Associations Among Pain Intensity, Sensory Characteristics, Affective Qualities, and Activity Limitations in Patients With Chronic Pain: A Momentary, Within-Person Perspective

Leighann Litcher-Kelly, Arthur A. Stone, Joan E. Broderick, and Joseph E. Schwartz

Abstract: **The purpose of this article is to explore the multidimensionality of the pain experience for patients with chronic pain by using a within-person, longitudinal approach. An Ecological Momentary Assessment design with a patient electronic diary was used to collect random momentary pain assessments several times a day for 2 weeks. We examined the within-person relationships between pain intensity, sensory characteristics, affective qualities, and activities limited by pain. All 3 dimensions (sensory, affective, and activities) were significantly related to pain intensity in a monotonic, but nonlinear, manner. These results expand our understanding of the pain experience by showing that changes of pain over time are associated with changes in sensory symptoms, affective distress, and activity limitations.**

Perspective: ***Although the relationships between pain dimensions have been examined between people, the results have been interpreted as within-persons. This article confirms that pain intensity is significantly related to sensory characteristics of pain, affective qualities of pain, and activity limitations due to pain within a person.***

Key words: *Pain intensity, within-person, momentary assessment, electronic diaries.*

Understanding the meaning of multidimensional pain scales is necessary for the advancement of pain research and management; without accurate and reliable measurement, one cannot know whether interventions designed to reduce or alleviate pain are effective. As befits the importance of the topic, scores of articles have been devoted to the dimensionality and scaling of pain assessments.[1,4,5,8,11,12,17-21,23,28,30,32,39,40]

Although pain intensity is usually the primary focus of pain assessment studies,[14,15,31,40] it is only one aspect of the pain experience. The literature documents that pain is a multifaceted experience that includes not only intensity, but also sensory characteristics (eg, aching, splitting), affective qualities (eg, tiring, scary), and activity limitations.[1,6-8,10,12,22,23,29,32,39,40]

Received February 26, 2004; Revised July 7, 2004; Accepted July 29, 2004.

From the Department of Psychiatry and Behavioral Science, Stony Brook University, Stony Brook, New York, USA.

Supported by a grant from the National Cancer Institute (CA85819; Arthur A. Stone, principal investigator). Dr Stone is the Associate Chairman of the Scientific Advisory Board at invivodata, inc.

Address reprint requests to Arthur A. Stone, PhD, Department of Psychiatry and Behavioral Science, Stony Brook University, Putnam Hall, South Campus, Stony Brook, NY 11794-8790. E-mail: arthur.stone@sunysb.edu

1526-5900/$30.00

doi:10.1016/j.jpain.2004.07.005

Relationships Between Pain Intensity, Sensory Characteristics, and Affective Qualities

The relationship between these 3 constructs can inform our understanding of the pain experience, but until now this relationship has only been examined by using a between-person or cross-sectional approach. One debate in the between-person pain literature questions whether these 3 constructs can be conceptualized as 3 distinct entities.[8,12,33] As cited by Fernandez and Turk,[8] Fernandez et al (1989) demonstrated that they are related, but not completely dependent. By administering a cognitive-behavioral treatment program focused on emotional issues, affective responses to pain and pain intensity were modified, while sensory reports remained unchanged in patients with chronic pain.[8] Price et al[33] examined the relationship between unpleasantness (an affective quality) and pain intensity by using visual analog scales (VAS) in several pain samples (chronic pain, childbirth labor pain, and experimental pain). They reported a linear relationship between the 2 pain dimensions for all groups, but they noted that the chronic pain samples reported higher unpleasantness than the other pain samples.

