Low Back Pain Flares
How do They Differ From an Increase in Pain?

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Objective: The term flare is commonly used to describe low back pain (LBP) fluctuations, but individuals with LBP consider that it does not always correspond to increased pain. This case cross-over study aimed to: (1) determine the extent to which days with a flare identified according to a multidimensional definition (self-reported flare, SRF) corresponded to days with greater than average pain (pain-defined flare, PDF) and (2) to investigate whether physical and psychosocial features differ between PDF and SRF.

Materials and Methods: Individuals with LBP for $\geq$3 months (N = 126) provided data on flares, physical, and psychosocial features daily for 28 days using a smartphone application.

Results: Most days with SRF (68%) did not have greater than average pain (ie, PDF), but most days with greater than average pain (64%) were reported as an SRF. On days with SRF-only all physical and psychosocial features were worse than nonflare days. SRF+PDF had lower sleep quality and higher pain intensity, fatigue, disability, pain catastrophizing, and fear avoidance than SRF-only. SRF+PDF had higher pain in the afternoon and evening, disability and pain catastrophizing than PDF-only. Self-efficacy at work and during leisure activities was worse on SRF+PDF days than SRF-only and PDF-only days.

Discussion: These findings highlight that when individuals with LBP consider they have a flare, they do not always have greater than average pain, but have worse psychosocial features. This emphasizes that flare has broader dimensions than pain alone. Consideration of flare according to broad dimensions is important when investigating symptom fluctuations across different LBP trajectories.

Key Words: low back pain, flares, pain intensity, case-control, trajectories

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Low back pain (LBP) is an extremely common symptom and a leading contributor to the global burden of disease.[1] Almost everyone experiences LBP at least once and many experience LBP fluctuations across the lifetime.[2–4] An important issue is that not all fluctuations are considered meaningful to an individual.[5] Meaningful fluctuations in symptoms are often referred to as flares.[5–7] LBP flares are associated with functional limitations, opioid use, physician visits, depressive symptoms, and inability to work.[7–10] Employees who experience exacerbations in LBP incur high costs and account for most loss of productivity.[11]

An important goal of LBP treatments is to decrease the frequency and severity of flares. An emerging issue is that many studies of LBP treatments focus on pain intensity as a primary outcome,[12] but individuals with LBP argue that flare is not characterized by pain alone.[5–7] Although decreased pain is relevant, this may not be sufficient to identify reduced flaring of the condition. It is increasingly recognized in many musculoskeletal conditions that the definition of flare requires consideration of it as a multidimensional experience with domains in addition to pain.[13] For LBP, the impact of pain on function and emotions are important features that distinguish a flare.[5,6] A recent multiphase process that included perspectives of consumers and experts achieved a consensus definition for LBP flare that distinguishes it from other changes in pain intensity and includes the broader dimensions.[6]

The subjective nature of the pain experience reinforces the need to consider personal perceptions of LBP flares and there is variation in perspective. Although many consider LBP flare according to the broad definition discussed above, others consider it to be equivalent to an increase in pain.[5] Adding to the complexity, some individuals consider they have LBP flare even when they are pain free.[7,14] The foundation for the consideration of flare according to broad multidimensional criteria is based on qualitative research of the experience of people living with LBP.[5,6] What is missing is empirical data to compare the experience of pain fluctuation and flare over time, and to compare the physical and psychosocial features of LBP events characterized by pain increase or report of flare.

This case cross-over study aimed to: (1) determine whether there was overlap between flares defined by a pain increase (pain-defined flare, PDF) or flares identified according to a broader definition of flare (self-reported flare, SRF) and (2) to investigate whether physical and psychosocial features differ between PDF and SRF. We hypothesized that some days, but not all, with an increase in pain (ie, PDF) would be identified as an SRF, and that SRF would be distinguished from PDF by worse psychosocial features.

MATERIALS AND METHODS

Participants

In all, 126 participants were recruited primarily thorough advertisements placed on social medial and in the community. We also invited participants who had completed other studies investigating LBP to participate in this study. Inclusion criteria: age between 18 and 50 years, LBP lasting for at least 3 months, access to a smartphone or internet, good understanding of spoken and written English, and no history of spinal surgery or a major disease/disorder other than LBP. The Institutional Medical Research Ethics Committee approved the study and participants provided informed consent. Participants were also involved in another study.[15] Participants were given a Fitbit activity monitor on completion of the 28-days of data entry.

