**Repetition-induced activity-related summation of pain in patients with fibromyalgia**

Dorothée Ialongo Lambin, Pascal Thibault, Maureen Simmonds, Christian Lariviere, Michael J.L. Sullivan

**Abstract**

This study compared individuals with fibromyalgia (FM) and individuals with chronic low back pain (CLBP) on repetition-induced summation of activity-related pain (RISP). Fear of movement, pain catastrophizing and depression were examined as potential mediators of group differences. The sample consisted of 50 women with FM and 50 women with CLBP who were matched on age, pain severity and pain duration. Participants were asked to lift a series of 18 weighted canisters. In one trial, participants were asked to rate their pain after each lift. In a second trial, participants estimated the weight of each of the canisters. An index of repetition-induced summation of pain was derived as the change in pain ratings across repeated lifts. Analyses revealed that women with FM obtained higher scores on the index of RISP than women with CLBP. The heightened sensitivity to RISP in individuals with FM was not due to generalized hyperalgesia or a greater work output. Consistent with previous research, fear of movement was positively correlated with RISP. Pain disability was also associated with greater RISP, but not pain catastrophizing or depression. Discussion addresses the processes by which individuals with FM might have increased RISP responses. The findings of this study point to possible neurophysiological mechanisms that could help explain the high levels of pain-related disability seen in individuals with FM.

**Keywords:** Fibromyalgia, Low back pain, Summation of pain, Disability, Fear of pain

**1. Introduction**

Fibromyalgia (FM) is characterized by chronic widespread pain and hypersensitivity to a variety of noxious stimuli [18]. Individuals with FM often experience a number of symptoms other than pain, including fatigue, sleep disturbances and a variety of neuropsychiatric problems such as memory difficulties, slowed information processing, and depressive symptoms [24]. These symptoms can be associated with a high level of disability that is often unresponsive to traditional pharmacological or rehabilitative intervention approaches for chronic pain [10,19].

Research has shown that individuals with FM experience increasing pain in response to noxious stimulation of constant intensity [32,28]. The term ‘temporal summation’ (TS) of pain (ie, windup) has been used to describe progressive increases in pain severity as a function of repeated noxious stimulation [28,33]. TS has been demonstrated in response to thermal stimulation, electrical stimulation or pressure with standardized duration of stimulation and inter-stimulus intervals [1,9,43]. There are indications that TS occurs centrally in second-order neurons in the spinal cord as a consequence of sustained C-fiber afferent input [22,28]. Enhanced TS has been observed in pain conditions in which the pathophysiology of the disorder is thought to involve a maladaptive degree of sensitization to noxious stimuli [33]. It has been suggested that TS might contribute to pain-related disability in individuals with persistent pain conditions [11].

Recent reports have described a phenomenon that has been termed “repetition-induced summation of activity-related pain” (RISP) [35,37]. In one study, patients with chronic pain were asked to rate their pain as they lifted a series of 18 weighted canisters. A subset of participants reported increasing levels of pain over successive lifts even though the overall physical demands of the task remained constant [35]. To date, RISP has been demonstrated in...
individuals with CLBP and in individuals with whiplash injuries [35,37]. It is unclear whether the mechanisms underlying RISP are similar to those underlying TS.

It is possible that RISP might be more pronounced in individuals with FM than individuals with CLBP. Increased RISP in individuals with FM might explain, at least in part, why individuals with fibromyalgia show more severe pain-related disability than individuals with CLBP. For example, research shows that individuals with FM report greater intolerance for physical activity than individuals with CLBP [25,26]. In addition, activity-based rehabilitation interventions that benefit individuals with CLBP have been shown to be less effective for individuals with FM [19,30]. To date, RISP has not been examined in individuals with FM.

The primary objective of the present study was to compare individuals with FM and individuals with CLBP on an index of RISP. Participants completed a simulated occupational lifting task designed to generate an index of RISP. It was predicted that individuals with FM would show higher levels of RISP than individuals with CLBP, and that the index of RISP would be associated with measures of functional disability. The role of pain-related psychological variables as mediators of group differences in RISP was also explored.

