Pain Medicine, 21(2), 2020, e191–e200
doi: 10.1093/pm/pnz259
Advance Access Publication Date: 18 October 2019
Original Research Article

Pain-Related Activity Management Patterns as Predictors of Treatment Outcomes in Patients with Fibromyalgia Syndrome

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Funding sources: Dr. Mélanie Racine's salary and travel support for writing this manuscript were funded by The Earl Russell Chair in Pain Research, Western University, London, Ontario, and by a bequest from the estate of Mrs. Beryl Ivey to Dr. Warren R. Nielson. Financial support for this activity was also provided, in part, by grants from Obra Social de Caixabank, Universitat Rovira i Virgili (PFR program), the Spanish Ministry of Economy and Competitiveness (PSI2015-70966-P; PSI2016-82004-REDT), and the European Regional Development Fund (ERDF) awarded to JM. JM's work is supported by the Institució Catalana de Recerca i Estudis Avançats (ICREA-Acadèmia) and Fundación Grünenthal. RV's work is supported by a Beatriu de Pinós Postdoctoral Fellowship (2014 BP-A 00009) granted by the Agency for Administration of University and Research Grants (AGAUR).

Disclosure and conflicts of interest: The authors declare no financial or other relationships that might lead to a conflict of interest related to this study. All authors reviewed and provided comments on drafts and subsequent revisions of this article and approved the final version for submission and publication.

Abstract

Objectives. This study sought to determine if pre- to post-treatment changes in pain-related activity patterns (i.e., overdoing, avoidance, and pacing) were associated with pre- to post-treatment changes in function (i.e., pain interference, psychological function, and physical function) in patients with fibromyalgia syndrome who participated in either an operant learning– or an energy conservation–based training in activity management. **Methods.** Sixty-nine patients with fibromyalgia syndrome participated in an activity management treatment (32 in an operant learning group and 37 in an energy conservation group). Outcomes were assessed at pre- and post-treatment, and patients provided demographic information and completed measures assessing pain intensity, pain interference, psychological function, physical function, and pain management activity patterns. Three linear hierarchical regression analyses predicting changes in pain outcomes from changes in pacing, overdoing, and avoidant activity patterns were performed. **Results.** Changes in pain-related activity patterns made significant contributions to the prediction of changes in patients' function. Specifically: (a) increases in overdoing predicted reductions in pain interference; (b) decreases in avoidance predicted improvements in psychological function; and (c) increases in pacing predicted improvements in physical function. **Conclusions.** This study provides support for a role of activity management treatments in improved adjustment to chronic pain. Research is needed to replicate and extend these findings in order to build an empirical basis for developing more effective chronic pain treatments for facilitating improved physical and psychological function in individuals with chronic pain.

Key Words: Fibromyalgia Syndrome; Activity Management Pattern; Activity Pacing; Avoidance; Overdoing; Physical Function; Psychological Function; Pain Interference

Introduction

Activity management is thought to play a crucial role in the development and maintenance of chronic pain disorders [1]. Individuals with chronic pain often alter the way they engage in daily activities to achieve specific goals. For example, some individuals seek to reduce pain severity by avoiding certain activities. Others may try to maintain or maximize function by overdoing activities despite pain. Still others may seek to accomplish valued activities by pacing their activities within acceptable pain or fatigue severity levels.

Activity avoidance may be defined as the avoidance or reduction of activities with the aim of minimizing pain or avoiding future pain. In the operant learning (OL) model, activity avoidance is viewed as likely reinforcing [1–3]. However, over time, the individual can become more vulnerable to pain exacerbations with movement [4,5]. Most research findings are consistent with this idea, in that they show significant associations between measures of avoidance and poorer function [6–12] .

Results from research examining overdoing as a response to pain are less consistent [8,11,13,14]. The OL model views overdoing as a pattern associated with individuals engaging in activities to the point of a pain flare-up, which is then thought to result in a period of inactivity during which the individual attempts to recover [1,3,15–17]. This overactive–underactive or so-called "yo-yo" pattern can result in increasingly longer periods of inactivity over time, followed by pain severity increases and poorer function [1,3].

