	.54	<.01	−.08	−0.07 (−0.40 to 0.26)	.67	−.06
Amotivation											
Immediately after the initial treatment	−0.25 (−0.62 to 0.12)	.19		−.25	−0.23 (−0.62 to 0.16)	.25		−.23	−0.25 (−0.62 to 0.12)	.19	−.25
Week 4	−0.36 (−0.67 to −0.05)	.02		−.37	−0.34 (−0.66 to −0.01)	.04		−.34	−0.36 (−0.67 to −0.05)	.02	−.37
Week 12	−0.47 (−0.81 to −0.12)	.01		−.48	−0.44 (−0.80 to −0.09)	.02		−.45	−0.47 (−0.81 to −0.12)	.01	−.48
Week 24	−0.58 (−1.02 to −0.13)	.01		−.59	−0.55 (−1.02 to −1.02)	.02		−.56	−0.58 (−1.02 to −0.13)	.01	−.59
Overall	−0.41 (−0.73 to −0.10)	.01	<.01	−.42	−0.39 (−0.72 to −0.06)	.02	.01	−.40	−0.41 (−0.73 to −0.10)	.01	−.42

NOTE. A positive value indicates that the experimental arm was higher on the outcome variable than was the control arm. Standardized mean difference effect sizes (*d*) were calculated using baseline SD of participants in the control arm. Where baseline measures were not relevant (eg, adherence variables), the control arm's SD at each time point was used to calculate *d*.

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient; MET, metabolic equivalent.

an increase in patients' perceived competence to follow their physiotherapists' advice ($d = .66$) and a decrease in their levels of amotivation ($d = -.42$). Previous studies[11] have shown that this type of training has positive motivational effects for people enrolled in interventions designed to promote weight loss, physical activity, smoking cessation, and oral hygiene. Our study suggests that these motivational benefits can also be achieved in populations with chronic musculoskeletal conditions.

Future research

CONNECT appeared to provide patients with a motivational basis that is likely necessary, but not sufficient for long-term adherence. Interventions could also directly target patients' ability to regulate the behaviors for which communication skills training has provided a motivational foundation.[5] These methods could include more extensive prompting (eg, text messages) and self-monitoring strategies than were included in the CONNECT intervention.[48] Interventions could also target social agents other than physiotherapists (eg, family members) who influence patients' motivation and adherence toward home-based rehabilitation.[49] Finally, complex interventions that target patient motivation could be combined with those targeting patients' perceptions of and reactions to pain (eg, cognitive behavioral therapy[50] and mindfulness-based stress reduction[51]). Changing patients' thoughts about pain and supporting their psychological needs may have synergistic effects on their adherence to home-based rehabilitation.

Study limitations

There is limited evidence regarding the clinimetric properties of adherence measures related to musculoskeletal pain rehabilitation.[52] There is no reason to believe that scores in this trial were biased in favor of patients in one arm over another, but future research is required to ensure that adherence measures are based on a clear conceptual framework (eg, what defines adherence?) and supported by strong validity evidence.[53]

Additional limitations include the relatively small sample size, which was powered to detect moderate-sized effects. We observed small effects in relation to some clinical outcomes, suggesting that CONNECT could be a useful component of complex interventions designed to improve clinical outcomes, but without a larger sample this suggestion is speculative.

Finally, our trial included multiple primary outcomes (ie, adherence, pain, pain-related function, and quality of life) and, in keeping with the recommendations of Schulz and Grimes,[54] we did not make a statistical correction for this multiplicity. However, it could be argued that restricting our primary outcomes to measures of adherence, and specifying other outcomes as secondary, would have facilitated interpretation of our results.

Conclusions

CONNECT communication skills training for physiotherapists had a moderate effect on psychological mediators of behavior change and a small effect on patients' adherence to home-based rehabilitation. This form of continuing professional development seems to provide a motivational basis for behavior change and may be a useful component in complex interventions to promote adherence. Finally, this form of communication skills training for health care practitioners may improve some clinical outcomes for women, but not for men.

Supplier

a. SPSS version 23; IBM Corp.