2. Methods

2.1. Participants

The study sample consisted of 50 women with FM and 50 women with CLBP. Participants were recruited through local pain centers and newspaper ads in Montreal, Quebec. Participants in both groups were matched in terms of age (+ or −3 years), pain severity (+ or −2 on a 0–10 scale) and pain duration (+ or −3 years). The mean age of the sample was 44 years (SD = 8 years), with a range of 25 to 59 years. The mean duration of pain was 12.1 years (SD = 6.0 years). The mean number of years of education was 12.7 (SD = 2.0). The majority of the sample (86%) was married or living in common-law. All participants underwent a medical evaluation in order to ascertain diagnosis and ensure there were no medical contraindications to performing the physical maneuvers of the lifting task. FM participants were diagnosed using the American College of Rheumatology (1990) criteria for fibromyalgia.

2.2. Measures

2.2.1. Pain severity

Participants rated the severity of their pain symptoms on a numerical rating scale (NRS) with the endpoints (0) no pain at all and (10) excruciating pain.

2.2.2. Disability

The Pain Disability Index (PDI) [27] was used as a self-report measure of pain-related disability. Participants rated their level of disability on 7 dimensions of every day life (home, social, recreational, occupational, sexual, self-care, life support). The PDI has high internal consistency (coefficient alpha = .87), and has been used with FM population [5,13].

2.2.3. Fear of movement/re-injury

The Tampa Scale for Kinesiophobia (TSK) [20] was used to assess fear of movement and re-injury associated with pain. Respondents indicated their level of agreement with each of 17 statements reflecting worries or concerns about the consequences of participating in physical activity. The TSK has been shown to be internally reliable (coefficient alpha = .77) [45], and has been used with FM population [5,13].

2.2.4. Catastrophizing

The Pain Catastrophizing Scale (PCS) [34] was used to assess catastrophic thinking associated with pain. Respondents rated the frequency with which they experienced each of 13 different thoughts and feelings when in pain. The PCS has been shown to have high internal consistency (coefficient alpha = .87), and to be associated with pain experience, pain behavior and disability [39].

2.2.5. Depression

The Beck Depression Inventory II (BDI-II) [3] was used to measure the severity of depressive symptoms. Respondents were asked to select phrases that best described how they had been feeling during the past two weeks. The BDI-II has been shown to be a reliable and valid index of depressive symptoms in chronic pain patients [2,36].

2.2.6. Activity-related pain

Patients provided verbal ratings of pain intensity as they lifted a series of 18 canisters (described in more detail below). Pain ratings were made on an 11-point NRS with the endpoints 0 (no pain) and 10 (excruciating pain). Mean activity-related pain (MARP) was computed as the mean of pain ratings provided for all 18 canister lifts.

2.3. Procedure and apparatus

This research received ethical approval from the Institutional Review Board of the Centre de recherche interdisciplinaire en réadaptation du Montréal métropolitain (CRIR). Participants signed a consent form as a condition of enrolment in the study.

Participants responded to advertisements seeking individuals with FM or CLBP for a research study on physical and psychological factors associated with pain and disability. Once the target sample size of 50 participants with FM had been reached, participants with FM were matched to individuals with CLBP on age, pain severity and pain duration. Since patients with FM and CLBP differ on a number of demographic and condition-related parameters, it was necessary to select matched CLBP patients from a substantially larger sample. The data for participants with CLBP were drawn from a larger sample (N = 265) of individuals, tested over the same time period, who had also participated in the same experimental protocol and were tested by the same research assistants. Portions of the data used as the CLBP comparison group have been reported in a previous paper [35]. A pain-free control group was not included as pilot testing revealed that the canister-lifting task did not generate pain in individuals without a pain condition characterized by movement-related pain.

Participants were asked to complete the NRS, the PDI, TSK, PCS and the BDI-II prior to completing the canister-lifting task. Participants were informed that the study was aimed at developing a new assessment procedure for individuals suffering from persistent pain. In the consent form, participants were made aware that the lifting task might lead to temporary increases in discomfort in the 24 to 48 hour period following completion of the task. However, no leading information was provided suggesting that participants might experience increases in pain during the lifting task. Participants were made aware that they were free to withdraw their participation at any point. There were no cases of participant withdrawal.