On the other hand, overdoing has also been viewed as a type of "task persistence" or "endurance behavior," and from this perspective it is considered as an adaptive activity management pattern, in that the individual with chronic pain chooses to persist in a valued life activity despite pain [6,8]. Given these two views (and possible outcomes) of overdoing/task persistence activity patterns, it is perhaps not surprising that studies examining the relationship between measures of this activity pattern have yielded conflicting results [6].

Like overdoing, activity pacing can be interpreted in different ways, which has led to confusion with respect to its conceptualization, measurement, and treatment methods [3,18–22]. There are two distinct theoretical approaches of activity pacing: the OL model, as previously mentioned, and the energy conservation (EC) model [3]. The OL model views pacing as goal-directed rather than pain-contingent activity [1,3]. Patients in OL treatments are taught to use pacing strategies such as activity–rest cycling (i.e., breaking tasks into smaller achievable pieces followed by a limited rest break), moving at a "slow and steady pace," or (preplanned) quota-based activity to accomplish valued activity goals despite pain [1,23,24]. In contrast, the EC model argues that patients with chronic disorders such as fibromyalgia syndrome (FMS) or multiple sclerosis have less energy resources available to them. Therefore, they need to find a balance between energy expenditure and achievement of their valued activities/goals [3,25–27]. Pacing from an EC perspective is therefore symptom-contingent. As a result, patients who receive EC treatment are taught strategies such as resting, slowing down, stopping, or abandoning activities in order to reduce pain and fatigue severity to allow the body to naturally recover and make it easier to engage in valued activities at a later time [3,24–28].

Most cross-sectional studies have reported activity pacing to be associated with higher pain intensity and worse physical function, but better psychological function [6,8,9,11,29]. In contrast, treatment studies targeting activity pacing from either an OL or an EC perspective have shown these treatments to result in improved function in patients with osteoarthritis [30], FMS [31–35], and multiple sclerosis [36–40].

Overall, then, although there is empirical support for both the OL and EC models of activity management, there remains a great deal that is not known regarding the causal role that pain-related activity management patterns has on patient function. To address this question, longitudinal treatment studies that target different activity management patterns in individuals with different chronic pain disorders, such as FMS, are needed. The aim of this study was to address this knowledge gap by examining the associations between pre- and post-treatment changes in pacing, overdoing, and avoidant activity management patterns and pre- to post-treatment changes in pain interference, psychological function, and physical function in patients with FMS. Using data from a published randomized controlled trial comparing the efficacy of OL- and EC-based activity management treatments [24], and based on OL theories and previous research, we hypothesized that pre- to post-treatment reductions in activity avoidance and overdoing would be associated with pre- to post-treatment improvements in patient function. Then, based on both the OL and EC theories, we predicted that increases in activity pacing would be associated with improved function. In addition to testing these associations, we explored whether there were any moderating effects of treatment condition (OL vs EC) on the associations between changes in activity patterns and changes in function, that is, if the role that activity pacing had in patient function differed according to the type of treatment received.

Methods

Study Design Overview and Procedure

This longitudinal study used data from a randomized controlled trial examining the efficacy of two activity pacing treatments (OL and EC) in tertiary care patients with FMS [24] (https://clinicaltrials.gov/ct2/show/NCT01674335). To address the present study's aims and hypotheses, only patients who completed both the pre- and post-treatment measures were included. Readers interested in the primary findings from the clinical trial or who want additional details regarding the study procedures may find them in previously published papers [24,41]. This study was performed at St. Joseph's Health Care London and was approved by the Western University (London, Canada) Research Ethics Board.