Relationship Between Pain Intensity and Activity Limitations

The relationship between pain intensity and activity limitations as a result of pain is also important to under-

standing a person's pain experience. Studies have shown that pain is significantly related to reports of activity limitations in patients with pain,[1,32,39] whereas others have noted wide within-person variation in the magnitude of these relationships,[40] and some have questioned whether the relationship even exists.[23] Whereas Tamburini et al[39] used a cross-sectional design to assess the relationship between pain intensity and sleeping and standing in 85 patients with cancer ($r = -0.33$ and $r = -0.32$, respectively), the remainder of the above studies cited used paper diaries to assess pain and activity restrictions. Affleck et al[1] used nightly diaries for 75 consecutive days and also reported a significant correlation ($r = 0.48$) between mean pain intensity and physical disability (which included lack of mobility, household activity, and other activities of daily living) in patients with rheumatoid arthritis. Furthermore, the type of activity might moderate the association between pain intensity and activity limitation. A nightly diary study of 119 patients with sickle cell disease reported that for days when participants reported being in pain, 45% reported cutting back on housework, 41% reported cutting back on social activities, but only 5% reported cutting back on work.[32] In contrast, a study assessing pain 8 times a day for 6 days reported that only 15 of 57 patients with chronic pain had a significant relationship between pain intensity and activity level.[40] Finally, a study assessing pain twice a day for 1 to 3 weeks found both a significant correlation between pain intensity and activities of daily living ($r = -0.69$) and a nonsignificant correlation between pain intensity and a self-reported activities checklist ($r = -0.10$).[23] Therefore, the impact of pain intensity on activity restrictions is a complex relationship that deserves additional study.

Between-Person Versus Within-Person Designs

An important distinction to highlight concerns the different interpretations that can be made from between- and within-person analyses. Although the studies examining the relationships between pain intensity, sensory and affective characteristics were between-person designs, one might incorrectly interpret their results as within-person. Many of these studies demonstrated a significant relationship between intensity and sensory and affective characteristics of pain across a sample of participants; however, that does not necessarily mean that for an individual, higher levels of pain intensity correspond with higher levels of sensory and affective characteristics. Although this, in fact, might be true, the between-person analyses are not testing this hypothesis, and, therefore, the results cannot be interpreted in this way. This is because between- and within-person analyses are statistically independent and can yield opposing results.[2,36] One example that illustrates this point is the relationship between heart rate and exercise; whereas the between-person results show that resting heart rate is lower in persons who exercise more, on average, the within-person results report that heart rate increases after exercise.

Recall Bias and Momentary Designs

An additional concern in the pain assessment literature has been the influence of retrospective biases on the validity of questionnaires that attempt to assess pain over extended periods of time (eg, days to weeks[3,40]; more generally[9]). Given the strong evidence for bias with recall assessments, it is acknowledged that there are significant advantages to assessing immediate or momentary pain.[3,31] Therefore, diary methods for monitoring pain have been developed that incorporate multiple assessments of pain throughout the day and allow for analyses of associations among dimensions of pain on a within-person basis. The many momentary measures are often used to summarize average pain levels during a given period of time.

A family of momentary protocols known as Ecological Momentary Assessment (EMA)[37] uses momentary sampling schedules, which are able to provide a rich picture of the ebb and flow of pain (or other outcome measures) through individuals' typical days and to provide summary measures of pain (eg, an average of momentary reports) that are reliable and free of recall bias. The development of patient electronic diaries (PEDs) has facilitated the implementation of complex momentary sampling schedules.[13] They also confer several other advantages over written diaries including providing convenient presentation and completion of the questions in an ambulatory format and electronically monitoring sampling protocol compliance.[38]

Present Study

To our knowledge, no information is available about how pain intensity is associated on a within-person basis with sensory and affective pain ratings. There have been within-person studies on activity limitations as a result of pain, however these studies used paper diaries and reported equivocal results with respect to the relationship with pain intensity. At first glance, having multiple moments for an analysis of these associations might appear to be a relatively minor change compared to between-person analyses. However, moving from a single sample of pain for each individual to multiple samples taken over time is a major conceptual shift. We have argued that between-person and within-person analyses provide different perspectives, and the within-person perspective is essential for understanding changes in pain over time, such as in treatment trials.[36] In this study we explore the within-person associations as reported by a sample of patients with chronic pain.

The overall goal of this article is to advance our knowledge of the relationships among components of a multidimensional, momentary pain measure. To increase our understanding of the interplay between pain intensity sensory characteristics, affective qualities, and activity limitations as a result of pain, we examined these associ-

ations with momentary data collected from a sample of patients with chronic pain. Specifically, our within-person analyses aimed to examine the form of the relationships between pain intensity and the 3 constructs. We hypothesized that there will be strong positive associations between pain intensity and sensory characteristics, affective qualities, and activity limitations. We also speculated that some qualities are only associated with high levels of pain intensity and thus examined the curvilinear relationships.