Baseline and Follow-up Assessments

At baseline, participants answered a series of online questionnaires regarding the duration of LBP, current pain intensity, age, sex, and presence of comorbidities. They also downloaded the smartphone application (RealLife Exp; LifeData) to report data each day for 28 consecutive days. This application was used to administer brief questionnaires, prompt participants to respond to them, record their responses, and transmit them to the server. The application was programmed to prompt participants to enter data 3 times per day: morning (randomly selected time between 6 and 10 AM, different each day), afternoon (randomly selected time between 12 and 6 PM, also different each day), and evening (at 8 PM for all participants, with the instruction to complete before going to bed). The variables assessed at each time point were:

Morning

Sleep quality: Participants rated their sleep quality on the previous night on an 11-point Numeric Rating Scale (NRS) anchored with "very bad" at 0 and "very good" at 10.
Sleep duration: Number of hours and minutes of sleep was recorded in response to the question—"*How many hours of actual sleep did you have last night [may be different than hours spend in bed]?*"
Pain: Morning pain intensity was assessed using an 11-point pain NRS anchored with "no pain" at 0 and "worst pain possible" at 10.

Afternoon

Pain: Current pain intensity was rated on the pain NRS.

Evening

Pain: Assessed using the pain NRS. Participants were prompted to indicate their average pain score of the day.
SRF: Flare was defined as: "*an increase in pain or other related symptoms that lasts from hours to weeks and is difficult to settle. You may also have mood changes and/or difficulty with your normal activity*." This was an interim version of a definition derived using a consensus process to identify a definition that was meaningful to experts and individuals with LBP.[6] After being presented the definition, participants answered the following question: "*Did you experience a flare of low back pain today?*" SRF was identified through an affirmative response to the question.
Fear avoidance (FA): Assessed using a single question from the Fear Avoidance Beliefs Questionnaire[16]: "*Physical activity might harm my back*." Participants were asked to rate the extent to which this statement described them on that day, using a 7-point scale (anchored with: 0—not at all, 3—moderately, 6—very much). This question considers one aspect of the Fear Avoidance Beliefs Questionnaire and cannot be considered to be equivalent or have the same psychometric properties as the entire questionnaire. It was considered unfeasible to use the entire questionnaire each day for 28 days and that using a single question that related to a key interest of this study (relationship between psychosocial, physical features, and flare) would provide insight into this domain.
Pain catastrophizing (PC): Assessed using a single question from the Pain Catastrophizing Scale[17]: "*I keep thinking about how much it hurts*." Participants were asked to rate the extent to which this statement described them on that day on a 7-point scale (0—not at all, 3—moderately, 6—very much). This question was selected as one aspect of catastrophizing that could be indicative to this state. Again, this was not expected to reflect the properties of the entire questionnaire.
Pain self-efficacy (SE): Assessed using 2 questions from the Pain Self-Efficacy Questionnaire[18]: "*I can do some form of work despite the pain*" (SE1) and "*I can still do many of the things I enjoy, such as hobbies or leisure activity, despite the pain*" (SE2). Participants used a 7-point scale to rate the extent to which these 2 statements applied to them on that day.
Physical activity: Participants indicated whether they engaged in any physical activity for transportation (yes/no) and during their leisure time (yes/no).
Fatigue: Perceived fatigue was assessed using the question: "*How fatigued were you today?*" Participants rated their fatigue using an 11-point NRS anchored with 0—not fatigued to 10—extremely fatigued.
Disability: Pain-related disability was assessed using the 24-item Roland Morris Disability Questionnaire.[19] Each item applicable to the participant receives a score of 1, with the total score varying from 0 (no disability) to 24 (severe disability).
Work: Participants indicated whether they engaged in paid work (yes/no).
Medication: Assessed using the question: "*Did you take medication for your low back pain today?*" (yes/no).
Treatment: Assessed through the following question: "*Did you get other treatment for your low back pain today?*" (yes/no).

Identification of SRFs, PDFs, and Nonflare Days

On the basis of each participant's daily responses, flares were identified in 2 ways. First, SRFs were identified by an affirmative answer to the SRF daily question asked in the evening. Second, PDFs were retrospectively identified from the data as days in which pain reported on the NRS was 2 or more points above the average pain scores across all days without an SRF (within-subject, calculated at the end of the study). We defined PDF as a 2-point increase over the patient average for 2 reasons. First, this is the value that has been used in previous studies of flares for other musculoskeletal conditions.[20] Second, this value is aligned with the proposed minimal important change previously recommended in the literature.[21,22] Nonflare days were defined as days when no flare was reported (ie, no SRF) and, in addition, pain was not > 2 points above the mean pain (ie, no PDF). SRF, PDF, and nonflare days were identified using custom programs written in MatLab 2014b (The MathWorks, Natick, MA).