Patients with FMS were recruited from different sources (e.g., FMS associations, community rheumatologists), but most of them were recruited through the hospital tertiary care units (i.e., Pain Clinic, Beryl & Richard Ivey Fibromyalgia Day Program, and Rheumatology Outpatient Clinic). The study was described to potential participants via telephone by the research coordinator (MR). The study inclusion criteria were (a) being 18 years old or older; (b) being fluent in English; (c) having a formal diagnosis of FMS confirmed by a rheumatologist and meeting either the American College of Rheumatology criteria 1990 [42] or the 2010 classification criteria [43,44]; (d) having never received a formal activity pacing treatment; and (e) having no severe psychological disorder or cognitive impairment that would prevent them from benefiting from the treatment, as determined by the interviewing occupational therapists and/or the research coordinator. Participants who agreed to be part of the study and who met the eligibility criteria were randomly assigned into one of the two activity pacing treatment conditions (OL or EC). All study participants were blinded with regards to the study aims and the treatment that they were going to receive. Before treatment, patients met with one of the treating occupational therapists for an intake assessment, during which they were asked to provide written informed consent, and where eligibility criteria were reviewed. Eligible participants who signed the consent form were invited to complete a structured interview and a series of pretreatment questionnaires.

Participants were then scheduled for the next available, randomly assigned treatment group. Briefly, the activity pacing treatment was provided by well-trained occupational therapists as a standardized "stand-alone" treatment in a small group format (eight to 12 patients) for 10 consecutive weeks (two hours per session, once a week). During these group sessions, patients learned how to pace either within an OL or an EC theoretical framework [3]. Both OL and EC treatments a) followed the same general outline, differing only in their respective pacing approaches, b) were personalized to each participant's daily life activities, c) were targeted to address both pain and fatigue symptoms, and d) were focused on five life activity domains (exercise/sports, chores, social/leisure activities, cognitive tasks, and work/volunteering/housework). At the end of the treatment, participants were administered the post-treatment questionnaires. Detailed descriptions of the OL and EC activity pacing treatments are available in Racine and colleagues' previous paper [24], and standardized treatment manuals and related materials (handouts, homework) are available on our website (http://research.melanieracine.com/activitymanagement).

Study Measures

Predictor Variables

Patients were asked to complete the Patterns of Activity Measure–Pain (POAM-P) [7]. This instrument has demonstrated excellent reliability and validity when used on patients with chronic pain, including those with FMS [7]. The POAM-P consists of 30 statements that assess activity management in three domains: Pacing (e.g., "I go back and forth between working and taking breaks when doing an activity"); Overdoing (e.g., "When I'm doing an activity I don't stop until it is finished"); and Avoidant (e.g., "I stop what I am doing when my pain starts to get worse"). Respondents rate the frequency with which they engage in each activity pattern on a 0 ("not at all") to 4 ("all the time") rating scale. The POAM-P scores are computed by summing all items that are part of each scale. The Pacing, Overdoing, and Avoidant scales evidenced good to excellent internal consistency reliability in the current sample (Cronbach's $\alpha = 0.92$, 0.82, and 0.87, respectively).

Dependent Variables

Pain interference was assessed with the Brief Pain Inventory [45] (BPI) Pain Interference scale, which has been shown to provide reliable and valid measures in individuals with chronic pain [46,47]. The BPI Pain Interference scale contains seven items asking respondents to rate the extent to which pain has interfered, in the last 24 hours, with a variety of life activity domains (i.e., activity, mood, walking ability, normal work, sleep, relations with other people, and enjoyment of life). Patients rate each item using a "0" ("does not interfere") to "10" ("completely interferes") scale. The BPI Pain Interference scale score is computed by summing the responses to the seven items. This scale demonstrated excellent internal consistency reliability (Cronbach's $\alpha = 0.90$) in the current sample.

Psychological and physical function were assessed using the Medical Outcomes Study 36-item Short-Form Health Survey, version 2 (SF-36v2) [48]. This instrument has also been extensively used in chronic pain populations [48]. It assesses how patients view their health function in eight different domains (i.e., physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional and mental health) in the previous month. The items can be scored to create a Physical and a Mental Component Summary (PCS and MCS, respectively) *t*-score (i.e., normative values; mean [SD] = 50 [10]), where a greater score indicates better perceived health. In this study, the internal consistencies of the PCS and the MCS were good (Cronbach's $\alpha = 0.82$ and 0.80, respectively).