Materials and Methods

Participants

After obtaining Institutional Review Board approval from Stony Brook University, recruitment was conducted from October 2001 to March 2002. Participants were recruited from suburban areas surrounding Stony Brook University by using radio and newspaper advertising, as well as flyers in the University hospital, doctors' offices, assisted living communities, and the newsletter of a local chapter of the Arthritis Foundation. Advertisements and flyers targeted individuals diagnosed with fibromyalgia, rheumatoid arthritis, osteoarthritis (knee or hip), or ankylosing spondylitis.

Eligibility criteria included having one of the above diagnoses (confirmed by their physician), being between the ages of 18 to 80 years, having no sight or hearing problems, being fluent in English, having no difficulty holding a pen or writing, waking up at or before 10 AM and going to bed at or after 7 PM, feeling pain for more than 6 months, feeling pain for 3 days or more per week, for 3 hours or more per day, with an average level of pain intensity of 4 or greater (on a 0 to 10 rating scale with 0 = no pain and 10 = excruciating pain), having no serious psychiatric impairment, having no alcohol or drug problems, and not having participated in a previous EMA study. This sample was also used to examine the characteristics of different EMA sampling densities and reactivity.[35]

The final sample of 68 participants completed baseline questionnaires and used the PED to collect momentary ratings of their pain for 2 weeks. Average sampling compliance with the PED was 94%; however, there were 2 outliers. These 2 participants had compliance rates of 63% and 77% and missed whole days' worth of assessments. Because of this, they were excluded from the analyses. Therefore, the final sample size for all analyses was 66. The average age of this sample was 51.0 $\pm$ 10.6 years (range, 25 to 75 years); most were female (84.9%), married (68.2%), and white (93.9%). All 66 participants had 1 or more of the following confirmed diagnoses (the number exceeds 66 because some participants had multiple diagnoses): fibromyalgia (44), rheumatoid arthritis (5), osteoarthritis of the knee (18), osteoarthritis of the hip (9), and ankylosing spondylitis (5).

Materials and Measures

Prospective momentary pain data were collected for 2 weeks by using a PED. The PED was a Sony Clie hand-held computer (Model PEGN610C; Sony Electronics Inc., Japan) installed with invivodata, inc software for data collection (Pittsburg, Pa). The computer featured auditory prompts and a touch screen. A stylus was used to select answers to each question. The software recorded the time and date of each entry. The PED has many "user friendly" features such as delay, suspend, nap, and sleep to minimize burden of participation. The PED was programmed to collect data by using an EMA design (multiple random prompts per day for 2 weeks).

Table 1 contains the details of the PED assessment content presented in this article. The assessment content was developed by using several validated paper measures of pain: Short form of the McGill Pain Questionnaire, the Brief Pain Inventory, the Pain Discomfort Scale, and the Health Assessment Questionnaire.[16,25-27] Several aspects of momentary pain were assessed, including the presence of pain (yes/no). If a participant endorsed "yes" for the presence of pain, the following variables were assessed: intensity of pain (on a 100-point horizontal VAS), sensory characteristics of pain (10-item checklist), affective qualities of pain (five100-point horizontal VASs), and activities limited by pain (a categorical variable assessing whether pain limited activities and, if "yes," a 6-item checklist). When "no" was chosen for the presence of pain question, pain intensity and the specific pain characteristics were not assessed. The use of VASs on electronic diaries has been demonstrated in past literature. Jamison et al[15] compared ratings made on paper VAS and electronic VAS and reported a correlation of 0.97 between the 2 types of assessments.

An index was computed for the sensory characteristics, and scales were computed for the affective qualities and activities limited. The index for the sensory characteristics was computed as the number of sensory adjectives endorsed (range, 0 to 10); the scale for the affective characteristics was the mean of the 5 affective VASs (range, 0 to 100; Cronbach α, 0.76); and the scale for the activities limited was the number of activities endorsed (range, 0 to 6; Cronbach α, 0.42).