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TABLE 1. Frequency of Flare Type With Respect to Sex and Duration of LBP

	n (%)		
Flare Types	**SRF-only**	**PDF-only**	**SRF+PDF**
No. participants	94	47	64
Sex			
Female (n = 64)	58 (90.6)	34 (53.1)	43 (67.2)
Male (n = 41)	36 (87.8)	13 (31.7)	21 (51.2)
LBP duration			
10 wk to 1 y (n = 26)	25 (96.2)	14 (53.8)	17 (65.4)
1 to 5 y (n = 34)	32 (94.1)	13 (38.2)	24 (70.6)
> 5 y (n = 45)	37 (82.2)	20 (44.4)	23 (51.1)

%—percentage of participants of each sex or LBP duration with a specific flare type.

LBP indicates low back pain; PDF, pain-defined flare; SRF, self-reported flare.

Statistical Analysis

Analyses were carried out in Stata, version 15 (StataCorp, College Station, TX). Two analysis approaches were performed. First, to address the primary aim, descriptive statistics were used to calculate the percentages of overlap between SRF and PDF, days that were SRF-only and days that were PDF-only over flare days. For the second aim, physical and psychosocial data were then compared between the different types of flare days in several ways. Significance was set at P-value < 0.05.

Continuous variables were assessed by fitting a mixed linear regression model. Random intercepts for participants were included to account for multiple measurements from each participant, and fixed effects for SRF and PDF flare days, and an interaction between the 2 types of flare were included. These regression models were interrogated to compare average outcomes on SRF-only days with nonflare days, PDF-only days to nonflare days, SDF+PDF to nonflare days, all SRF (SRF-only and SRF+PDF) to nonflare days, all PDF (PDF-only and SRF+PDF) to nonflare days, SRF-only to PDF-only, SRF-only to SRF+PDF, and PDF-only to SRF+PDF.

For binary variables, mixed logistic regression models were fit to determine whether the odds of the presence of these variables differed during flare (all SRF, all PDF, SRF-only, PDF-only) and nonflare periods. Models included random effects for participants, and fixed effects for SRF and PDF flare days, and an interaction between the 2 types of flare. As for the comparison of binary outcomes, logistic regression models were interrogated to yield comparisons between different types of flare and nonflare days.

As an additional analysis, we investigated whether SRF and PDF were independent from each other. For this analysis χ^2 tests were used to compare the frequency of PDFs which occurred 1 day after an SRF with the frequency SRFs which occurred 1 day after PDF. This was repeated for 2 and 3 days and compared with nonflare days.

RESULTS

A total of 126 participants were recruited for the study. Data for 14 participants were excluded (8 participants withdrew from the study, 5 participants had missing data, and 1 participant had no days without flares). Of the included participants, 105 had flares. Over half of the sample were women (60%) and the mean (SD) age was 32 (9) years. The mean (SD) of average pain over the week preceding inception into the study was 4.4 (2). Just over half (52%) of participants reported experiencing days without pain, ranging from 1 to 20 consecutive days. The remaining 48% of participants reported pain every day. Participants provided flare data for 27 (lower quartile: 25, upper quartile: 30) days. Table 1 summarizes the number of participants that had each flare type (SRF-only, PDF-only, and SRF+PDF) with respect to their sex and duration of LBP history.

How Often do SRF and PDF Overlap?

A total of 813 flare days were identified as either SRF-only, PDF-only, or SRF+PDF out of 3082 days of data recorded. Of those, 57% (N = 465) were SRF-only, 27% (N = 222) were both SRF and PDF, and 15% (N = 126) were PDF-only (Fig. 1). This means that of the 687 days with SRF, most (N = 465, 68%) were not accompanied by pain that exceeded the mean of the data collection period by > 2 points (PDF) (Fig. 1), and for 126 (36%) of the days with PDF (N = 348), participants did not consider they had a flare (Fig. 1).

Comparison of Physical and Psychosocial Features Between Flare Classifications

Table 2 shows all the summary results and tests for this comparison. Comparisons of PDF-only and SRF-only showed that pain in the morning, afternoon (random), and evening were higher on PDF-only days. Fatigue, disability, PC, and FA were also higher on days that were PDF-only than SRF-only.