Control Variables

Sociodemographic characteristics (sex, age, marital status, and employment status) were collected. Information about pain was also obtained including FMS onset and mean pain intensity, consisting in a composite score (Cronbach's $\alpha = 0.87$) of the four BPI pain scales (worst, least, average, and current pain in the past 24 hours) [49]. The treatment condition (OL or EC) that patients were assigned to was also controlled for in the planned analyses.

Data Analysis

For descriptive purposes, demographic and pain characteristics were first computed: means and standard deviations (SD) for continuous variables and percentages for dichotomous variables. To address the primary study aim—that is, to examine the extent to which pre- to post-treatment changes in activity patterns made a unique and independent contribution to the prediction of pre- to post-treatment changes in function—we performed three hierarchical linear regression analyses predicting changes in pain interference, psychological function, and physical function from measures of changes in pacing, overdoing, and avoidant activity patterns. Before their entry into the regression models, pre- to post-treatment change scores were computed for the three primary predictor variables (i.e., pacing, overdoing, and avoidant activity patterns) and were then mean-centered to reduce potential multicollinearity biases, given that we planned to test for interaction effects using these as components of the interaction terms. Next, predictor change scores were examined to determine if they met the assumptions (e.g., normality, homoscedasticity) of the planned regression analyses. In order to evaluate for possible multicollinearity, Pearson correlations and variance inflation factors (VIF; i.e., estimation of multicollinearity among multiple predictors) were computed among the predictor variables and with respect to the prediction of each criterion variable. If significant overlap between the predictor variables was found (as determined by correlation coefficients of ≥ 0.70 or VIFs scores of ≥ 10), we planned to combine them into single composite scores [50,51]. Treatment condition (OL or EC) was coded as a dummy variable.

In the linear regression analyses, post-treatment scores were used as dependent variables for the criterion variables (pain interference, psychological function, and physical function). In step 1, the pretreatment score for the criterion variable was entered. By controlling for pretreatment score in this way, all variables entered subsequently predicted the residual of the post-treatment scores after the variance associated with the pretreatment score was removed, that is, essentially a pre- to post-treatment change in the criterion variable [52]. In step 2, demographic characteristics (sex and age) were entered. Pain intensity at pretreatment was entered in step 3 to control for its potential biasing effects on the predictors and criterion variables. Treatment condition (OL vs EC) was entered in step 4. In the event that a statistically significant treatment effect was observed in this step, we planned to perform an independent *t* test to compare the mean change in the criterion variable for the two treatment groups. In step 5, the three scores representing changes in activity patterns were entered to test the primary study hypotheses. In step 6, using a stepwise method, three interaction terms (Treatment Condition × Change in Pacing, Treatment Condition × Change in Overdoing, Treatment Condition × Change in Avoidance) were entered to examine the potential moderating impact of the treatment condition on the associations between changes in activity patterns and changes in function. In the event that a significant interaction effect was found, we planned to interpret our findings by computing correlation coefficients between the predictor and the criterion variable for each group separately. All analyses were performed using SPSS, version 22.0 (IBM; http://www.ibm.com/software/analytics/spss/).

Results

Patients with FMS Characteristics

A total of 517 individuals were referred to the activity management treatment, and 339 of these were excluded for various reasons (e.g., declined participation, not reachable, ineligible). Thus, 178 individuals were randomized to either the OL or EC intervention. Of these patients, five were found to be ineligible after treatment allocation, 60 dropped out before the treatment began, and another 44 dropped out after the treatment started. This left a final sample of 69 participants with FMS who completed treatment (32 patients in the OL condition and 37 patients in the EC condition). Further analyses were performed to check if treatment completers differed from noncompleters. Both groups were comparable with respect to their baseline measures of sociodemographic characteristics (i.e., age [$t_{122} = 0.510$, $P = 0.611$], sex [$\chi^2 = 1.875$, $P = 0.297$], marital status [$\chi^2 = 0.086$, $P = 0.856$], work status [$\chi^2 = 0.359$, $P = 0.579$]) and pain intensity ($t_{123} = 0.898$, $P = 0.371$). The only exception was FMS duration, for which the noncompleters (mean [SD] = 12.56 [9.31] years) reported having FMS for a longer period of time ($t_{122} = 2.003$, $P = 0.047$) than the completers (mean [SD] = 9.25 [9.04] years).