Keywords

Competence; Compliance; Motivation; Rehabilitation; Self care

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Supplemental Table S1 Proportion of patients in each arm who received advice from their physiotherapists

Advice Provided	Experimental	Control
Remain active rather than resting	93%	91%
Posture	90%	84%
General exercise	92%	93%
Restoring functionally relevant activities into daily life	68%	63%
Specific rehabilitation exercises	90%*	75%
Decreasing fear avoidance and illness behavior	69%*	51%

* Between-arm difference in χ^2 ($P>.05$).

Supplemental Table S2 Mean values for outcomes

Outcome	Control	Experimental
Adherence outcomes		
Home-based adherence, ARS	Mean score ± SD	Mean score ± SD
Week 1	5.61±1.44	6.09±1.02
Week 4	5.85±1.27	6.03±1.13
Week 12	5.10±1.79	5.59±1.29
Week 24	4.86±1.92	4.95±1.98
Clinic-based adherence, SIRAS	Mean score ± SD	Mean score ± SD
Week 1	4.30±0.68	4.49±0.58
Week 4	4.50±0.61	4.50±0.70
Week 12	4.49±0.60	4.65±0.67
Week 24	NA	NA
Specific adherence to back exercises, HECA	Mean score ± SD	Mean score ± SD
Week 1	80.20±22.15	84.63±21.44
Week 4	78.30±27.46	82.63±21.08
Week 12	71.40±24.10	78.42±27.10
Week 24	71.27±26.32	70.31±30.03
Physical activity (METs/wk), IPAQ	Change score ± SD	Change score ± SD
Week 1	−554.89±−554.89	−811.17±5936.86
Week 4	330.87±4634.43	−682.03±7251.97
Week 12	1156.63±4992.22	−871.39±6659.47
Week 24	−221.11±3171.80	−917.82±7313.01
Clinical outcomes and quality of life		
Pain intensity	Change score ± SD	Change score ± SD
Week 4	−0.88±2.26	−0.78±2.37
Week 12	−1.31±2.36	−1.53±2.71
Week 24	−1.18±3.19	−1.53±2.78
Pain bothersomeness	Change score ± SD	Change score ± SD
Week 4	−0.18±1.21	−0.37±1.22
Week 12	−0.43±1.49	−0.57±1.28
Week 24	−0.66±1.54	−8.80±1.45
Pain interference	Change score ± SD	Change score ± SD
Week 4	−0.25±1.26	−0.42±1.35
Week 12	−0.47±1.41	−0.75±1.29
Week 24	−0.45±1.54	−0.86±1.46
Satisfaction with current symptoms	Change score ± SD	Change score ± SD
Week 4	0.47±1.14	0.54±1.17
Week 12	1.13±1.60	0.93±1.53
Week 24	1.26±1.56	1.19±1.68
Treatment satisfaction	Mean score ± SD	Mean score ± SD
Week 4	4.47±0.84	4.51±0.80
Week 12	4.33±1.01	4.52±0.92
Week 24	4.40±1.08	4.21±1.22
Perception of recovery	Mean score ± SD	Mean score ± SD
Week 4	1.50±2.78	1.69±2.58
Week 12	2.30±2.71	2.46±2.60
Week 24	2.58±3.07	2.46±2.63

(*continued on next page*)

Supplemental Table S2 (*continued*)