The lifting task was the same as the one described in Sullivan et al [38]. Participants were asked to stand in front of a height-adjustable table, and to lift 18 canisters (4-liter size paint canisters) that were partially filled with sand. The canisters weighed 2.9, 3.4 or 3.9 kilograms and were arranged in 6 columns with 3 canister positions. The canisters were positioned such that each weight was represented twice in each location of a double latin square.
The height of the table was adjusted so that the handle of the canisters in the first row (i.e., closest to the participant) was at standing elbow height. Participants were asked to lift the canisters, with their dominant arm, in a pre-determined sequence (i.e., column 1, first, second, third row; column 2, first, second, third row; etc). The experimenter demonstrated the lift of the first three canisters to minimize inter-individual variations in the approach to the lifting task.

Participants assumed three postural positions to perform the lifting task. For canisters in the first row (i.e., closest to the body), the participant stood erect with his or her elbow bent at 90 degrees; for canisters in the second row, the participant stood erect with his or her arm fully extended; for canisters in the third row, the participant’s trunk was forward flexed with his or her arm fully extended [7]. Fig. 1 depicts the weight and position configuration of the canister-lifting task. In a previous study, it was estimated that mean net moments (i.e., force x distance corresponding to the weight and body segments) was approximately equivalent across columns, varying from 17.3 to 17.9 Nm at the shoulder and from 34.0 to 35.0 Nm at the back (L4/L5 joint) [6]. The corresponding mean percentage of strength varies from 40.3% to 41.5% at the shoulder and from 20.2 to 20.7% at the back.

The participants performed the lifting task twice; in one trial, participants were asked to provide a verbal rating of their pain as they lifted each of the 18 canisters. In a second trial, participants were asked to provide a verbal estimate of the weight of each of the canisters they lifted. Participants could provide their estimates either in imperial or metric units. All weight estimates were transformed into metric units for analysis. The order of the pain rating and weight estimation trials was counterbalanced across participants. Participants were asked to proceed through the pain rating and weight estimate tasks at a comfortable pace. There was an interval of one minute between the two trials of the lifting task, during which time the experimenter provided instructions for the second trial.

Participants were video taped while performing the canister-lifting task. From the video records, two trained coders calculated the duration of each lift (defined as the number of seconds that a canister was off the table) and calculated the duration of inter-lift intervals (defined as the number of seconds elapsed from the release of the canister handle to the time the next canister was lifted off the surface of the table). The correlations between coders’ calculations of canister lift duration and inter-lift intervals were .92 and .94. The average of the coders’ calculations of lift duration and inter-lift interval were used in analyses.

2.4. Data analytic approach

As described above, participants lifted 18 canisters arranged in 6 “columns” of 3 canisters. Each weight was represented within each column, thus equalizing columns in terms of total weight lifted and in terms of net loading (torque) at the shoulder and the back. Mean pain ratings within “Column” were computed. An index of RISP was derived by subtracting the mean for pain ratings for canisters in the 1st Column from the mean pain ratings for canisters in the 6th Column. Higher values on the index of RISP reflect greater increase in pain across successive lifts. Average lift duration and average duration of inter-lift rest periods were also computed for the first and last columns of canister lifts.

The difference between the participants’ weight estimates and the actual weight of the canisters was used as an indirect measure of perceived work demands [17]. Differences between actual weights and weight estimates were averaged within ‘column’. Positive values reflect over-estimates of weight and negative values reflect under-estimates of weight. In previous research using the canister-lifting task, weight estimates have been shown to vary according to postural position and repetition of lifts [7,38]. As such, there is support for the view that the weight estimates during the lifting task reflect, at least in part, the perception of physical demands.