Procedure

The study required 4 weekly visits to the laboratory and 2 weeks of momentary data collection on the PED. The protocol was as follows: at visit 1, participants gave consent and completed baseline questionnaires; at visit 2, participants were trained on the use of the PED (via a 90-minute PowerPoint [Microsoft, Redmond, WA] presentation and guided practice) and were sent home to begin the 2 weeks of momentary data collection; at visits 3 and 4, participants were given compliance feedback on the use of the PED and debriefed at the last.

The 2-week momentary data collection protocol required participants to carry the PED with them at all times and to respond to all random prompts. Participants were randomly assigned to groups that were prompted 3, 6, or 12 times a day to complete ratings about their pain, and it only took about 2 minutes to complete each entry. A previous report examined possible reactive effects between the 3 sampling densities (3, 6, and 12 times

Table 1. Details of the PED EMA Pain Assessment

Measure	Presentation on the Screen	Scale
Presence of momentary pain	Before prompt, were you in any pain?	Yes (1), No (0)
Pain intensity	If yes, how much pain did you feel?	100-point VAS with the anchors "No Pain" to "Extreme Pain"
Sensory characteristics of pain	Before prompt, my pain was (Please check all that apply): Aching, Throbbing, Shooting, Stabbing, Gnawing, Sharp, Tender, Burning, Penetrating, Numbing	All 10 sensory questions rated: Yes (1), No (0)
Affective characteristics of pain	Before prompt ... How unpleasant was the pain? Before prompt ... The pain I felt was unbearable. Before prompt ... I was scared about the pain I felt. Before prompt ... My pain was an annoyance to me. Before prompt ... Pain was stopping me from enjoying life.	All 5 affective questions rated on 100-point VAS with the anchors "Not at all" to "Extremely"
Activities limited by pain	Before prompt, how much was your pain limiting your activities?	None (1) A little (2) Some (3) A lot (4)
	Before prompt, which activities were limited? (Please check all that apply): Housework, Walking, Grooming, Work, Sleeping, Socializing	All 6 activities limited questions rated: Yes (1), No (0)

Abbreviations: PED, patient electronic diary; EMA, Ecological Momentary Assessment; VAS, visual analog scale.

per day) and found no differences between the 3 groups.[35] All participants were compensated $100 for their time.

Statistical Analyses

All statistical analyses were conducted in SAS Version 8.0 (SAS Institute, Inc, Cary, NC) by using multilevel modeling (Proc Mixed[24,34]) to estimate within-person relationships. To examine the relationship of sensory characteristics, affective qualities, and activity limitations to pain intensity, we ran several models. The 3 scales (sensory, affective, and activities limited) were each treated as a dependent variable in a model in which pain intensity was the predictor. To test for possible curvilinearity, we ran 3 models for each scale (model 1, pain intensity linear term only; model 2, linear and quadratic terms; model 3, linear, quadratic, and cubic terms). We also reported the proportionate reduction in the total within-person variance that can be accounted for by pain intensity. To compute and plot least-square means for each scale, the continuous 100-point pain intensity variable was transformed into a 10-level categorical variable (0 to 10 = 1, 11 to 20 = 2, etc) and was then entered into separate multilevel models, one for each scale. All multilevel analyses used a compound symmetry error structure. The full (with predictors) and constrained (without predictors) models were compared to assess improvement in goodness of fit. All full models were a significantly better fit than their associated constrained models.

Results

Participants reported being in pain in 80.8% of the random prompts they received (range, 16.1% to 100%). For those prompts in which people endorsed being in pain, the electronic diary assessed pain intensity, sensory characteristics, affective ratings, and activities limited. Therefore, the analyses examining the relationship between pain intensity and these variables focused on only the prompts in which participants reported being in pain. For the activities limited questions, if the participant responded "None" to "How much was your pain limiting your activities?," then the diary did not present the activities limited checklist, and, therefore, the items were scored as zero. Thus, of the prompts that participants reported being in pain, they reported that pain limited their activities 82.7% of the time (range, 4.9% to 100%). Table 2 presents the mean and standard deviations of the participants' means for each momentary pain measure.