Outcome	Control	Experimental
Pain-related function, Disability, RMDQ	Change score ± SD	Change score ± SD
Week 4	−2.11±4.90	−2.23±5.82
Week 12	−2.82±5.77	−3.48±5.72
Week 24	−4.09±5.95	−4.87±5.86
Pain-related function, PSFS	Change score ± SD	Change score ± SD
Week 4	0.81±2.02	1.25±2.21
Week 12	1.44±2.32	2.00±2.47
Week 24	1.76±2.74	2.39±2.99
Quality of life, EurQoL weighted health index	Change score ± SD	Change score ± SD
Week 4	0.24±0.29	0.18±0.28
Week 12	0.25±0.28	0.21±0.27
Week 24	0.24±0.27	0.21±0.24
Motivational outcomes		
Fear avoidance	Change score ± SD	Change score ± SD
Week 4	−1.72±7.82	−3.29±7.70
Week 12	−2.21±9.47	−4.00±8.79
Week 24	−4.41±9.88	−4.63±9.93
Perceived competence to follow recommendations	Change score ± SD	Change score ± SD
Immediately after the initial treatment	0.11±0.59	0.33±0.74
Week 4	−0.37±0.86	−0.08±0.93
Week 12	−0.57±1.43	−0.07±1.11
Week 24	−0.92±1.51	−0.50±1.52
Autonomous motivation to follow recommendations	Change score ± SD	Change score ± SD
Immediately after the initial treatment	0.22±0.51	0.15±0.50
Week 4	−0.21±0.80	−0.05±.59
Week 12	−0.17±0.92	−0.06±0.68
Week 24	0.00±0.76	−0.15±0.68
Controlled motivation to follow recommendations	Change score ± SD	Change score ± SD
Immediately after the initial treatment	−0.11±1.02	−0.21±1.13
Week 4	−0.16±1.35	−0.14±1.55
Week 12	−0.34±1.37	−0.31±1.27
Week 24	−0.51±1.42	−0.58±1.43
Amotivation	Change score ± SD	Change score ± SD
Immediately after the initial treatment	0.19±0.92	−0.09±0.93
Week 4	0.35±1.59	0.04±1.63
Week 12	0.41±1.61	−0.20±1.45
Week 24	0.62±1.19	0.14±1.69

(*continued on next column*)

NOTE. NA denotes not applicable, because no participants were receiving physiotherapy treatment at 24wk. Where baseline measures were not relevant (eg, adherence variables), mean scores, rather than change scores, are presented.

Abbreviations: ARS, Adherence to Recommendations Scale; EurQoL, European Quality of Life Questionnaire; HECA, Home Exercise Compliance Assessment; IPAQ, International Physical Activity Questionnaire — Short Form; MET, metabolic equivalent; PSFS, Patient-Specific Function Scale; RMDQ, Roland-Morris Disability Questionnaire; SIRAS, Sports Injury Rehabilitation Adherence Scale.

Supplemental Table S3 Effects of the CONNECT intervention on mean levels of outcomes: results from linear mixed models examining mean levels