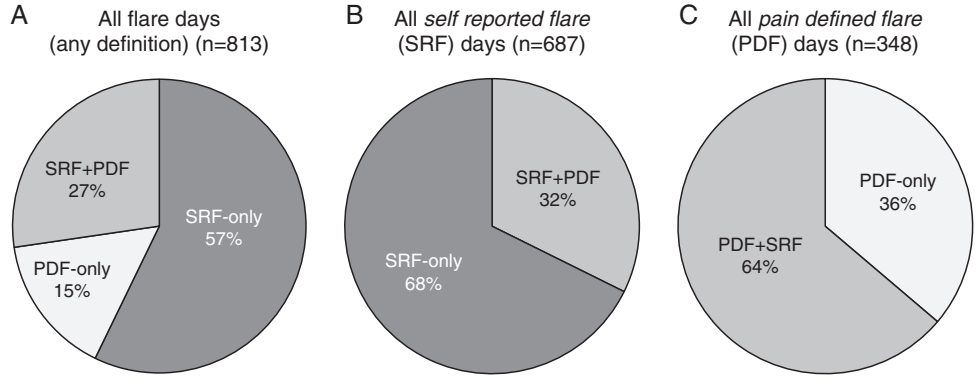

FIGURE 1. Summary of the overlap between days identified as self-reported flare (SRF) and pain-defined flare (PDF). Percentage of days with and without overlap between flares of different definitions is shown for all flare days (either PDF or SRF or both) (A), all SRF days (B), and all PDF days (C). The total number of days identified by each definition is shown.

TABLE 2. Comparisons of Physical and Psychosocial Features Between SRF-only, PDF-only, and SRF+PDF

	Mean (SE)			Regression Coefficient (95% CI), *P*		
Features	**SRF-only**	**PDF-only**	**SRF+PDF**	**SRF-only vs. PDF-only**	**SRF+PDF vs. SRF-only**	**SRF+PDF vs. PDF-only**
Sleep quality	6.14 (0.16)	5.83 (0.22)	5.62 (0.19)	0.31 (−0.10 0.72), 0.14	−0.52 (−0.87, −0.18), 0.003	−0.21 (−0.65, 0.23), 0.34
Sleep hours	6.85 (0.12)	6.72 (0.16)	6.73 (0.14)	0.13 (−0.18, 0.44), 0.42	−0.12 (−0.39, 0.14), 0.36	0.005 (−0.33, 0.34), 0.98
Pain morning	2.71 (0.18)	3.75 (0.21)	3.87 (0.20)	−1.04 (−1.35, −0.72), <0.001	1.16 (0.90, 1.43), <0.001	0.13 (−0.21, 0.46), 0.46
Pain random	3.09 (0.18)	4.22 (0.21)	4.81 (0.19)	−1.13 (−1.45, −0.80), <0.001	1.72 (1.46, 1.97), <0.001	0.59 (0.25, 0.93), 0.0008
Pain evening	3.43 (0.17)	5.95 (0.18)	6.25 (0.17)	−2.52 (−2.73, −2.31), <0.001	2.82 (2.65, 2.99), <0.001	0.30 (0.08, 0.52), 0.007
Fatigue	4.80 (0.18)	5.27 (0.23)	5.64 (0.20)	−0.47 (−0.86, −0.08), 0.017	0.83 (0.52, 1.15), <0.001	0.36 (−0.05, 0.77), 0.084
RMDQ	5.40 (0.43)	6.74 (0.47)	8.25 (0.45)	−1.34 (−1.85, −0.83), <0.001	2.85 (2.44, 3.26), <0.001	1.51 (0.98, 2.05), <0.001
PCS	2.22 (0.12)	2.74 (0.14)	3.21 (0.13)	−0.52 (−0.71, −0.34), <0.001	0.99 (0.84, 1.15), <0.001	0.47 (0.27, 0.67), <0.001
Fear avoidance	2.64 (0.15)	2.92 (0.16)	3.12 (0.15)	−0.28 (−0.48, −0.08), 0.005	0.48 (0.32, 0.65), <0.001	0.20 (−0.008, 0.41), 0.059
SE1	4.30 (0.13)	4.27 (0.15)	3.89 (0.14)	0.03 (−0.19, 0.25), 0.78	−0.41 (−0.59, −0.23), <0.001	−0.38 (−0.61, −0.15), 0.001
SE2	4.16 (0.14)	3.86 (0.16)	3.43 (0.14)	0.30 (0.10, 0.50), 0.0037	−0.73 (−0.89, −0.57), <0.001	−0.43 (−0.64, −0.22), <0.001

CI indicates confidence interval; PCS, Pain Catastrophizing Scale; PDF, pain-defined flare; RMDQ, Roland Morris Disability Questionnaire; SE1, self-efficacy (work); SE2, self-efficacy (leisure); SRF, self-reported flare.

Self-efficacy for leisure activities was lower (worse) for PDF-only than SRF-only days.

