



Published in final edited form as:

Pain. 2020 November ; 161(11): 2603–2610. doi:10.1097/j.pain.0000000000001959.

Daily pain catastrophizing predicts less physical activity and more sedentary behavior in older adults with osteoarthritis

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Abstract

Musculoskeletal disorders such as knee osteoarthritis (OA) are the primary cause of chronic pain in older adults. Recommended self-management strategies for knee OA include staying physically active in the face of pain, but many patients avoid activities they are capable of doing. The overall purpose of this study was to examine the extent to which daily pain catastrophizing, a maladaptive coping strategy, could influence OA patients' physical activity and sedentary behavior. The current study utilized data from 143 older knee OA patients who completed electronic daily diaries for 22 days and wore an accelerometer to capture physical activity and sedentary behavior. At the beginning of each day, patients reported their pain catastrophizing regarding the day ahead. Results from multilevel models demonstrated that on mornings when patients catastrophized more than usual about their pain in the day ahead, they spent more time in sedentary behavior and engaged in fewer minutes of moderate to vigorous physical activity that day. Cross-day lagged analyses further showed that the effect of morning pain catastrophizing on subsequent sedentary behavior extended to the next day. More time spent in sedentary behavior, in turn, contributed to greater pain catastrophizing the next morning. These findings support the mechanistic role of daily pain catastrophizing in the avoidance of physical activity for older OA patients, and suggest that effective interventions for pain catastrophizing may also reduce sedentary behavior and enhance physical activity, with longer-term benefits for pain management, physical function, and overall health.

Introduction

Chronic or persistent pain affects approximately 60%-75% of adults over the age of 65 in the United States [22]. Musculoskeletal disorders such as knee osteoarthritis (OA) are the

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Disclosure: (1) The authors have no conflict of interest to declare. (2) The findings in this manuscript were not reported in any previous presentation of the research, manuscript, or abstract.

Conflict of interest statement

The authors have no conflict of interest to declare.

primary cause of chronic pain in older adults [27]. Recommended self-management strategies for knee OA include staying physically active in the face of pain, but many patients avoid activities they are capable of doing [48]. According to the fear-avoidance model, pain catastrophizing—the exaggerated negative cognitive-emotional responses to real or anticipated pain—can lead to pain-related fear and avoidance of physical activities [39,47]. In the long-term, activity avoidance might result in disuse, depression, disability, and further exacerbation of chronic pain [47]. In fact, pain catastrophizing was found to be more disabling and emotionally distressing than the actual experience of pain [5,8].

Empirical investigations to confirm the hypothesized role of pain catastrophizing in avoidance of physical activity are relatively sparse, and the few existing studies have mostly focused on young and middle-aged adults and produced inconsistent findings. For example, some cross-sectional studies found significant associations between greater pain catastrophizing and lower levels of physical activity [9] or walking speed tested in the lab [36]. Other studies did not find a significant association between pain catastrophizing and free-living physical activity [1] or lab assessments of aerobic fitness [35]. In addition, all of these studies treated pain catastrophizing as a stable personal trait. Recent evidence suggests that pain catastrophizing varies significantly from day to day for the same person [7,38]; and this within-person fluctuation of pain catastrophizing significantly predicts pain severity, psychological distress, affect, and spouses' responses to patients' pain on a daily basis [7,17,38,52].

To our knowledge, no prior studies have examined the within-person association between pain catastrophizing and subsequent avoidance of physical activity (e.g., decrease in physical activity and/or increase in sedentary behavior) in daily life, especially among older adults with knee OA. Examining such a temporal-ordered within-person association is a crucial first step toward establishing the causal relationship between pain catastrophizing and the avoidance of physical activity proposed by the fear-avoidance model [47]. Such findings would also have important implications for interventions targeting pain catastrophizing as a way to improve physical activity and other long-term pain-related health outcomes.

The overall purpose of this study was to examine the extent to which within-person fluctuations in pain catastrophizing from day to day predict knee OA patients' subsequent physical activity and sedentary behavior on a daily basis. This study used a sample of older knee OA patients who completed 22-day surveys (3 times/day) and wore an accelerometer to assess their daily physical activity and sedentary behavior objectively. Based on the fear-avoidance model, we hypothesized that when patients catastrophize more about pain in the morning, they engage in less physical activity and more sedentary behavior throughout the day. To explore the potential dynamic interplay between pain catastrophizing and physical activity, we also examined bidirectional associations between pain catastrophizing and physical activity or sedentary behavior across days.