Means and standard deviations were computed for demographic and dependent measures. Separate t-tests for independent samples were used to examine group differences on demographic and dependent measures. Mixed analysis of variance was used to...
examine group differences in pain ratings and weight estimates over successive lifts. The pain ratings and weight estimation data from the lifting task were initially analyzed as a three-way mixed factorial with Diagnosis (FM, CLBP) and Task order (pain rating first, weight estimation first) as between groups factors and Column (Columns 1 through 6) as the within groups factor. Initial analyses revealed main effects for Task order such that pain ratings, F (1, 96) = 4.1, p < .05, and weight estimates, F (1, 96) = 3.8, p < .05, were significantly greater when the respective tasks were performed second. Task order did not interact with any other factor. As such, task order was not included as a factor in the analyses reported below. For the repeated measures analyses of variance, in cases where sphericity was violated, the Greenhouse–Geisser corrected F is reported.

3. Results

3.1. Sample characteristics

Mean scores on measures of condition-related pain severity, fear of movement/re-injury (TSK), disability (PDI), depression (BDI-II), and catastrophizing (PCS) for FM and CLBP participants are presented in Table 1. T-tests for independent samples revealed that participants with FM obtained higher scores on the PDI (t (98) = 3.1, p < .01), than participants with CLBP. Participants with FM rated their pain during the canister-lifting task (averaged across 18 canister lifts) as marginally more intense than participants with CLBP (t (98) = 1.9, p = .06). Participants with FM obtained higher scores on the index of RISP than participants with CLBP (t (98) = 3.2, p < .001). No significant differences were found between participants with FM and CLBP on the TSK, the BDI-II and the PCS. Means and standard deviations on these measures are comparable to values that have been reported in previous research with individuals with FM [8,15,42].

3.2. Correlations among measures

Correlations among the three pain indices (ie, NRS, MARP, the index of RISP), and the psychological variables (PCS, TSK, BDI-II, PDI) are presented in Table 2. All psychological variables were significantly inter-correlated. The index of RISP was significantly correlated with MARP and the PDI. Consistent with previous research, the index of RISP was significantly correlated with the TSK [35]. The BDI-II and the PCS were not significantly correlated with the index of RISP.

Table 2

<table>
<thead>
<tr>
<th>1. Pain (0–10)</th>
<th>2. PCS</th>
<th>3. TSK</th>
<th>4. BDI-II</th>
<th>5. PDI</th>
<th>6. MARP</th>
<th>7. RISP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.474**</td>
<td>.313**</td>
<td>.493**</td>
<td>.456**</td>
<td>.362**</td>
<td>.010</td>
</tr>
<tr>
<td>2. PCS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. TSK</td>
<td>.70**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. BDI-II</td>
<td>.59**</td>
<td>.361**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. PDI</td>
<td>.360**</td>
<td>.284**</td>
<td>.430**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. MARP</td>
<td>.284**</td>
<td>.243**</td>
<td>.430**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. RISP</td>
<td>.088</td>
<td>.088</td>
<td>.210</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: n = 100. Pain, condition-related pain severity; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale for Kinesiophobia; BDI-II, Beck Depression Inventory II; PDI, Pain Disability Index; MARP, mean activity-related pain; RISP, repetition-induced summation of activity-related pain. Values in parentheses are SDs. ** P < .01.

3.3. Repetition-induced activity-related pain

A two-way (Diagnosis × Column) repeated measures analyses of variance (ANOVA) revealed a significant main effect for Column, F (5, 490) = 36.6, p < .001, and a significant Diagnosis × Column interaction, F (5, 490) = 6.7, p < .001. The main effect for Diagnosis was marginally significant, F (1, 98) = 3.5, p = .060. The results of this analysis are presented in Fig. 2. Tests of simple effects revealed that participants with FM and CLBP did not differ significantly for pain ratings provided for the first column of canisters. Participants with FM reported more intense pain for canisters lifted in the second, fifth and sixth columns, ps < .05.