Pain intensity at random times in the afternoon and evening, disability and PC were higher when PDF was also identified as an SRF than a PDF alone (Table 2). Self-efficacy at work and leisure were lower (ie, worse) when a PDF was accompanied by an SRF, than PDF alone.

Days that were identified as both SRF and PDF were characterized by lower sleep quality and higher pain intensity at all times (ie, morning, at random times during the afternoon and evening) than days that were SRF-alone. Likewise, fatigue, disability, PC, and FA were higher in days characterized by both flare definitions than SRF-alone. SE at work and leisure were worse for SRF+PDF than SRF-only.

Comparison of Features Between Flare and Nonflare Days

For both SRF (ie, all SRF = SRF-only and SRF+PDF days) and PDF (ie, all PDF = PDF-only and PDF+SRF) all pain, disability, fatigue, PC, FA, and SE measures were worse than those reported on nonflare days (Table 3). Sleep quality and hours did not differ. Although SRF-only days excluded days that were also PDF (ie, days where pain >2 points above average), pain reported during SRF-only days was significantly greater than that on nonflare days at all measurement times. All other variables, except sleep variables, were worse for SRF-only than nonflare days (Table 4). Days defined as PDF-only were characterized by worse pain (at all measurement times), fatigue, disability, PC, FA, and SE than nonflare days (Table 5).

Taking Action: Medication, Treatment, and Engaging in Physical Activity as Transport

Individuals were more likely to take medication and seek treatment during flare (any definition) days than in nonflare days (Table 6). SRF days were also associated with greater engagement in physical activity as a means of transport than nonflare days.

Additional Analysis of Independence of PDF and SRF

The results of the χ^2 tests of independence of the 2 flare types showed that all comparisons were significant ($P<0.001$; Supplementary Tables 1–9, Supplemental Digital Content 1, http://links.lww.com/CJP/A735), which suggests that PDF and SRF are not independent. To gain further insights into which order of events is more likely we considered the percentage of PDFs that occurred after SRFs and nonflare days, as well as the percentage of SRFs that occurred after PDFs and nonflare days (Table 7). These values indicate that it is more common for an SRF to follow a nonflare day than a PDF, it is more common for a PDF to follow a nonflare day than an SRF, and it is more common to experience greater pain (PDF) after reporting a flare (SRF) than reporting a flare after increased pain.

DISCUSSION

This study has shown that individuals often reported flares even when they did not experience pain that was >2 points above their average pain across all days without an SRF. Conversely, there were days in which pain was greater than this threshold, but they did not report a flare. Together these observations highlight that an individual's perception of LBP flare is not the same as an increase in pain.

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TABLE 3. Comparisons of Physical and Psychosocial Features Between All SRF, All PDF, and Nonflare Days

	Mean (SE)			Regression Coefficient (95% CI), *P*	
Features	**All SRF**	**All PDF**	**Nonflare**	**All SRF vs. Nonflare**	**All PDF vs. Nonflare**
Sleep quality	6.08 (0.15)	5.78 (0.19)	5.92 (0.13)	0.17 (−0.04, 0.38), 0.11	−0.19 (−0.48, 0.10), 0.20
Sleep hours	6.84 (0.11)	6.72 (0.14)	6.93 (0.09)	−0.06 (−0.22, 0.10), 0.43	−0.18 (−0.41, 0.04), 0.10
Pain morning	2.85 (0.18)	3.78 (0.20)	2.43 (0.17)	0.26 (0.10, 0.42), 0.001	1.28 (1.06, 1.50), <0.001
Pain random	3.28 (0.17)	4.35 (0.20)	2.45 (0.16)	0.64 (0.48, 0.79), <0.001	1.76 (1.53, 2.00), <0.001
Pain evening	3.74 (0.17)	6.01 (0.18)	2.47 (0.16)	0.88 (0.78, 0.99), <0.001	3.33 (3.18, 3.48), <0.001
Fatigue	4.90 (0.17)	5.35 (0.20)	4.47 (0.16)	0.33 (0.14, 0.52), 0.0007	0.81 (0.53, 1.09), <0.001
RMDQ	5.72 (0.43)	7.08 (0.45)	4.01 (0.42)	1.40 (1.15, 1.65), <0.001	2.76 (2.39, 3.12), <0.001
PCS	2.33 (0.12)	2.85 (0.13)	1.43 (0.11)	0.75 (0.66, 0.84), <0.001	1.24 (1.11, 1.37), <0.001
Fear avoidance	2.69 (0.15)	2.97 (0.16)	2.09 (0.14)	0.51 (0.41, 0.61), <0.001	0.75 (0.61, 0.90), <0.001
SE1	4.25 (0.13)	4.18 (0.14)	4.54 (0.12)	−0.26 (−0.36, −0.15), <0.001	−0.30 (−0.46, −0.14), 0.0002
SE2	4.08 (0.14)	3.77 (0.15)	4.50 (0.13)	−0.35 (−0.45, −0.25), <0.001	−0.66 (−0.80, −0.51), <0.001