Method

Study Design and Participants

Data for the current study were from a larger study of couples in which one partner (i.e., the patient) was diagnosed with knee OA (for a detailed description, see [16]). This study included three in-person interviews conducted over a period of 18 months and a 22-day daily assessment immediately after the first interview. During the daily assessment period, all patients and spouses wore an accelerometer continuously for 22 days to assess their daily physical activity and sedentary behavior. Patients and spouses also used handheld computers to complete a short survey three times per day (i.e., morning, afternoon, and end-of-day). The current report utilized OA patients' data from the baseline interview, accelerometers, and the morning, afternoon and end-of-day surveys from the 22-day daily assessments.

Primary sources of recruitment were research registries for rheumatology clinics and for older adults interested in research, flyers distributed at the University of Pittsburgh, and word of mouth. To be eligible for this study, patients had to be diagnosed with knee OA by a physician, experience usual knee pain of moderate or greater intensity, be at least 50 years of age, and be married or in a long-term relationship and living with their spouse or partner. Exclusion criteria for couples included (a) patient had a comorbid diagnosis of fibromyalgia or rheumatoid arthritis; (b) patient planned to have hip or knee surgery in the next six months; (c) spouse had arthritis pain of moderate or greater intensity, or required assistance with personal care activities; (d) either patient or spouse used a wheelchair to get around; and (e) either patient or spouse was not cognitively functional as indicated by the accuracy of their answers to questions regarding the current date, day of the week, their age, and birth date.

A total of 606 couples were screened for eligibility. Of these, 221 couples declined to participate; the most frequent reasons were lack of interest ($N = 87$) and illness in the family ($N = 55$). An additional 233 couples were ineligible for the study; the most frequent reasons were lack of OA of the knee ($N = 55$) and OA pain that was mild ($N = 47$). A total of 152 couples were enrolled in the study and a total of 145 couples completed the diary assessment section. Due to missing accelerometer data, the sample size for the current analyses was 143 patients. Table 1 provides descriptive information for the final sample.

Out of 3,146 potential daily accelerometer assessments ($143 \text{ participants} \times 22 \text{ days}$) from valid participants in the final sample (i.e., having at least 4 days of 10 or more hours of accelerometer wearing time), data for 2,648 accelerometer assessments were available (84%). On average, patients wore the accelerometer for 18.52 ($SD = 3.19$) days in the study and for 14.20 hour each day on average ($SD = 1.11$). In addition, out of a potential 3,146 morning, afternoon or end-of-day assessments, 2,925 morning assessments (93%), 2,892 afternoon assessments (92%), and 2,913 end-of-day assessments (93%) were completed. Morning assessments that were completed more than 120 min after waking and end-of-day assessments that were completed more than 120 min before bedtime were excluded from analysis. In addition, participants were instructed and signaled to complete the afternoon assessment between 2 pm and 4 pm each day. The afternoon assessments that were completed too close (< 4 hours) or too far away (> 11 hours) from the completion time of the

morning or end-of-day assessments within the same day were also excluded from analyses. Using these criteria, 2,603 morning, 2,867 afternoon and 2,596 end-of-day assessments were included in analysis. Missing data analyses suggested that the percentage of missing daily self-report or accelerometer data did not vary with person-level covariates such as gender, age, education level, employment status, knee OA duration and the overall knee pain, or the day-level variables of morning pain catastrophizing, negative affect and daily pain.

Measures

Morning pain catastrophizing.—Patients were asked to report their catastrophizing thoughts in the morning using two items adapted from the Coping Strategies Questionnaire [30] which were validated by Jensen and colleagues for use in daily diary research [12]. The items are “Today, I feel that the pain is terrible and is never going to get any better” and “I feel I can’t stand the pain anymore.” Both items are rated on a scale from 1 (strongly disagree) to 6 (strongly agree). These two items were used in previous research that assessed daily catastrophizing [14]. The mean score for pain catastrophizing, which was calculated by averaging responses to these two items, was 1.98 ($SD = 0.85$). The between-person (BP) and within-person (WP) reliabilities were calculated using generalizability coefficients approach [32,34] and indicated high BP and adequate WP reliabilities: BP reliability = 0.99, WP reliability = 0.65.