Diagnosis-related differences on the index of RISP were also examined in relation to the number of participants who showed an increase in pain ratings of three points or greater from the first to the sixth column of canister lifts. An increase of three points or greater on a 0–10 severity scale would be considered clinically significant [16]. Results of this analysis showed that 28% of participants with FM experienced an increase in pain of three points or greater from the first to the sixth column of canisters, compared to only 6% of participants with CLBP (χ² = 8.7, p < .001).

3.4. Task-related influences on pain summation: work output

An index of work output was computed by dividing lift duration by the duration of rest periods between lifts (for the pain rating task). Higher scores on this measure reflect greater energy.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>FM (n = 50)</th>
<th>CLBP (n = 50)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>44.6 (8.3)</td>
<td>43.3 (8.1)</td>
<td>.042</td>
</tr>
<tr>
<td>Pain duration (years)</td>
<td>12.9 (5.4)</td>
<td>11.1 (6.4)</td>
<td>.14</td>
</tr>
<tr>
<td>Education (years)</td>
<td>12.7 (2.0)</td>
<td>12.8 (2.2)</td>
<td>.78</td>
</tr>
<tr>
<td>Pain severity</td>
<td>4.9 (2.0)</td>
<td>4.9 (2.3)</td>
<td>.92</td>
</tr>
<tr>
<td>PCS</td>
<td>29.3 (9.6)</td>
<td>28.2 (14.2)</td>
<td>.65</td>
</tr>
<tr>
<td>TSK</td>
<td>44.1 (7.3)</td>
<td>43.3 (8.3)</td>
<td>.70</td>
</tr>
<tr>
<td>BDI-II</td>
<td>22.1 (10.3)</td>
<td>19.0 (13.6)</td>
<td>.20</td>
</tr>
<tr>
<td>PDI</td>
<td>39.0 (10.7)</td>
<td>30.5 (16.1)</td>
<td>.01</td>
</tr>
<tr>
<td>MARP</td>
<td>5.2 (2.0)</td>
<td>4.4 (2.1)</td>
<td>.06</td>
</tr>
<tr>
<td>RISP</td>
<td>1.9 (1.8)</td>
<td>.85 (8.4)</td>
<td>.0001</td>
</tr>
</tbody>
</table>

FM, fibromyalgia; CLBP, chronic low back pain; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale for Kinesiophobia; BDI-II, Beck Depression Inventory II; PDI, Pain Disability Index; MARP, Mean Activity-Related Pain; RISP, Repetition Induced Summation of Activity-Related Pain. Values in parentheses are SDs; significance values are 2-tailed.
expenditure relative to rest periods. A two-way (Diagnosis x Column) ANOVA was conducted in order to examine whether the work output of performing the lifting task also showed a repetition-induced summation effect and varied according to Diagnosis. This analysis was conducted to examine whether higher scores on the index of RISP by participants with FM were due to greater work output during the task. The analysis yielded a significant main effect of Column, $F(5, 490) = 8.0, p < .001$, and a significant two-way interaction, $F(5, 490) = 2.3, p < .05$. The main effect for Diagnosis was not significant. As shown in Fig. 3, there was no indication that participants with FM expended more energy during the task than participants with CLBP.

Change in work output was inversely correlated with index of RISP, $r = −.24, p < .01$, indicating that participants expended less energy during the lifting task as their pain levels increased.

### 3.5. Perceived work demands (accuracy of weight estimates)

Indices of perceived work demands were derived as the mean discrepancy of actual and estimated weights for each of the three weights (ie, 2.9 kilograms, 3.4 kilograms, 3.9 kilograms). A two-way (Diagnosis x Weight) ANOVA revealed significant main effects for Diagnosis, $F(1, 98) = 4.1, p < .05$, and Weight ($F_{\text{Greenhouse–Geisser}}(2, 196) = 30.1, p < .001$). As shown in Table 3, participants with FM estimated the weights to be heavier than participants with CLBP, and the weight of heavier canisters was overestimated compared to the weight of lighter canisters.