The final sample was mostly composed of middle-aged (mean [SD] = 51.12 [10.44] years) women (96%), and more than half of the patients reported being in a relationship (58%) and were either disabled or unemployed (58%). With respect to pain characteristics, pain intensity was moderate on average (mean [SD] = 6.15 [1.85]/10 on the numerical pain composite scale). The patients reported that their pain interfered moderately to severely with their daily life activities (mean [SD] = 47.84 [14.80], on a possible 0–70 scale), whereas perceived psychological function (mean [SD] = 37.24 [8.96]) and physical function (mean [SD] = 30.07 [7.11]) were about 1 to 2 SD units lower, respectively, than those from the general population (US norms mean [SD] = 50 [10]) [53]. Average scores were comparable between the three activity patterns (pacing: mean [SD] = 24.26 [8.23]; overdoing: mean [SD] = 22.26 [6.73]; avoidant: mean [SD] = 25.35 [7.38]).

Hierarchical Regression Analyses Predicting Changes in Pain Interference, Psychological Function, and Physical Function

All variables were normally distributed and met the assumptions for the planned regression analyses. An examination of the associations among the scores in the controls and predictors (i.e., all $r < 0.70$) and of the VIFs (all < 10) for each independent variable revealed no multicollinearity issues. All regression models were found to be significant (all $P < 0.001$ for each model).

Pain Interference

With respect to the prediction of pain interference at post-treatment (Table 1), pretreatment scores (step 1) accounted for a large and statically significant 44% of the variance. Neither the sociodemographic variables (step 2) nor pain intensity (step 3) accounted for any additional significant variance in the criterion. Treatment condition explained an additional 4% of the variance in the criterion ($P = 0.039$). To better understand this effect, we used a t test to compare the pre- to post-treatment mean change in pain interference for the two groups and found that patients in the OL treatment group tended to report greater reductions in pain interference than those in the EC treatment group (mean difference scores [SD] = 7.50 [11.17] and 1.95 [12.31], respectively, $t_{67} = 1.95$, $P = 0.055$). As a group, the individual activity pattern change scores contributed to an additional 5% of the amount of the total variance, although this change was not statistically significant ($P = 0.113$). However, an examination of the individual beta weights revealed that changes in overdoing activity patterns significantly and independently predicted changes in pain interference ($\beta = -0.43$, $P = 0.039$); that is, patients who reported increasing their overdoing patterns were also more likely to report greater pre- to post-treatment reductions in pain interference. None of the interaction terms were significant, so they are not listed in Table 1.

Psychological Function

As can be seen in Table 2, and with respect to the prediction of psychological function, pretreatment psychological function scores explained 35% of the variance. Sociodemographic variables, pain intensity, and treatment condition did not contribute to explaining a statistically significant amount of variance of the criterion variable. Regarding activity patterns as predictors, they accounted for an additional and statistically significant 10% of the predicted total variance ($P = 0.008$). An examination of the beta weights indicated that a change in activity avoidance was the only significant independent predictor of change in psychological function ($\beta = 0.49$, $P = 0.001$). Patients who reported a greater pre- to post-treatment decrease in activity avoidance also reported a greater pre- to post-treatment improvement in psychological function. None of the interaction terms were statistically significant.

Physical Function

As can be seen in Table 3, pretreatment physical function scores accounted for 47% of the variance in post-treatment physical function. Sociodemographic variables, pain intensity, and treatment condition did not contribute significantly to the prediction of post-treatment physical function. In contrast, activity patterns explained another 7% of the variance in post-treatment physical function ($P = 0.032$). Only the change in activity pacing made a statistically significant and independent contribution to the prediction of changes in physical function ($\beta = -0.18$, $P = 0.029$). That is, patients who increased activity pacing also reported a greater improvement in physical function from pre- to post-treatment. None of the other interaction terms were statistically significant.