CI indicates confidence interval; PCS, Pain Catastrophizing Scale ("I keep thinking about how much it hurts"); PDF, pain-defined flare; RMDQ, Roland Morris Disability Questionnaire; SE1, self-efficacy (work—"I can do some form of work, despite the pain"); SE2, self-efficacy (leisure—"I can still do many of the things I enjoy, such as hobbies or leisure activity, despite the pain"); SRF, self-reported flare.

TABLE 4. Comparisons of Physical and Psychosocial Features Between SRF-only and Nonflare Days

	Mean (SE)		
Features	**SRF-only**	**Nonflare**	**SRF-only vs. Nonflare, Regression (95% CI), *P***
Sleep quality	6.14 (0.16)	5.92 (0.13)	0.22 (−0.008, 0.445), 0.059
Sleep hours	6.85 (0.12)	6.93 (0.09)	−0.07 (−0.25, 0.10), 0.41
Pain morning	2.71 (0.18)	2.43 (0.17)	0.28 (0.11, 0.45), 0.001
Pain random	3.09 (0.18)	2.45 (0.16)	0.65 (0.48, 0.81), <0.001
Pain evening	3.43 (0.17)	2.47 (0.16)	0.96 (0.85, 1.07), <0.001
Fatigue	4.80 (0.18)	4.47 (0.16)	0.33 (0.12, 0.53), 0.0019
RMDQ	5.40 (0.43)	4.01 (0.42)	1.39 (1.12, 1.66), <0.001
PCS	2.22 (0.12)	1.43 (0.11)	0.79 (0.69, 0.89), <0.001
Fear avoidance	2.64 (0.15)	2.09 (0.14)	0.55 (0.44, 0.65), <0.001
SE1	4.30 (0.13)	4.54 (0.12)	−0.24 (−0.36, −0.12), <0.001
SE2	4.16 (0.14)	4.50 (0.13)	−0.34 (−0.45, −0.23), <0.001

CI indicates confidence interval; PCS, Pain Catastrophizing Scale; RMDQ, Roland Morris Disability Questionnaire; SE1, self-efficacy (work); SE2, self-efficacy (leisure); SRF, self-reported flare.

TABLE 5. Comparisons of Physical and Psychosocial Features Between PDF-only and Nonflare Days

	Mean (SE)		
Features	**PDF-only**	**Nonflare**	**PDF-only vs. Nonflare, Regression Coefficient, (95% CI), *P***
Sleep quality	5.83 (0.22)	5.92 (0.13)	−0.09 (−0.45, 0.26), 0.61
Sleep hours	6.72 (0.16)	6.93 (0.09)	−0.20 (−0.48, 0.07), 0.15
Pain morning	3.75 (0.21)	2.43 (0.17)	1.31 (1.04, 1.59), <0.001
Pain random	4.22 (0.21)	2.45 (0.16)	1.77 (1.48, 2.06), <0.001
Pain evening	5.95 (0.18)	2.47 (0.16)	3.48 (3.29, 3.66), <0.001
Fatigue	5.27 (0.23)	4.47 (0.16)	0.80 (0.46, 1.14), <0.001
RMDQ	6.74 (0.47)	4.01 (0.42)	2.73 (2.28, 3.18), <0.001
PCS	2.74 (0.14)	1.43 (0.11)	1.31 (1.14, 1.47), <0.001
Fear avoidance	2.92 (0.16)	2.09 (0.14)	0.83 (0.66, 1.01), <0.001
SE1	4.27 (0.15)	4.54 (0.12)	−0.27 (−0.46, −0.08), 0.006
SE2	3.86 (0.16)	4.50 (0.13)	−0.64 (−0.81, −0.46), <0.001

CI indicates confidence interval; PCS, Pain Catastrophizing Scale; PDF, pain-defined flare; RMDQ, Roland Morris Disability Questionnaire; SE1, self-efficacy (work); SE2, self-efficacy (leisure).