Daily physical activity and sedentary behavior.—Accelerometers were used to assess OA patients’ daytime physical activity and sedentary behavior during the 22-day diary assessment period. Accelerometers are motion-sensitive monitors that count the number of movements taken per pre-specified time interval. Participants wore the GT1M or GT3X model of the CSA/MTI triaxial ActiGraph, with placement on the hip in order to best capture ambulatory activities. Participants were instructed to wear the monitor during the day and remove it at night; a reminder to put the monitor on in the morning was provided electronically via the handheld computers. Participants used a written log to record waking time, sleep time, time they put on the accelerometer, time they took off the accelerometer, and any waking periods during which they did not wear the accelerometer for longer than 30 min. Data were collected in 1-min epochs. Non-wear was defined by an interval of 90 consecutive minutes of zero counts/minute, with allowance of up to 2 minutes of low (<100) activity counts [26, 37]. To be included in the analysis, at least 4 adherent days, with an adherent day indicating no less than 10 hours of accelerometer wear, were required. Data were also screened for anomalous values (activity counts > 6,000 at any given minute), which affected <1 % of the activity data.

The intensity thresholds used by the National Health and Nutrition Examination Survey (NHANES) were applied to identify moderate-to-vigorous physical activity (MVPA) and sedentary behavior. Sedentary behavior was defined as < 100 activity counts/minute, and MVPA intensity was defined as ≥ 760 activity counts/minute based on previous studies that incorporated more lifestyle physical activities [19] and studies on physical activity among older OA patients [16,51]. In addition to MVPA, daily steps were also measured by the accelerometers as another indicator of patients’ daily physical activity. Daily steps and

MVPA have each been linked with different health outcomes [3,23], and both describe free-living physical activity in metrics that are readily understood and have real-world referents.

Covariates—Covariates were selected based on previous research identifying factors that are related to physical activity or sedentary behavior [50,51]. Patients' demographics (age, gender, race, education, employment), knee OA duration and the overall knee pain experienced in the past month [21], and accelerometer wear time every day were included as covariates in all analyses. In addition, patients' morning negative affect and daily pain were controlled because these factors may influence patients' concurrent pain catastrophizing and subsequent physical activity in the day ahead.

Morning Negative affect.—During the 22-day diary assessment period, patients reported to what extent they felt negative affect over the past 30 minutes in the morning [41]. Five items (e.g., depressed or blue, frustrated, angry or hostile, unhappy, worried or anxious) were rated on a 7-point scale (0 = not at all; 6 = extremely), and were averaged to create a mean score of morning negative affect ($M = 0.54$, $SD = 0.64$, BP reliability = .99 and WP reliability = 0.78).

Daily pain.—Patients reported the pain or tenderness in 10 sets of joints over the past 30 minutes in the morning, afternoon and end-of-day assessments [18]. Separate ratings were made for multiple joints or joint groups (e.g., knees, hips, hands) on a scale from 0 to 3 (0 = no pain/tenderness; 1 = mild pain/tenderness; 2 = moderate pain/tenderness; 3 = severe pain/tenderness). Items from three assessments within a day were averaged to create a mean score for patients' daily pain ($M = 0.59$, $SD = 0.47$, BP reliability = 1.00; WP reliability = 0.74).

Data Analysis

Multilevel modeling [33] was used to examine the associations between patients' pain catastrophizing in the morning and time patients spent in physical activity and sedentary behavior throughout the rest of the day. The data were structured hierarchically, with daily assessments (Level-1) nested within persons (Level-2). Thus, daily variables (e.g., pain catastrophizing, MVPA, steps, sedentary behavior) could vary over days within a person as well as across persons. Analyses were conducted using SAS PROC MIXED with restricted maximum likelihood (REML) to handle missing data and robust standard errors to adjust against the slight skewness of the residuals [15]. Three sets of multilevel models were used to examine the within-day prospective associations between patients' morning pain catastrophizing and subsequent MVPA, steps and sedentary behavior throughout that day respectively. Specifically, for each outcome (i.e., daily MVPA, daily steps or daily sedentary behavior), the model included the following fixed effects: the predictive effects of morning pain catastrophizing (predictor) and a set of covariates (morning negative affect, daily pain, daily accelerometer wear time, age, gender, race, employment, education, knee OA duration and overall knee pain severity). All Level-1 predictor (pain catastrophizing) and covariates (morning negative affect, daily pain, daily accelerometer wear time) were person-mean centered in these models. For the random effects, a random intercept only model and a random intercept and random slope model were fitted for each outcome respectively: the random intercept allows the mean score of the outcome to vary across individuals and the