Discussion

The present study sought to determine if pre- to post-treatment changes in pain-related activity patterns were uniquely and independently associated with pre- to post-treatment changes in function in patients with FMS who received either an OL-based or EC-based activity management training. When pretreatment variance for the criterion variables, sociodemographic characteristics, pain intensity, and the type of treatment received (OL or EC) were controlled, we found that changes in pain-related activity patterns made significant contributions to the prediction of changes in patients' function. More precisely, but only partially supporting study hypotheses, the results revealed that pre- to post-treatment changes in different activity patterns were significantly associated with pre- to post-treatment improvements in different outcomes: (a) increases in an overdoing activity pattern predicted reductions in pain interference; (b) decreases in an avoidant activity pattern predicted improvements in psychological function; and (c) increases in an activity pacing pattern predicted improvements in physical function. No significant interaction effect for treatment condition (OL or EC) on the associations between changes in activity patterns and changes in function was observed. The present study also supports that pain interference (i.e., the extent to which pain, specifically, interferes with a variety of activities of daily living) and physical

Table 1. Results of the hierarchical regression analysis predicting change in pain interference

Variables	R^2	R^2_{change}	F	F_{change}	F_{change} P Value	β to Enter	β to Enter P Value
Step 1: Pain interference at pretreatment	0.44	0.44	52.95	52.95	<0.001	0.66	<0.001
Step 2: Sociodemographic variables	0.46	0.02	18.68	1.31	0.277		
Sex						5.00	0.452
Age						–0.19	0.205
Step 3: Pain intensity	0.46	<0.01	13.80	<0.01	0.974	–0.03	0.978
Step 4: Treatment condition (OL vs EC)	0.50	0.04	12.52	4.44	0.039	5.63	0.039
Step 5: Activity patterns	0.55	0.05	9.01	2.08	0.113		
Pacing change						0.02	0.905
Overdoing change						–0.43	0.039
Avoidance change						<0.01	>0.999

EC = energy conservation; OL = operant learning.

Table 2. Results of the hierarchical regression analysis predicting change in psychological function

Variables	R^2	R^2_{change}	F	F_{change}	F_{change} P Value	β to Enter	β to Enter P Value
Step 1: Psychological function at pretreatment	0.35	0.35	35.82	35.83	<0.001	0.70	<0.001
Step 2: Sociodemographic variables	0.39	0.04	13.55	1.91	0.156		
Sex						–1.97	0.700
Age						0.19	0.069
Step 3: Pain intensity	0.39	<0.01	10.00	<0.01	0.966	0.03	0.966
Step 4: Treatment condition (OL vs EC)	0.42	0.03	8.94	3.27	0.075	–3.78	0.075
Step 5: Activity patterns	0.52	0.10	8.06	4.27	0.008		
Pacing change						0.01	0.957
Overdoing change						0.11	0.473
Avoidance change						0.49	0.001

EC = energy conservation; OL = operant learning.

Table 3. Results of the hierarchical regression analysis predicting change in physical function

Variables	R^2	R^2_{change}	F	F_{change}	F_{change} P Value	β to Enter	β to Enter P Value
Step 1: Physical function at pretreatment	0.47	0.47	59.28	59.28	<0.001	0.64	<0.001
Step 2: Sociodemographic variables	0.47	<0.01	19.36	0.15	0.858		
Sex						–0.20	0.946
Age						0.03	0.585
Step 3: Pain intensity	0.48	<0.01	14.45	0 33	0.568	0.22	0.568
Step 4: Treatment condition (OL vs EC)	0.51	0.03	12.90	3.99	0.050	–2.38	0.050
Step 5: Activity patterns	0.58	0.07	10.06	3.14	0.032		
Pacing change						–0.18	0.029
Overdoing change						0.02	0.832
Avoidance change						0.10	0.283

EC = energy conservation; OL = operant learning.

function (i.e., a patient's general view of perceived physical functioning) evidenced different associations with the activity management patterns, consistent with the idea that both measures (BPI and SF36v2-PCS) assess different domains of function. These findings have important theoretical and clinical implications.