TABLE 6. Association Between Changes in Medication Usage, Treatment, PA for Transport, Leisure, and Work and Odds of SRF, PDF, SRF-only, PDF-only

Features	Mean (SD)					OR (95% CI), *P*			
	All SRF Number of Days*	SRF-only Number of Days*	All PDF Number of Days*	PDF-only Number of Days*	Nonflare Number of Days*	All SRF vs. Nonflare	All PDF vs. Nonflare	SRF-only vs. Nonflare	PDF-only vs. Nonflare
Medication	0.22 (0.42)	0.20 (0.40)	0.21 (0.41)	0.11 (0.32)	0.07 (0.26)	4.77 (1.93, 11.79), <0.001	3.91 (1.29, 11.85), 0.016	5.06 (3.22, 7.98), <0.001	4.40 (2.04, 9.47), <0.001
Treatment	0.06 (0.23)	0.06 (0.23)	0.07 (0.25)	0.07 (0.26)	0.02 (0.14)	2.58 (0.91, 7.31), 0.075	3.84 (1.18, 12.45), 0.025	3.02 (1.64, 5.55), <0.001	5.23 (2.20, 12.41), <0.001
PA Transport	0.26 (0.44)	0.28 (0.45)	0.19 (0.39)	0.16 (0.36)	0.20 (0.40)	1.48 (0.67, 3.25), 0.33	1.17 (0.43, 3.21), 0.75	1.47 (1.04, 2.06), 0.027	1.16 (0.61, 2.20), 0.65
PA Leisure	0.31 (0.46)	0.29 (0.46)	0.30 (0.46)	0.22 (0.42)	0.28 (0.45)	1.20 (0.59, 2.45), 0.62	0.81 (0.33, 2.00), 0.65	1.10 (0.83, 1.46), 0.50	0.69 (0.41, 1.15), 0.15
PA Work	0.48 (0.50)	0.46 (0.50)	0.50 (0.50)	0.50 (0.50)	0.45 (0.50)	1.06 (0.52, 2.13), 0.87	1.43 (0.59, 3.43), 0.42	1.07 (0.82, 1.41), 0.61	1.47 (0.91, 2.38), 0.12

*Number of days the feature was present.
CI indicates confidence interval; OR, odds ratio; PA, physical activity; PDF, pain-defined flare; SRF, self-reported flare.

TABLE 7. Percentage of PDF and SRF Days After SRF, PDF, and Nonflare Days

	SRF After PDF	SRF After Nonflare	PDF After SRF	PDF After Nonflare
1 d	12.8	70.9	25.1	67.4
2 d	8.9	77.2	24.3	69.7
3 d	6.0	82.1	17.8	79.0

PDF indicates pain-defined flare; SRF, self-reported flare.

Individuals Do Not Consider Their Condition to Be Flared Simply on the Basis of Greater Than Average Pain

Although, when pain intensity was considered over all SRFs (including those with PDF), the pain intensity was higher than nonflare days, most SRF days (68%) were not characterized by greater than average pain. Pain intensity is an important feature of a flare in LBP and other musculoskeletal conditions,[13] but our data highlight that it was not a prerequisite for a flare. This aligns with the opinion of people with LBP that flare is not necessarily the same as, or only, an increase in pain.[5]

The flare definition used here was derived from perspectives of individuals with LBP and experts, and aimed to differentiate LBP flares from other symptom fluctuations.[6] The definition highlights flare as a multidimensional experience that is characterized by domains other than pain. Several findings presented here provide further insight into the multidimensional nature of LBP flares. First, days with greater than average pain were often *not* considered to be an SRF (36% of PDF days). This again indicates that pain alone does not determine the occurrence of a flare.

Second, pain, disability, PC, and SE at work and leisure were worse when flare was identified by PDF+SRF than when flare was characterized only by pain (PDF). This supports the hypothesis that psychosocial features may impact an individuals' perception of flare. In this context, it seems that greater than average pain was not enough for individuals to consider they were experiencing a flare, unless it was accompanied by broader dimensions.

Third, psychosocial features were worse for days identified as SRF-only than nonflare days. Of note, although pain was not >2 above average on the days that were SRF-alone (because it excluded PDF days), pain was still greater for SRF-alone than nonflare days. This suggests that when psychosocial features were elevated, even a smaller increase in pain was sufficient to be considered a flare. Yet, contrary to this notion, most psychosocial variables were higher for days with PDF-alone than SRF-alone. That is, despite high pain and poor measures of psychosocial well-being, some days with greater than average pain were not considered a flare. Although this relates to a small proportion of PDF days (15%), it highlights that an understanding of an individual's perception of flare requires consideration of an array of factors that is more complex than those included here.

Fourth, when SRF co-occurred with pain greater than average, it involved worse psychosocial features than when SRF was reported without greater than average pain. This was characterized by worse sleep quality, more disability, fatigue, FA and catastrophizing, and lower SE at both work and leisure time, and highlights that pain *is* an important consideration.