random slope of the pain catastrophizing allows the association between daily pain catastrophizing and each outcome to vary between individuals. The likelihood ratio test was then used to compare these two random effects models with the same fixed effects. The random intercept only models were selected to report as the final models because the likelihood ratio tests suggested that the random slope of pain catastrophizing did not significantly improve the model fit for any outcome.

Diagnostic checks were conducted for each of these models. The results revealed that the distributions of the residuals of MVPA were slightly skewed (skewness of Level-1 and Level-2 residuals: 1.18 and 1.29) whereas the distributions of the residuals of daily steps and sedentary behavior were normal (skewness of Level-1 and Level-2 residuals of daily steps: 0.69 and 0.52; skewness of Level-1 and Level-2 residuals of sedentary behavior: -0.45 and -0.57). Thus, sensitivity analysis was conducted by using multilevel negative binomial models, which treated the outcomes (MVPV, daily steps and sedentary behavior) as count variables. Results from the sensitivity analysis (see Supplementary Table 1) suggest that the within-person effects of pain catastrophizing on MVPA, daily steps and sedentary behavior remained unchanged. All significant results were evaluated at $\alpha=.05$ level.

In addition to within-day analysis, we examined the cross-day lagged effect of pain catastrophizing by predicting day t 's MVPA, daily steps or sedentary behavior from day $t-1$ pain catastrophizing controlling for day t 's pain catastrophizing. Finally, the potential bidirectional lagged effect was tested by predicting day t 's morning pain catastrophizing from day $t-1$'s MVPA, daily steps or sedentary behavior.

Results

Descriptive Analyses

As shown in Table 1, the knee OA patients in the final sample were on average 65.39 years old ($SD = 9.53$), 87% of them self-identified as Caucasian, and 58% were women. On average, this sample of patients had knee OA for 12.75 years and reported mild-to-moderate severity of overall knee pain experienced in the past month ($M = 3.53$ on a 5-point scale).

As shown in Table 2, at the daily level, OA patients reported generally low levels of morning pain catastrophizing across 22 days ($M = 1.98$ on a 6-point scale), but the intraclass correlation (ICC) indicated that 32% of the total variance in pain catastrophizing occurred from day to day at the within-person level. On average, patients took 4,656.20 steps and spent 70.00 min (1.17 hours) in moderate-to-vigorous physical activity (MVPA) each day. They also spent 576.21 min (9.6 hours) each day in sedentary behavior. The amount of day-to-day within-person variability in steps and MVPA was 39% to 40% whereas the within-person variability in sedentary behavior was 50%. The correlations based on daily data aggregated at the person-level suggest that OA patients who catastrophized more (*vs.* less) about their pain engaged in fewer daily steps and less MVPA on average.

Primary Analyses

The within-day prospective effects of patients' morning pain catastrophizing on daily steps, daily MVPA time, and daily sedentary time were examined in three multilevel models that

controlled for patients' morning negative affect, joint pain throughout the day, accelerometer wearing time and individual differences in demographics, knee OA duration and overall level of knee pain severity (Table 3). As hypothesized, morning pain catastrophizing significantly predicted less time spent in MVPA ($b = -3.08$, $p = .006$, 95% CI [-5.27, -0.88]) and more time spent in sedentary behavior within the same day ($b = 5.50$, $p = .016$, 95% CI [1.04, 9.96]). Specifically, on days when patients had one unit higher than usual catastrophic thinking about their pain in the morning (on a 6-point scale), they spent 3.08 less minutes in MVPA and 5.50 more minutes in sedentary behavior that day. Morning pain catastrophizing also predicted fewer steps taken within the same day (111 fewer steps for 1 unit increase in pain catastrophizing), although this effect did not reach the significance level ($p = .088$, 95% CI [-238.99, 16.55]). Among other covariates, daily pain was significantly associated with more steps taken, more time spent in MVPA and less time spent in sedentary behavior in the same day. Gender (being female) and race (being non-White) significantly predicted less time spent in sedentary behavior; more years of education significantly predicted more daily steps and MVPA. Finally, patients with longer knee OA duration and higher overall knee pain severity in the past month had less physical activity each day than those with short OA duration or lower overall pain severity.