	Effects of Treatment										
	Site Cluster Adjusted				Therapist Cluster Adjusted				Not Cluster Adjusted		
Outcome	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	*d*
Adherence outcomes											
Home-based adherence											
Week 1	0.46 (0.02 to 0.90)	.04		0.32	0.47 (−0.01 to 0.94)	.04		.33	0.46 (0.02 to 0.90)	−.32	0.32
Week 4	0.28 (−0.19 to 0.76)	.24		0.19	0.38 (−0.12 to 0.89)	.24		.26	0.28 (−0.19 to 0.75)	−.19	0.22
Week 12	0.59 (−0.13 to 1.06)	.01		0.41	0.62 (0.13 to 1.11)	.01		.43	0.59 (0.13 to 1.06)	−.41	0.33
Week 24	0.17 (−0.26 to 0.60)	.44		0.12	0.18 (−0.27 to 0.64)	.45		.13	0.17 (−0.26 to 0.60)	−.12	0.09
Overall	0.38 (0.07 to 0.69)	.03	<.001	0.26	0.41 (0.08 to 0.75)	.03	<.01	.28	0.38 (0.07 to 0.69)	.26	0.23
Clinic-based adherence											
Week 1	0.14 (−0.42 to 0.70)	.58		0.21	0.04 (−0.28 to 0.37)	.79		.06	0.14 (−0.12 to 0.40)	.29	0.21
Week 4	−0.03 (−0.59 to 0.54)	.91		−0.04	−0.12 (−0.46 to 0.22)	.48		−.18	−0.03 (−0.31 to 0.25)	.83	−0.04
Week 12	0.14 (−0.44 to 0.72)	.61		0.21	0.06 (−0.31 to 0.42)	.76		.09	0.16 (−0.14 to 0.46)	.28	0.24
Overall	0.09 (−0.47 to 0.64)	.73	.08	0.13	0.01 (−0.30 to 0.32)	.96	.10	.01	0.09 (−0.32 to 0.14)	.44	0.13
Specific adherence to back exercises											
Week 1	4.45 (−3.74 to 12.63)	.27		0.07	3.94 (−4.25 to 12.13)	.34		.06	4.20 (−2.65 to 11.04)	.23	0.06
Week 4	2.93 (−6.08 to 11.94)	.51		0.04	4.55 (−3.90 to 12.99)	.29		.07	2.90 (−4.93 to 10.74)	.47	0.04
Week 12	7.26 (−3.07 to 17.60)	.16		0.11	7.80 (−1.53 to 17.12)	.10		.12	7.19 (−2.24 to 16.61)	.13	0.11
Week 24	0.38 (−10.90 to 11.67)	.95		0.01	0.77 (−8.77 to 10.31)	.87		.01	0.25 (−10.13 to 10.64)	.96	0.00
Overall	3.76 (−3.46. 10.97)	.28	<.001	0.06	4.26 (−1.35 to 9.88)	.13	<.01	.07	3.63 (−1.55 to 8.82)	.17	0.06
Physical activity (METs/total)											
Week 1	−1282.37 (−5005.31 to 2440.56)	.40		−0.36	−498.27 (−2207.44 to 1210.90)	.56		−.14	−541.04 (−2021.61 to 939.53)	.47	−0.15
Week 4	−1977.20 (−5659.39 to −1704.99)	.22		−0.56	−1143.23 (−2988.43 to 701.96)	.22		−.32	−1240.26 (−2894.15 to 413.63)	.14	−0.35
Week 12	−1375.84 (−5071.38 to 2319.70)	.37		−0.39	−749.03 (−2559.00 to 1060.94)	.41		−.21	−653.06 (−2232.77 to 926.65)	.42	−0.19
Week 24	−1346.10 (−5130.70 to 2438.49)	.37		−0.38	−600.37 (−2184.05 to 983.30)	.45		−.17	−621.62 (−1964.93 to 721.70)	.36	−0.18
Overall	−1495.38 (−5305.88 to 2315.12)	.33	.02	−0.42	−747.73 (−2282.62 to 787.16)	.33	.004	−.21	−764 (−2057.92 to 529.93)	.25	−0.22
Pain, function, and quality of life											
Pain intensity											
Week 4	−0.37 (−1.28 to 0.53)	.40		−0.15	−0.35 (−1.37 to 0.68)	.50		−.14	−0.36 (−1.16 to 0.45)	.39	−0.15
Week 12	−0.17 (−1.05 to 0.71)	.69		−0.07	−0.19 (−1.15 to 0.78)	.70		−.08	−0.15 (−0.92 to 0.62)	.70	−0.06
Week 24	0.17 (−0.65 to 0.98)	.67		0.07	0.27 (−0.62 to 1.16)	.54		.11	0.19 (−0.49 to 0.86)	.59	0.08
Overall	−0.13 (−0.91 to 0.66)	.73	.03	−0.05	−0.09 (−0.95 to 0.77)	.84	.002	−.04	−0.11 (−0.72 to 0.51)	.74	−0.05
Pain bothersomeness											
Week 4	−0.13 (−0.68 to 0.42)	.62		−0.11	−0.17 (−0.63 to 0.29)	.46		−.15	−0.13 (−0.53 to 0.27)	.53	−0.11
Week 12	−0.04 (−0.59 to 0.51)	.87		−0.03	−0.10 (−0.56 to 0.35)	.66		−.09	−0.03 (−0.44 to 0.38)	.87	−0.03
Week 24	−0.08 (−0.61 to 0.45)	.73		−0.07	−0.08 (−0.49 to 0.33)	.69		−.07	−0.09 (−0.44 to 0.26)	.62	−0.08
Overall	−0.08 (−0.60 to 0.43)	.72	.01	−0.07	−0.12 (−0.51 to 0.27)	.55	.01	−.10	−0.08 (−0.41 to 0.25)	.62	−0.07

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Supplemental Table S3 (*continued*)