### Table 3

<table>
<thead>
<tr>
<th>Canister weight</th>
<th>FM (n = 50)</th>
<th>CLBP (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9 kilograms</td>
<td>.20 (1.9)</td>
<td>−.55 (1.2)</td>
</tr>
<tr>
<td>3.4 kilograms</td>
<td>.96 (2.9)</td>
<td>.02 (1.7)</td>
</tr>
<tr>
<td>3.9 kilograms</td>
<td>1.50 (3.9)</td>
<td>.35 (2.3)</td>
</tr>
</tbody>
</table>

*Note: Index of perceived work demands was computed as the difference between actual canister weights and estimated canister weights. Values in parentheses are SDs. FM, fibromyalgia; CLBP, chronic low back pain.*

### 4. Discussion

The findings of the present study replicate previous findings showing that a subset of individuals with persistent pain conditions experience clinically significant increases in pain in response to repeated low or moderate level physical activity [35]. The findings extend previous research in showing that individuals with FM are more susceptible than individuals with CLBP to activity-related increases in pain, as quantified with the RISP index. There were no differences between the two groups on level of condition-related (ie, spontaneous) pain or in pain ratings provided during the lift of the first three canisters (ie, activity evoked pain). As such, the higher index of RISP in participants with FM cannot be attributed to generalized hyperalgesia. It is also unlikely that the heightened index of RISP in individuals with FM was the result of increased force or energy expenditure. A measure of work output was derived as a ratio of lift duration to inter-lift rest periods. Analyses revealed that work output decreased over successive lifts for both groups, and no significant effect of diagnosis was observed.

The results of the present study replicate previous research showing that the index of RISP was positively correlated with fear of movement [35]. It has been suggested that fear of movement might impact on the index of RISP by contributing to increased muscle tension, in turn, leading to ischemic changes that could, directly or indirectly, increase nociceptive input to the spinal cord [35]. However, it is also necessary to consider an alternate causal pathway. Fears of movement might be more likely to develop in individuals who experience increasing pain in response to repeated movement. Although fear of movement was correlated with RISP, there were no indications that fear of movement accounted for diagnosis-related differences in RISP.

Numerous research investigations have shown that while exercise leads to hypoalgesic responses in pain free individuals, exercise appears to contribute to hyperalgesia in individuals with FM [44]. It has been suggested that proinflammatory responses to muscle activation might be one of the processes that underlies exercise-induced hyperalgesia in individuals with FM [29]. These same proinflammatory responses might also underlie the greater susceptibility to RISP in individuals with FM. It has also been suggested that central processing of nociceptive stimuli from the muscles might be upregulated in patients with FM [14,21].

At present, the precise mechanisms underlying RISP remain unclear. As noted earlier, TS of pain has been discussed in relation to central sensitisation consequent to sustained or repeated C-fiber input to the dorsal horn [28]. It is possible that similar mechanisms contribute to RISP. However caution must be exercised in extrapolation TS research to RISP. One of the distinguishing features of TS and RISP paradigms concerns the temporal component of noxious stimulation. In most studies examining TS in individuals with FM, TS has been observed with stimulus presentations of heat pulses of approximately 1 second duration and inter-stimulus intervals of approximately 3 seconds. Extending the inter-stimulus duration to more than 3 seconds appears to attenuate the TS effect. There is one study, however, that showed that in response to repeated mechanical pressure to peripheral muscles, TS effects were observed in individuals with FM even when the inter-stimulus interval was 5 seconds [31]. In the present study, over 95% of the inter-lift intervals were between 2 and 5 seconds. It is possible that the inter-stimulus period necessary to elicit summation of pain might differ for signals emanating from mechanical stimulus on the skin or the muscle.

Another difference between paradigms used to generate TS and RISP is that RISP arises from self-initiated and self-paced muscle activation whereas the stimuli used to generate TS are experimenter controlled. A host of central and peripheral processes associated with self-initiation of movement might play a role in RISP but not in TS. The self-initiation component of RISP might afford it greater ecological relevance, at least in relation to the level of disability observed in individuals with FM. Participation in daily activities requires self-initiated muscle activation and many activities of daily living require repeated muscle activation. It is interesting to note that although participants with FM did not differ in their ability to lift canisters, the FM group showed a lower work output compared to the CLBP group. This suggests that the greater susceptibility to RISP in individuals with FM might be related to differences in self-initiated muscle activation.
significantly from individuals with CLBP on the severity of their condition-related pain, or on the intensity of the pain they experienced in response to the first three canister lifts, participants with FM showed greater RISP and more pronounced disability than participants with CLBP. RISP might be one of the factors that contributes to heightened disability in individuals with FM.