Increases in Overdoing Predict a Reduction in Pain Interference

As mentioned previously, overdoing can be viewed as being either maladaptive (i.e., doing too much while disregarding the body's warning signs to slow down and pace appropriately) or as adaptive (i.e., being persistent in accomplishing valued activities or achieving valued goals despite pain). Supporting this "double-edged sword" view, McCracken and Samuel [11] identified two types of overdoing patterns using cluster analyses: a) a "doers" group who reported high levels of activity despite pain, low levels of avoidance behavior, and low levels of naturalistic pacing (i.e., spontaneous, untrained pacing) and b) an "extreme cyclers" group who reported high levels of activity even when they had pain, greater efforts at pacing, and higher levels of avoidance behavior (this second group would be viewed as "poor pacers" from an

OL perspective). They found that the "doers" demonstrated better function than the "extreme cyclers." Based on their factor analytic studies, Kindermans et al. [8] and Esteve et al. [14] provided additional support for this two-sided view of overdoing/task persistence, as they found "excessive persistence" to be related to poorer function, whereas "task persistence" was found to be associated with better outcomes.

In the current study, and inconsistent with our hypothesis based on the OL model, we found that a pre- to post-treatment increase in the overdoing pattern was associated with a reduction in pain interference. That is, overdoing—as defined in the current study—appeared to be representing the adaptive "task persistence" aspect of this activity pattern, perhaps related to the possibility that the patients in both arms of the parent clinical trial [24] learned how to pace better. Thus, with treatment, patients may have experienced a shift from using an excessive and maladaptive type of pain persistence pattern to a more adaptive and goal-directed type of task persistence, such that those in both treatment conditions learned strategies for decreasing pain's interference with daily life. In any case, modifying the overdoing pattern appears to be beneficial in decreasing pain interference, thus supporting this activity pattern as a treatment target in chronic pain patients.

Decreases in Avoidance Predict Better Psychological Function

Although questions remain regarding whether overdoing/task persistence and pacing represent adaptive or maladaptive activity patterns, activity avoidance has long been recognized as a maladaptive activity pattern across all theoretical frameworks [1]. For example, it is viewed as a key maladaptive component in the fear avoidance model of chronic pain [4,5]. Also, almost all cross-sectional studies have found higher scores on measures of activity avoidance to be associated with worse function in individuals with chronic pain [6–12,14,54]. In addition, and consistent with the OL theoretical view, previous empirical findings (e.g., [31,55–58]), and the study hypotheses, we found that decreases in the avoidance pattern from pre- to post-treatment were significantly associated with pre- to post-treatment improvements in psychological function. This finding suggests that avoiding certain daily activities might have detrimental consequences on patients' perceived mental well-being. As a result of this theoretical and empirical consistency, teaching patients the skills needed to engage in less activity avoidance should be viewed as an important target of chronic pain treatments.

Increases in Pacing Predict Better Physical Function

Among the three activity patterns examined here, pacing has been the least frequently studied. It has also been plagued by varying theoretical views and by being measured in different ways based on differing perspectives [3,18–22]. Complicating the picture further, many studies examine naturalistic pacing, which refers to reactive behaviors in response to daily pain and fatigue symptoms, whereas treatment studies are based on programmatic pacing, which refers to the use of preplanned pacing coping strategies that are usually taught as part of chronic pain treatment programs [3,59,60]. However, based on both the OL and EC perspectives, activity pacing is viewed as an adaptive coping response and a key component of multidisciplinary chronic pain treatments [1,61–64]. Consistent with this view, treatment studies from an OL perspective support a conclusion that activity pacing treatments are effective in improving function in patients with osteoarthritis [30] and FMS [31–35]; similar findings also emerged for EC-based treatment in those with multiple sclerosis [36–40]. In contrast, and inconsistent with a view of pacing as an adaptive management pattern, almost all cross-sectional studies have found naturalistic activity pacing to be associated with greater pain intensity and poorer physical function, but better psychological function [6,8,9,11,29].