Two additional insights regarding SRF come from ancillary analyses in the study. Analysis of the characteristics of participants reporting each flare type suggests that participants with a longer history of LBP tended to be less likely to report SRF-only than those with shorter LBP duration, and female participants were more likely than men to experience a PDF or PDF+SRF. This has implications for interpretation of changes in reporting of flares over time and sex differences. The additional analysis indicated that PDF and SRF were not independent. Most notably, having higher pain (PDF) is not necessarily a precursor to a flare, but a flare (SRF) is commonly a precursor to more pain. This has potential implications for understanding the participant's interpretation of SRF and requires further investigation.

Relationship Between Sleep and Flare

Poor sleep duration and quality on days without flare have been shown to increase the risk for a flare to occur 1, 2, and 3 days later.[15] Although this study did not show any differences in sleep features *during* flare and nonflare days, days characterized by both higher than average pain and SRF were marked by lower sleep quality. Taken together, these data imply that although poor sleep increases risk for flare, sleep is not necessarily modified during flare unless there is both greater than average pain and broader dimensions of flare. It is important to note that this study relied on subjective report of sleep, and objective measurements of sleep may provide a more accurate evaluation of the relationship between sleep and flares.

Contextualizing Findings

The observation that an individual's perception of flare is not accounted for by a pain increase alone is important for understanding the causes of LBP and effectiveness of treatments. Pain intensity is the most commonly assessed domain in research and clinical practice, but consideration of pain alone would have failed to identify 57% of the days with flare, and identified 126 days as flare when participants had not considered they experienced a flare. Focus on pain as an outcome measure may have negative consequences, such as inaccurate estimation of success or failure of a treatment and unnecessary overuse of analgesics.[23,24] For instance, opioid treatments have been used to reduce pain scores but at the expense of greater disability and suffering, and failure in assisting individuals to cope with pain fluctuations.[23] Reduction of the frequency and the impact of flares may be important to consider as a target.

In an attempt to establish standards for research in persistent LBP, it has been suggested that research for persistent LBP should adopt a minimal dataset to characterize the impact of LBP and this should include consideration of depressive symptoms, sleep disturbance, catastrophic and fear-avoidance cognitions, work disability, and treatments received.[25] In light of this study, we argue that LBP flares could be advocated as a standard outcome measure when investigating LBP, as it characterizes the multidimensional impact of LBP fluctuations. The present findings show that even when pain is not higher, a person may experience a flare, accompanied by worse psychosocial features (eg, greater catastrophizing) than other fluctuations. Consideration of LBP flares according to self-report using a standardized definition, such as the one used in this study with input from experts with patient,[6] is likely to aid interpretation of outcomes of interventions in clinical practice and clinical trials. Note that the version used here was a preliminary version of that definition.

Research into other musculoskeletal conditions has already considered flare frequency as an outcome in randomized controlled trials (eg,[26]), a prognostic indicator in epidemiologic investigations (eg,[27]), and a measure of disease severity that assists investigation of the mechanisms involved in these conditions (eg,[28]). Flare definitions in other musculoskeletal conditions generally consider domains in addition to pain.[13]

Study Strengths and Limitations

The strengths of this study include the relatively large sample with successful data collection through a smartphone application for 28 days. There are also some limitations. First, for feasibility, some psychosocial features were assessed using 1 or 2 questions, rather than complete questionnaires. This approach has been used previously.[17] Although this is not expected to provide equivalent information to the complete questionnaires, questions were selected with specific relevance to our context (eg, questions related to fear of physical activity). Second, sleep was considered based on numerical rating and self-reported sleep duration. Objective measures may provide more accurate estimates. Third, our inclusion criteria for study participation was broad and it is possible that physical and psychosocial features differ for specific subgroups such as individuals with a specific LBP diagnosis or mental health issues. Fourth, because multiple domains are included in the flare definition, it is impossible to interpret the factor(s) that led individuals to report the occurrence of an LBP flare. Additional measures or a new scale that separately measures flare according to different domains (as has been developed for rheumatoid arthritis[29]) would be required.

CONCLUSIONS

Flares do not always coincide with greater than average pain. Regardless of how flare is defined, flare days are characterized by worse pain, fatigue, disability, FA, PC, and SE than days without flare. Days characterized by both greater than average pain and SRFs were marked by worse pain, disability, PC, and SE than days characterized only by greater than average pain. Both research and clinical practice should consider individuals' SRFs when investigating fluctuations of symptoms across different LBP trajectories.

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