In order to explore whether patients' pain catastrophizing would influence their physical activity and sedentary behavior the next day, lagged analyses were conducted in which patients' pain catastrophizing on day $t-1$ predicted steps, MVPA or sedentary behavior on day t , while controlling for day t 's pain catastrophizing. As shown in Table 4, the results of these models suggested that morning pain catastrophizing did not significantly predict the next day's steps ($b = -15.64$, $p = .788$, 95% CI [-129.86, 98.59]) or time spent in MVPA ($b = -0.45$, $p = .667$, 95% CI [-2.50, 1.60]), but significantly predicted more time spent in sedentary behavior the next day ($b = 5.88$, $p = 0.030$, 95% CI [0.58, 11.17]). We then conducted lagged analyses to examine whether today's physical activity and sedentary behavior would influence the patients' pain catastrophizing the next morning. The results suggested that today's physical activity (steps and MVPA) did not significantly predict patients' pain catastrophizing ($p > 0.313$) in the next morning. However, the time (hours) that patients spent in sedentary behavior today significantly predicted greater pain catastrophizing the next morning ($b = 0.02$, $p = 0.002$, 95% CI [0.01, 0.03]). It is important to note that, this predictive effect of today's sedentary behavior on the next morning's pain catastrophizing was independent from the pain intensity experienced today, which also significantly predicted greater pain catastrophizing the next morning ($b = 0.32$, $p = 0.003$, 95% CI [0.11, 0.54]). Together, the cross-day lagged analyses highlight that the influences of pain catastrophizing on subsequent sedentary time could extend to the next day. More importantly, these results also suggest a cyclical process whereby days of greater pain catastrophizing in the morning leads to more sedentary time throughout the day, which in turn contributes to greater pain catastrophizing the next morning.

Discussion

Pain catastrophizing is an important psychological risk factor for a wide range of pain-related outcomes, including increased pain intensity, increased emotional distress, depression, decreased physical function, and prolonged disability [29,31,49]. One pathway

through which pain catastrophizing may lead to long-term pain persistence and other pain-related outcomes is through its impact on daily physical activity [47]. Physical activity is well documented as one of the most effective nonpharmacologic treatments to manage chronic pain, and sufficient physical activity can significantly improve pain and related health outcomes [2]. However, few empirical studies have examined how catastrophic thinking about pain could influence daily physical activity and sedentary behavior, including in older adults. Using a sample of older knee osteoarthritis (OA) patients and objective assessments of physical activity, the current study conducted robust tests of the predictive effects of morning pain catastrophizing on subsequent changes in physical activity and sedentary behavior throughout the day and across days, beyond the influences of the daily pain experience itself, negative affect, and individual differences in demographics and overall knee OA severity and duration. The results demonstrated that patients spent less time in moderate-to-vigorous physical activity (MVPA) but more time in sedentary behavior on days when they endorsed greater levels of catastrophic thinking about pain in the morning. The predictive effects of patients' pain catastrophizing also extended to their sedentary behavior the next day. Finally, patients reported greater pain catastrophizing in the morning if they spent more time than usual in sedentary behavior the previous day, suggesting that pain catastrophizing could be worsened by avoiding physical activities. These results provide strong evidence to support the hypothesized role of pain catastrophizing in affecting pain patients' physical activity in everyday life.