	Effects of Treatment										
	Site Cluster Adjusted				Therapist Cluster Adjusted				Not Cluster Adjusted		
Outcome	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	*d*
Interference											
Week 4	−0.35 (−0.99 to 0.29)	.26		−0.31	−0.36 (−0.88 to 0.17)	.18		−.32	−0.42 (−0.82 to −0.01)	.05	−0.37
Week 12	−0.29 (−0.93 to 0.35)	.35		−0.25	−0.24 (−0.74 to 0.26)	.34		−.21	−0.35 (−0.75 to 0.06)	.09	−0.31
Week 24	−0.11 (−0.74 to 0.51)	.70		−0.10	−0.00 (−0.49 to 0.48)	.99		−.00	−0.18 (−0.56 to 0.20)	.34	−0.16
Overall	−0.25 (−0.86 to 0.36)	.38	.01	−0.22	−0.20 (−0.66 to 0.26)	.38	.02	−.18	−0.32 (−0.65 to −0.02)	.07	−0.28
Symptoms											
Week 4	−0.11 (−0.63 to 0.42)	.68		−0.14	−0.07 (−0.58 to 0.45)	.80		−.09	−0.12 (−0.58 to 0.33)	.60	−0.16
Week 12	−0.25 (−0.79 to 0.28)	.34		−0.32	−0.22 (−0.75 to 0.29)	.39		−.29	−0.27 (−0.74 to 0.21)	.27	−0.35
Week 24	−0.01 (−0.45 to 0.46)	.98		−0.01	−0.04 (−0.44 to 0.36)	.83		−.05	−0.00 (−0.35 to 0.34)	.98	−0.00
Overall	−0.12 (−0.57 to 0.33)	.57	.003	−0.16	−0.11 (−0.50 to 0.28)	.57	.01	−.14	−0.13 (−0.46 to 0.20)	.44	−0.17
Treatment satisfaction											
Week 4	0.16 (−0.18 to 0.49)	.34		0.19	0.20 (−0.13 to 0.54)	.24		.24	0.16 (−0.14 to 0.45)	.29	0.19
Week 12	−0.17 (−0.52 to 0.19)	.39		−0.20	−0.17 (−0.54 to 0.20)	.37		−.20	−0.17 (−0.49 to 0.15)	.31	−0.20
Week 24	0.06 (−0.24 to 0.35)	.69		0.07	0.11 (−0.18 to 0.40)	.47		.13	0.06 (−0.19 to 0.30)	.65	0.07
Overall	0.02 (−0.26 to 0.29)	.90	.002	0.02	0.05 (−0.22 to 0.31)	.72	.01	.06	0.02 (−0.19 to 0.23)	.89	0.02
Global perception of recovery											
Week 4	0.58 (−0.26 to 1.43)	.16		0.27	0.42 (−0.28 to 1.12)	.23		.19	0.52 (−0.11 to 1.16)	.11	0.24
Week 12	0.81 (−0.05 to 1.68)	.06		0.37	0.68 (−0.04 to 1.41)	.06		.31	0.75 (0.08 to 1.42)	.03	0.35
Week 24	0.43 (−0.42 to 1.29)	.29		0.20	0.28 (−0.45 to 1.00)	.45		.13	0.37 (−0.28 to 1.02)	.27	0.17
Overall	0.61 (−0.19 to 1.41)	.12	.03	0.28	0.46 (−0.14 to 1.06)	.13	.03	.21	0.55 (0.03 to 1.07)	.04	0.25
Disability, RMDQ score											
Week 4	−0.78 (−3.29 to 1.72)	.51		−0.17	−0.71 (−2.65 to 1.23)	.47		−.15	−0.90 (−2.52 to .74)	.28	−0.19
Week 12	−0.56 (−3.09 to 1.96)	.64		−0.12	−0.62 (−2.57 to 1.33)	.53		−.13	−0.65 (−2.30 to 1.00)	.44	−0.14
Week 24	0.10 (−2.37 to 2.57)	.93		0.02	0.06 (−1.94 to 1.82)	.95		.01	0.02 (−1.57 to 1.54)	.98	0.00
Overall	−0.42 (−2.82 to 1.99)	.71	0.01	−0.09	−0.46 (−2.18 to 1.26)	.59	.02	−.10	−0.52 (−1.88 to 0.84)	.45	−0.11
Patient-specific function											
Week 4	0.48 (−0.55 to 1.50)	.32		0.24	0.39 (−0.43 to 1.21)	.34		.19	0.41 (−0.23 to 1.05)	.20	0.20
Week 12	0.49 (−0.55 to 1.53)	.32		0.24	0.45 (−0.41 to 1.31)	.30		.22	0.42 (−0.27 to 1.11)	.23	0.21
Week 24	0.57 (−0.51 to 1.66)	.28		0.28	0.42 (−0.54 to 1.38)	.38		.21	0.50 (−0.29 to 1.29)	.21	0.25
Overall	0.51 (−0.49 to 1.52)	.27	.07	0.25	0.42 (−0.37 to 1.21)	.29	.16	.21	0.44 (−.015 to 1.04)	.14	0.22
Quality of life											
Week 4	−0.06 (−0.13 to 0.02)	.14		−0.27	−0.06 (−0.13 to 0.01)	.10		−.27	−0.06 (−0.13 to 0.01)	.12	−0.27
Week 12	−0.04 (−0.11 to 0.04)	.30		−0.18	−0.04 (−0.11 to 0.04)	.32		−.18	−0.04 (−0.11 to 0.03)	.28	−0.18
Week 24	−0.03 (−0.10 to 0.04)	.33		−0.14	−0.02 (−0.08 to 0.05)	.63		−.09	−0.03 (−0.10 to 0.03)	.31	−0.14
Overall	−0.04 (−0.11 to 0.02)	.18	.002	−0.18	−0.04 (−0.10 to 0.02)	.20	<.01	−.18	−0.04 (−0.10 to 0.01)	.13	−0.18