The clinical implications of the present findings warrant reflection. The results of the present study might offer insight into the factors underlying poor rehabilitation treatment outcomes for individuals with FM. Intervention approaches that incorporate exposure to repeated physical activity might augment the pain experience of individuals with FM. The results of the present study showed that increases in pain were associated with decreases in work output, which could reflect efforts to compensate for increases in pain experience. If individuals with FM approach rehabilitation exercises with the same compensatory approach, they will likely benefit less from treatment. It is also possible that increases in pain during rehabilitation treatment might impact negatively on individuals’ expectancies for positive treatment outcome, or their motivation to comply with treatment.

Research on the therapeutic benefits of activity/exercise suggests that hypoalgesic effects of exercise may follow an initial period of hyperalgesia [4,23]. Following more extensive repetition of activity, processes associated with descending inhibition might lead to an attenuation or reduction in RISP. Research conducted to date has not addressed whether RISP values continue to increase until pain tolerance is reached, or whether some type of habituation occurs. It is possible that FM might be associated with a delayed onset, as opposed to absence, of descending inhibitory processes in response to physical activity.

Caution must be taken in the interpretation of the results of the present study. First, the pain induced in the laboratory setting may not be comparable to the pain experience of individuals in their day-to-day activities. In the laboratory, participants are reassured about the safety of the task and the benign nature of the pain they are likely to experience. Such reassurance does not accompany the pain exacerbations that individuals with persistent pain might experience. The rigor demands of experimentation necessarily tradeoff a certain degree of ecological validity. It is also important to note that the average increase in pain during the lifting task was less than 2 points on an 11-point severity scale. As such, the clinical relevance of the findings warrants cautionary reflection. Finally, although participants with FM and CLBP were matched on their condition-related pain (ie, spontaneous pain), they were not matched on number of pain sites. By definition, FM is associated with widespread pain. It is possible that the demand of the lifting task engaged more affected muscle groups for participants with FM than with CLBP. In other words, it is possible that differences in RISP were the result of group differences in the number of pain sites as opposed to factors specific to the pathophysiology of FM.

It is also important to note that although the absolute value of weight lifted was constant across columns, the net moments (ie, force required to lift the canisters) varied slightly across columns. In order to rule out the possibility that RISP effects were due to slight variations in force demands across columns, the data were re-analysed using an index of RISP computed as the difference in pain ratings provided for the lift of the 2.9 kilograms canister in column 1, from the pain ratings provided for the lift of the 2.9 kilograms canister in column 6. Both canisters are in the third position, thus equalizing force demands in terms of weight and position. Re-analysis of the data yielded a pattern of findings identical to that reported with the index of RISP computed as the difference in mean pain ratings from the first to the 6th column of canisters.

For ethical reasons, it was necessary to keep the physical demands of the task within acceptable limits. The disadvantage however was that many participants provided activity-related pain ratings, particularly for the 2.9 kilograms canisters that were below their spontaneous pain severity. To date, little research has been conducted on how individuals ‘compartamentalize’ their pain experience when multiple sources of pain are being experienced. However, the process appears more involved than the summative cumulative of the different sources of pain. Previous studies using measures of evoked and spontaneous pain have reported similar findings [12].

In spite of limitations, the results of the present study show that individuals with FM are more susceptible to RISP than individuals with CLBP. The findings are consistent with empirical and anecdotal accounts of the difficulties that individuals with FM experience in the context of repeated physical activity. Future research aimed at elucidating the parameters of RISP could provide the empirical foundation for the development of more effective rehabilitation approaches for individuals with FM.

Conflict of interest

The authors have no financial interests related to the findings reported in this paper.

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