In the context of a clinical trial, we studied programmatic pacing and found, as hypothesized, that patients who learned how to pace their activities while engaging in day-to-day activities also reported greater improvements in physical function. This may be related to the possibility that, by learning how to pace in an appropriate manner, patients with FMS also became better able to accomplish more activities throughout the day. Furthermore, our results suggest that patients with chronic pain may benefit from individualized assessment and targeted treatment sessions addressing their own specific activity pacing needs. Additional research is needed to better understand the role that both naturalistic and programmatic pacing have in patient function. Nevertheless, the findings from the current study are consistent with the idea that targeting appropriate activity pacing for change is beneficial for improving global physical function.

Limitations

The present study has several limitations that should be considered when interpreting the results. These include the fact that the study participants were patients with FMS seeking tertiary care treatment, were mostly women who spoke English, and were interested in participating in a targeted activity pacing treatment trial (OL or EC). Therefore, the extent to which these findings generalize to other chronic pain populations is not known. More research is needed with patients who have a variety of pain problems in order to determine the reliability and generalization of the study findings. Also, only patients who completed the activity management treatment and provided data at both pre- and post-treatment were included in the analyses. Even though both treatment completers and noncompleters were comparable with respect to their sociodemographic and most pain characteristics (the single exception being FMS duration), the two groups may have differed in ways that we could not determine. Thus, we cannot be sure that the study findings would necessarily generalize to all individuals with FMS. Another important limitation has to do with the limited sample size available for the planned analyses. As a result, the study may have been underpowered for detecting true associations between the activity patterns studied and their outcomes. Additional research using larger sample sizes would be needed to confirm the associations between activity management patterns and the outcomes found in this study. Finally, no corrections for multiple statistical testing were done. Thus, it is possible that some of the significant effects found may not be reliable. This also supports the need for additional research replicating the analyses in additional samples of individuals in order to determine the extent to which our findings can be confirmed.

Conclusions

Despite the study's limitations, to our knowledge, the analyses presented here are the first that used a longitudinal design to evaluate the associations between a variety of activity management patterns and outcomes in the same study. Thus, the findings may be viewed as a first step in pursuing a greater (and perhaps more nuanced) understanding of the role that activity management plays in the life of people with chronic pain, and especially with FMS. The results showed that increases in overdoing patterns were associated with less pain interference, suggesting the possibility that with treatment, patients may shift from a less adaptive to a more adaptive task-persistent type of "overdoing." We also found that a pre- to post-treatment reduction of avoidance was associated with a pre- to post-treatment improvement of psychological function, suggesting the possibility that this activity pattern may be more closely associated with emotional and psychological processes than with physical function. Finally, the results showed that the increase in activity pacing was an independent predictor of improvement in physical function, suggesting that this pattern might facilitate an improvement in global physical function through an increased ability to accomplish daily activities/goals. The findings from this study provide empirical support for the role of activity management treatments in adjusting to chronic pain. More research is needed to replicate and extend these findings in order to build an empirical basis for developing more effective chronic pain treatments and to facilitate improvements in physical and psychological function in individuals with chronic pain.

Authors' Contributions

MR participated in the design of the study, provided input on the data analysis plan, conducted the statistical analyses, and prepared the first draft of the manuscript; ES-R, RV, SG, ES, MPJ, JM, and DEM provided input on the data analysis plan and feedback on multiple drafts of the manuscript; WRN participated in the decision to conduct this research, provided input on the data analysis plan, and provided feedback on multiple drafts of the manuscript.

Acknowledgments

We would like to thank the Rheumatology Day Program's occupational therapists: Joan Laxamana, Tammy Rice, Karen Tomlin, and Stacey Gicante. Special thanks are also due to the Rheumatology Centre (Drs. Janet Pope, Sherry Rochekar, Gina Rochekar, Nicole le Riche, Andy Thompson, Lillian Bara, and Sarah Haig) and the Pain Clinic (Dr. Patricia Morley-Forster and Cathy Rohfritsch) of St. Joseph's Heath Care London and to Dr. Manfred Harth for their active role in referring patients to our study. We would also like to acknowledge the work of our research volunteer Sandra Leckie and of Martin-Luc Girard for his editing work on the manuscript and his work on the website.

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