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Supplemental Table S3 (*continued*)

	Effects of Treatment										
	Site Cluster Adjusted				Therapist Cluster Adjusted				Not Cluster Adjusted		
Outcome	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	ICC	*d*	Mean (95% CI)	*P*	*d*
Motivational outcomes											
Fear avoidance											
Week 4	−1.09 (−4.08 to 1.91)	.45		−0.16	−0.60 (−3.31 to 2.11)	.66		−.09	−1.03 (−3.49 to 1.44)	.41	−0.15
Week 12	−1.33 (−4.55 to 1.88)	.40		−0.19	−1.16 (−4.22 to 1.89)	.45		−.17	−1.29 (−4.10 to 1.52)	.37	−0.19
Week 24	−0.80 (−4.23 to 2.64)	.64		−0.11	−0.19 (−3.69 to 3.32)	.92		−.03	−0.75 (−3.84 to 2.34)	.63	−0.11
Overall	−1.07 (−3.93 to 1.78)	.42	.002	−0.15	−0.65 (−3.19 to 1.89)	.61	.01	−.09	−1.02 (−3.23 to 1.19)	.36	−0.15
Perceived competence to follow recommendations											
Immediately after the initial treatment	0.19 (−0.04 to 0.43)	.10		0.33	0.19 (−0.14 to 0.51)	.27		.33	0.21 (0.02 to 0.40)	.03	0.37
Week 4	0.39 (0.06 to 0.72)	.02		0.68	0.39 (−0.01 to 0.76)	.04		.68	0.41 (0.10 to 0.71)	.01	0.72
Week 12	0.39 (−0.03 to 0.82)	.07		0.68	0.42 (0.04 to 0.79)	.03		.74	0.41 (−0.01 to 0.82)	.05	0.72
Week 24	0.60 (−0.08 to 1.12)	.02		1.05	0.54 (0.15 to 0.92)	.01		.95	0.61 (0.10 to 1.12)	.02	1.07
Overall	0.40 (0.11 to 0.68)	.01	<.001	0.70	0.38 (0.12 to 0.64)	.01	<.001	.67	0.41 (0.15 to 0.67)	.002	0.72
Autonomous motivation to follow recommendations											
Immediately after the initial treatment	0.16 (−0.14 to 0.46)	.29		0.30	0.22 (−0.03 to 0.47)	.09		.41	0.19 (−0.04 to 0.43)	.11	0.35
Week 4	0.03 (−0.30 to 0.35)	.87		0.06	0.07 (−0.21 to 0.36)	.89		.13	0.06 (−0.21 to 0.33)	.65	0.11
Week 12	−0.10 (−0.42 to 0.22)	.53		−0.19	−0.02 (−0.30 to 0.26)	.89		−.04	−0.05 (−0.32 to 0.21)	.68	−0.09
Week 24	−0.10 (−0.35 to 0.16)	.41		−0.19	−0.04 (−0.21 to 0.13)	.67		−.07	−0.07 (−0.22 to 0.08)	.35	−0.13
Overall	0.00 (−0.26 to 0.25)	.98	.007	0.00	0.06 (−0.12 to 0.24)	.52	.003	.11	0.03 (−0.13 to 0.20)	.71	0.06
Controlled motivation to follow recommendations											
Immediately after the initial treatment	−0.10 (−0.49 to 0.29)	.57		−0.08	−0.21 (−0.53 to 0.12)	.21		−.16	−0.11 (−0.42 to 0.21)	.51	−0.09
Week 4	−0.08 (−0.58 to 0.43)	.76		−0.06	−0.03 (−0.53 to 0.47)	.91		−.02	−0.08 (−0.56 to 0.39)	.73	−0.06
Week 12	0.09 (−0.39 to 0.58)	.69		0.07	0.13 (−0.34 to 0.61)	.58		.10	0.09 (−0.37 to 0.54)	.71	0.07
Week 24	−0.15 (−0.69 to 0.38)	.57		−0.12	−0.19 (−0.73 to 0.36)	.50		−.15	−0.16 (−0.68 to 0.35)	.53	−0.12
Overall	−0.06 (−0.35 to 0.46)	.76	.001	−0.05	−0.07 (−0.45 to 0.30)	.70	<.001	−.05	−0.07 (−0.42 to 0.29)	.71	−0.05
Amotivation											
Immediately after the initial treatment	−0.26 (−0.70 to 0.17)	.22		−0.27	−0.27 (−0.60 to 0.06)	.10		−.28	−0.27 (−0.55 to 0.00)	.05	−0.28
Week 4	−0.26 (−0.75 to 0.23)	.29		−0.27	−0.17 (−0.75 to 0.41)	.56		−.17	−0.25 (−0.80 to 0.31)	.38	−0.26
Week 12	−0.60 (−1.10 to −0.10)	.02		−0.61	−0.55 (−1.11 to 0.02)	.06		−.56	−0.58 (−1.11 to 0.04)	.04	−0.59
Week 24	−0.50 (−1.03 to 0.04)	.07		−0.51	−0.49 (−1.12 to 0.14)	.13		−.50	−0.48 (−1.05 to 0.09)	.10	−0.49
Overall	−0.40 (−0.80 to 0.01)	.05	.001	−0.41	−0.37 (−0.75 to 0.01)	.06	.005	−.38	−0.31 (−0.58 to 0.05)	.02	−0.32