Theoretical and Practical Implications

Fear-avoidance, which refers to the avoidance of movements or activities based on fear, has been proposed as a central mechanism in the development of chronic pain problems [47]. Past research suggests that expectation, rather than experience, of pain may be responsible for avoidance behavior (e.g., avoidance of work, physical activity and social activity) [5,8,47]. Particularly, the negative appraisals about pain and its consequences, such as catastrophic thinking, are considered a potential precursor of pain-related fear and consequent avoidance of daily activities. Although a good deal of research has been conducted to examine the influence of pain catastrophizing on persistent pain [4], emotional distress [20,45,46], and physical performance in the lab setting [35, 36], relatively little research has examined the role played by pain catastrophizing in everyday physical activity, especially using objective assessments. To our knowledge, our study is the first to examine how fluctuations of day-to-day pain catastrophizing impact older OA patients' physical activity and sedentary behavior in daily life, independent of the pain experience itself. The clear temporal order established between pain catastrophizing and subsequent changes in physical activity and sedentary behavior in our study provides robust empirical evidence to support the fear-avoidance model and pain catastrophizing as an antecedent to avoidance behaviors [47]. In addition, our results showed that on days when patients catastrophized slightly more than usual in the morning (one unit higher on a 6-point scale), they spent 3 minutes less in MVPA but 6 minutes more in sedentary behavior that day. Although these decreases in physical activity and increases in sedentary behavior per day may seem to be of low magnitude, if accumulated over time, such daily changes in activity level would have significant detrimental influences on the health for older adults with OA, given the importance of physical activity for OA management and health.

Our findings also have important implications for pain management and wellness in older adult populations and future interventions designed to optimize whole-person health. Particularly, the results from our cross-day lagged analyses demonstrate a cyclical process of pain catastrophizing in older OA patients' daily life: greater pain catastrophizing in the morning leads to subsequent avoidance of physical activity (e.g., increased time spent in sedentary behavior), which in turn exacerbates patients' catastrophizing about pain on the following day. This result suggests that negative thoughts about pain impair engagement in future activities as well as being modified by activity level. Thus, pain catastrophizing should be considered an important therapeutic target for interventions aimed at reducing sedentary behavior and improving physical activity for older adults with chronic pain. Also, given that reduced activity facilitates greater pain in the long-term, our findings also underscore the need to assess and target psychological factors such as pain catastrophizing in an integrated pain treatment approach.

A recent meta-analysis of 79 randomized controlled trial studies demonstrates that pain catastrophizing can be reduced, with strongest (modest size) effects found for cognitive-behavioral therapy and multimodal treatments combining exercise and cognitive-behavioral therapy [31]. Although most health interventions that target pain catastrophizing are delivered through face-to-face sessions, there is growing evidence that novel mobile technology such as smartphones and sensors may allow just-in-time adaptive interventions, which are designed to deliver highly personalized treatments in real time and in one's natural environment [13,25,42]. The finding of the bidirectional association between daily pain catastrophizing and sedentary behavior in our study suggests that future interventions may yield stronger effects from using mobile technology to monitor patients' activity levels in everyday life and provide just-in-time adaptive interventions targeting patients' pain catastrophizing to reduce their sedentary behavior.

These findings also have high public health significance, as it is estimated that nearly half of U.S. adults will develop symptomatic knee OA in their lifetime [24]. Being physically active is one of the most effective non-pharmacological treatments of chronic pain [2,11], and has also been recommended to improve the overall health and prevent a large number of chronic diseases by the Physical Activity Guidelines for Americans [43]. However, the majority of adults with OA are not physically active [48] and spend even more time in sedentary behavior than the general population [44], likely due to the fear of pain [28]. As implied by our findings, reducing daily pain catastrophizing may help older patients increase physical activity and reduce time spent in sedentary behavior on a daily basis, which in the long-term could improve their chronic pain conditions, physical function, and overall health, and reduce the possibility of hospitalization, institutionalization and health care costs.

Limitations and Future Directions

It is important to acknowledge limitations of this research and important next steps for future research. First, our measurement of daily pain catastrophizing was designed to be brief and only captured the helplessness dimension of pain catastrophizing. Evidence from previous daily diary studies supported daily pain catastrophizing as a unidimensional factor [7], but future research may benefit from further examining whether other aspects of daily pain

catastrophizing, such as rumination and magnification, impact daily physical activity in a similar fashion. In addition, concerns have been raised by recent research about whether self-report measures of pain catastrophizing could distinctively assess this construct [6]. Future research needs to carefully consider the content overlap between pain catastrophizing and other pain-related constructs, as well as their predictive effects on physical activity and other outcomes. Second, our study demonstrates the effects of pain catastrophizing on the avoidance of physical activity. An interesting next step in this line of research is to examine the influences of pain catastrophizing on other avoidance behaviors in daily life, especially the avoidance of social activities and its psychological, cognitive and physical consequences for older adults. Given that social isolation and loneliness are major problem for older adults and are associated with increased morbidity and mortality [10,40], such research may help us better understand potential psychological risk factors (e.g. pain catastrophizing) for social isolation, and facilitate the development of interventions aimed to reduce social isolation among older adults and improve the overall health and life quality in later life. Finally, this study provided some evidence that pain catastrophizing could be modified by patients' daily sedentary behavior, but more research is needed to better understand what factors or mechanisms may contribute to the development of pain catastrophizing. Future research may also benefit from further exploring the dynamic interplay between daily activity and pain catastrophizing and how those dynamics may shape pain patients' experience and behavior over time.