To address the question of whether there are substantial, positive within-person associations between pain intensity and sensory characteristics, affective qualities, and activities limited, we tested the linear relationships of each of the 3 scales to pain intensity. There were significant associations of pain intensity with all 3 scales. As pain intensity increased, participants endorsed more sensory items and reported more affective qualities and more activity limitations ($F_{1,4124} = 1414.99$, $P < .001$, and 50.2% of within-person variance was accounted for the sensory scale; $F_{1,4124} = 4011.97$, $P < .001$,and 69.1% of within-person variance for the affective scale; $F_{1,3407} = 107.80$, $P < .001$, and 23.8% of within-person variance for the activities limited scale).

To determine whether there are nonlinear relationships between pain intensity and the 3 scales, we tested the curvilinear components of pain intensity and their associations with each scale. All 3 components (linear,

Table 2. Means and Standard Deviations of Participants' (n = 66) Overall Means for EachMomentary Pain Item

	Mean	*Standard Deviation*
Presence of pain	80.8%	2.4%
Pain Intensity	53.5	18.0
Sensory items		
Ache	85.0%	23.8%
Throb	43.2%	30.7%
Shoot	12.5%	15.4%
Stab	20.5%	22.3%
Gnaw	40.5%	34.5%
Sharp	37.1%	31.6%
Tender	53.1%	36.4%
Burn	31.2%	36.1%
Penetrate	56.4%	34.1%
Numb	20.3%	28.3%
Affective items		
Unpleasant	55.4	19.1
Unbearable	37.1	22.5
Scared	11.5	16.6
Annoyed	63.2	20.9
Stop enjoying life	47.2	23.9
Activities limited		
How much was pain limiting activities?	2.5	0.8
Housework	39.3%	30.4%
Walking	50.5%	35.7%
Grooming	14.3%	22.6%
Working	17.6%	23.1%
Sleeping	15.8%	21.4%
Socializing	25.5%	25.7%

NOTE. Total number of prompts for presence of pain, 5244. Number of prompts for the remaining items, 4191. Average number of prompts per person, 80 (range, 29-162).

quadratic, and cubic) of pain intensity were significant ($P \leq .01$) when predicting all 3 scales. For the sensory scale the within-person variance accounted for by the 3 pain intensity terms was 52.2% ($F_{1,4122} = 18.05$ for linear, $F_{1,4122} = 6.07$ for quadratic, and $F_{1,4122} = 17.42$ for cubic). For the affective scale the within-person variance accounted for was 69.6% ($F_{1,4122} = 89.75$ for linear, $F_{1,4122} = 19.77$ for quadratic, and $F_{1,4122} = 30.12$ for cubic). Finally, for the activities limited scale the within-person variance accounted for was 24.4% ($F_{1,4122} = 16.64$ for linear, $F_{1,4122} = 8.90$ for quadratic, and $F_{1,4122} = 11.31$ for cubic). Figs 1, 2, and 3 show the predicted curves based on the model estimates when predicting the sensory, affective, and activities limited scales from all 3 pain intensity components (linear, quadratic, and cubic).

In addition to the predicted curves, we also computed least-square means of each scale for 10 categories of the pain intensity variable by transforming the continuous pain intensity measure into a 10-level categorical variable. This categorical pain intensity variable was treated as a class variable, and least-square means (and their standard errors) were computed and plotted for each subscale (Fig 1, 2, and 3). As can be seen from Figs 1 and 2 for the sensory and affective scales, there is a slight