NOTE. Standardized mean difference effect sizes (*d*) were calculated using baseline SD of participants in the control arm. Where baseline measures were not relevant (adherence variables), the control arm's SD at each time point was used to calculate *d*.

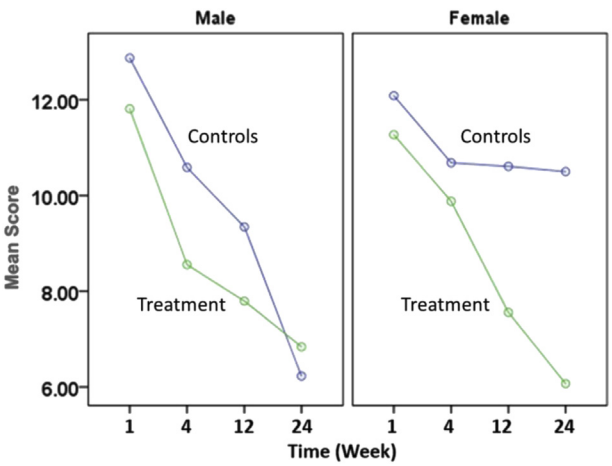
Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient; MET, metabolic equivalent; RMDQ, Roland-Morris Disability Questionnaire.

Supplemental Table S4 Sex moderation results: linear mixed model estimates of fixed effects

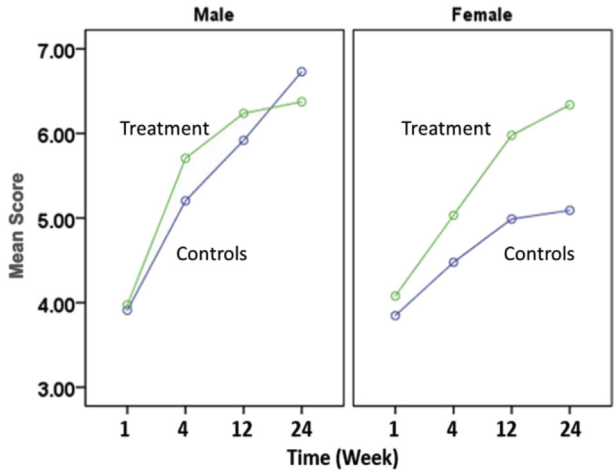
Parameter	Estimate	SE	*df*	*t*	*P*	95% CI
RMDQ — Intercept	13.31	.36	242.60	36.62	.00	12.60 to 14.03
Arm	−0.28	.36	242.68	−0.77	.44	−1.00 to 0.44
Sex	0.62	.37	242.64	1.70	.09	−0.10 to 1.34
Time	−1.43	.13	213.00	−11.31	.00	−1.67 to −1.18
Arm × time	−0.18	.13	213.11	−1.45	.15	−0.43 to 0.07
Time × sex	−0.33	.13	213.11	−2.58	.01	−0.58 to −0.08
Arm × time × sex	0.31	.10	211.36	3.16	.00	0.12 to 0.50
PSFS — Intercept	3.59	.23	7.40	15.80	.00	3.06 to 4.12
Arm	0.02	.16	226.59	0.15	.88	−0.29 to 0.34
Sex	−0.07	.16	237.07	−0.44	.66	−0.39 to 0.25
Time	0.69	.06	220.56	10.90	.00	0.57 to 0.82
Arm × time	0.08	.06	220.49	1.20	.23	−0.05 to 0.20
Time × Sex	0.12	.06	220.24	1.83	.07	−0.01 to 0.24
Arm × time × sex	−0.09	.05	212.96	−1.98	.05	−0.19 to 0.00