Conclusions

Pain catastrophizing has been identified as a key predictor of pain intensity, distress, disability and overall adjustment to chronic pain. The impact of pain catastrophizing on physical activity is also critically important but has received much less attention. The current study extends the literature by demonstrating daily level mechanistic associations between pain catastrophizing and physical activity and sedentary behavior among older adults with chronic pain, thereby providing strong evidence to support the hypothesized role of pain catastrophizing in daily activity avoidance. These findings also identify the need for future just-in-time interventions to support adaptive cognitive patterns within the context of chronic pain in order to reduce their sedentary behavior and improve physical activity in everyday life.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research and the preparation of this manuscript were supported by the following grants: NIH/NIA R01 AG026010, NIH/NIA R03 AG067006 and NIH/NCCIH R01AT008561.

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Table 1

Demographic Characteristics of the Sample.

| Variable | <i>M or %</i> | <i>SD</i> |
|-----------------------------|----------------------|------------------|
| Gender (female) | 58.04% | |
| Age | 65.39 | 9.53 |
| Race (White) | 86.71% | |
| Employed (yes) | 42.66% | |
| Education (years) | 16.03 | 2.02 |
| Duration of knee OA (years) | 12.75 | 11.36 |
| Overall knee pain severity | 3.53 | 0.88 |

Note. N=143. OA= osteoarthritis. M= mean. SD= standard deviation.

Range for overall knee pain severity scale is 1 (none)-5 (severe).

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Table 2.

Descriptive Information and Correlations Between Key Study Variables.

| Variable | M | SD | ICC | 1 | 2 | 3 | 4 | 5 | 6 |
|----------------------------------|---------|---------|------|---------------------|---------------------|---------------------|------|------------------|----|
| 1. Morning pain catastrophizing | 1.98 | 0.85 | 0.68 | -- | | | | | |
| 2. Daily steps | 4656.20 | 2104.82 | 0.60 | -.28 ^{***} | -- | | | | |
| 3. Daily MVPA time | 70.00 | 43.16 | 0.61 | -.18 [*] | .82 ^{***} | -- | | | |
| 4. Daily sedentary behavior time | 576.21 | 88.25 | 0.50 | .02 | -.43 ^{***} | -.62 ^{***} | -- | | |
| 5. Morning negative affect | 0.54 | 0.64 | 0.48 | .36 ^{***} | -.13 | -.07 | .04 | -- | |
| 6. Daily pain | 0.59 | 0.47 | 0.91 | .42 ^{***} | -.22 ^{**} | -.11 | -.03 | .20 [*] | -- |

Note: N=143. M=mean, SD=standard deviation, ICC=intraclass correlation. MVPA= moderate-to-vigorous physical activity.

Ms, SDs and correlations were calculated based on aggregated data at the person level

*
 $p < 0.05$

**
 $p < 0.01$

 $p < 0.001$.

Table 3.

Results of Within-Day Prospective Analyses of Predicting Daily Steps, Daily MVPA Time and Daily Sedentary Time from Patients' Morning Pain Catastrophizing