Interference — Intercept	3.25	.09	239.96	36.42	.00	3.07 to 3.43
Arm	0.11	.09	239.90	1.20	.23	−0.07 to 0.28
Sex	−0.06	.09	240.51	−0.62	.53	−0.23 to 0.12
Time	−0.22	.03	221.15	−6.90	.00	−0.28 to −0.15
Arm × time	−0.08	.03	220.98	−2.45	.02	−0.14 to −0.02
Time × sex	0.01	.03	221.51	0.46	.65	−0.05 to 0.08
Arm × time × sex	0.04	.02	222.51	1.89	.06	0.00 to 0.08

NOTE. All *P* values are 2-tailed. Pairwise comparisons identified an effect size for the mean difference between treated women and controls at week 24: RMDQ, $d = .92$; PSFS, $d = .55$; Interference, $d = .89$.

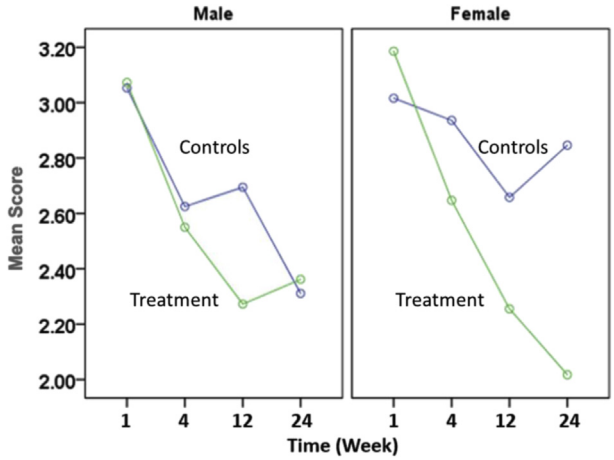
Abbreviations: CI, confidence interval; Interference, interference with work; PSFS, Patient-Specific Function Scale; RMDQ, Roland-Morris Disability Questionnaire.



Supplemental Fig S1 Roland-Morris Disability Questionnaire mean scores at 4 measurement points in time for men and women in the experimental and control groups.



Supplemental Fig S2 Patient-Specific Functional Scale mean scores at 4 measurement points in time for men and women in the experimental and control groups.



Supplemental Fig S3 Interference with work mean scores at 4 measurement points in time for men and women in the experimental and control groups. ("During the past week, how much did pain interfere with your normal work (inside/outside home)": rated on 1—5 scale.)