| Fixed Effect | Daily Steps | | | Daily MVPA Time | | | Daily Sedentary Time | | |
|------------------------------|-------------|----------|----------|-----------------|--------|----------|----------------------|--------|----------|
| | Est. | SE | <i>p</i> | Est. | SE | <i>p</i> | Est. | SE | <i>p</i> |
| Intercept | 8599.740 | 1837.190 | .000 | 173.300 | 37.970 | .000 | 293.170 | 85.264 | .001 |
| Morning pain catastrophizing | -111.220 | 65.152 | .088 | -3.077 | 1.120 | .006 | 5.502 | 2.274 | .016 |
| Morning negative affect | 58.798 | 65.106 | .367 | 1.682 | 1.164 | .149 | -4.032 | 2.223 | .070 |
| Daily pain | 869.780 | 264.020 | .001 | 21.536 | 5.831 | .000 | -47.358 | 11.405 | .000 |
| Accelerometer wearing time | 361.440 | 34.501 | .000 | 4.323 | 0.606 | .000 | 37.574 | 1.486 | .000 |
| Age | -74.143 | 18.511 | .000 | -1.906 | 0.342 | .000 | 3.292 | 0.755 | .000 |
| Gender (Female) | -68.254 | 275.290 | .805 | -3.731 | 5.977 | .534 | -36.605 | 13.250 | .007 |
| Race (White) | -28.752 | 417.710 | .945 | -12.648 | 10.324 | .223 | 50.247 | 22.032 | .024 |
| Employed (Yes) | 506.000 | 340.920 | .140 | 1.171 | 6.916 | .866 | 22.786 | 17.108 | .185 |
| Education (years) | 180.500 | 74.662 | .017 | 3.310 | 1.587 | .039 | 1.128 | 3.538 | .750 |
| Duration of knee OA (years) | -38.308 | 9.751 | .000 | -0.648 | 0.228 | .005 | 0.395 | 0.532 | .460 |
| Overall knee pain severity | -614.050 | 166.250 | .000 | -3.439 | 3.174 | .281 | -3.000 | 7.605 | .694 |

Note: N=143 patients, n=2,238 observations used in the models. Est., unstandardized coefficients; SE, standard error. MVPA= moderate-to-vigorous physical activity. All day-level predictors were person-mean centered and represent within-person effects.

Table 4.

Results of Cross-Day Lagged Analyses of Predicting Day t Steps, MVPA Time and Sedentary Time from Day t-1 Morning Pain Catastrophizing

| Fixed Effect | Day t Steps | | | Day t MVPA Time | | | Day t Sedentary Time | | |
|--------------------------------------|-------------|----------|----------|-----------------|--------|----------|----------------------|--------|----------|
| | Est. | SE | <i>p</i> | Est. | SE | <i>p</i> | Est. | SE | <i>p</i> |
| Intercept | 8729.820 | 1874.000 | .000 | 176.840 | 38.740 | <.0001 | 303.270 | 87.143 | .001 |
| Day t-1 morning pain catastrophizing | -15.635 | 58.242 | .788 | -0.450 | 1.043 | 0.667 | 5.878 | 2.700 | .030 |
| Day t morning pain catastrophizing | -89.499 | 66.823 | .181 | -2.731 | 1.205 | 0.024 | 4.997 | 2.497 | .046 |
| Day t morning negative affect | 39.433 | 76.093 | .604 | 1.632 | 1.312 | 0.214 | -3.030 | 2.445 | .216 |
| Day t pain | 988.510 | 284.990 | .001 | 22.834 | 6.702 | 0.001 | -54.918 | 13.053 | .000 |
| Day t accelerometer wearing time | 370.750 | 36.301 | .000 | 4.336 | 0.611 | <.0001 | 37.217 | 1.565 | .000 |
| Age | -72.258 | 18.680 | .000 | -1.833 | 0.344 | <.0001 | 3.081 | 0.776 | .000 |
| Gender (Female) | -47.053 | 278.260 | .866 | -2.427 | 5.823 | 0.678 | -41.841 | 13.382 | .002 |
| Race (White) | 8.952 | 431.630 | .984 | -7.978 | 9.565 | 0.406 | 42.004 | 19.301 | .031 |
| Employed (Yes) | 494.640 | 350.380 | .160 | 0.621 | 6.897 | 0.928 | 25.405 | 17.704 | .154 |
| Education (years) | 182.320 | 75.063 | .017 | 2.840 | 1.538 | 0.067 | 1.299 | 3.492 | .711 |
| Duration of knee OA (years) | -39.675 | 9.855 | .000 | -0.734 | 0.216 | 0.001 | 0.547 | 0.525 | .299 |
| Overall knee pain severity | -693.050 | 170.240 | .000 | -4.601 | 3.228 | 0.156 | -1.286 | 7.904 | .871 |

Note: N=143 patients, n=1,987 observations used in the models. Est., unstandardized coefficients; SE, standard error. MVPA= moderate-to-vigorous physical activity. All day-level predictors were person-mean centered and represent within-person effects.