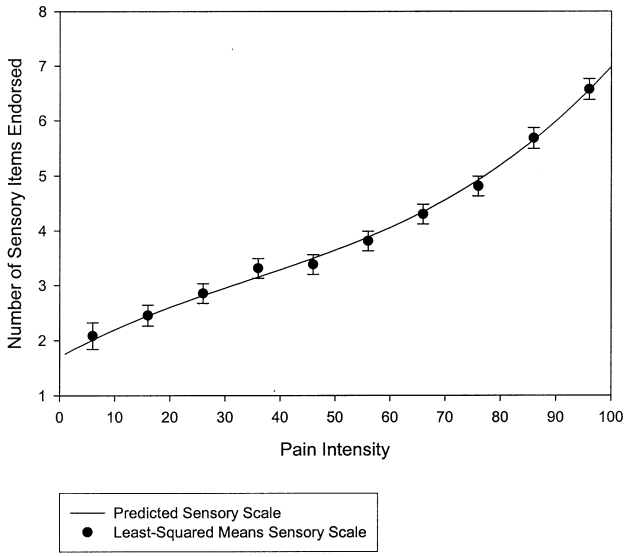

Figure 1. Relationship of sensory scale to pain intensity VAS (predicted cubic curve and least-squared means ± 1 standard error).

flattening of the curves for the middle range of the pain intensity scale, whereas at the high and low ranges of the pain intensity scale, the slopes of the curves are steeper. This is more pronounced in Fig 3 for the activities limited scale, in which the curve for the lower and higher range of pain intensity is much steeper than the flattened middle range.

Discussion

The goal of this article was to examine the relationship between pain intensity and sensory, affective, and activity limitation dimensions of pain from a within-person

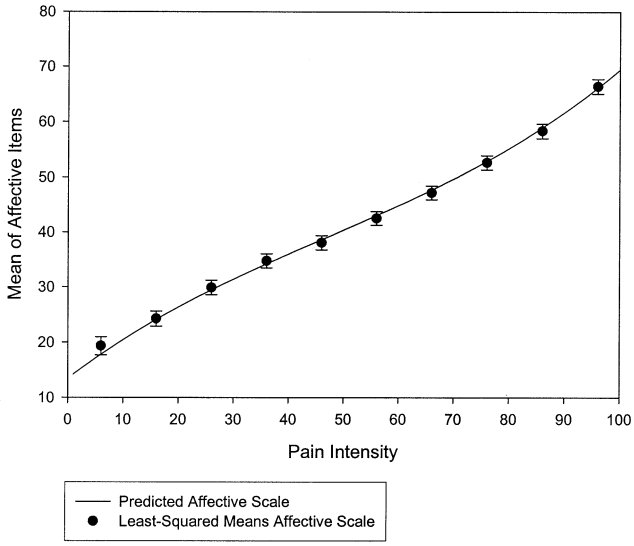

Figure 2. Relationship of affective scale to pain intensity VAS (predicted cubic curve and least-squared means ± 1 standard error).

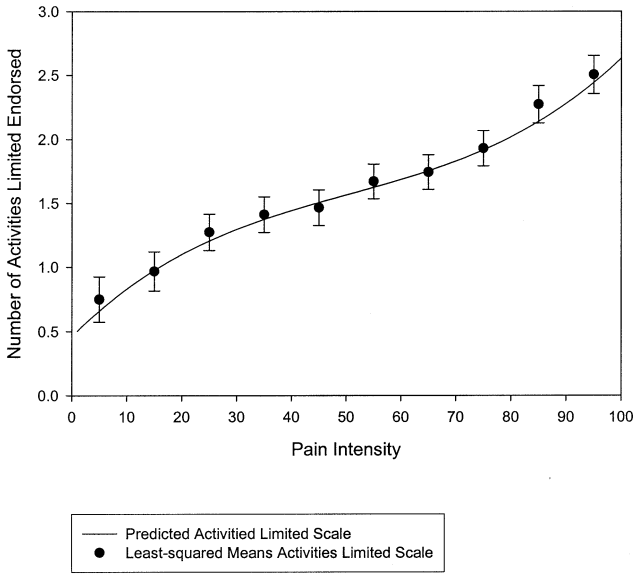

Figure 3. Relationship of activities limited scale to pain intensity VAS (predicted cubic curve and least-squared means ± 1 standard error).

perspective. The results indicate that pain intensity is significantly associated with these 3 dimensions of pain. Although the literature has reported this finding for between-person analyses,[8,39] this study reinforces the validity of this association by showing that this is also true within-persons. Importantly, replication of this between-person association by using within-person data did not have to occur because between- and within-person associations are mathematically independent.[36] Thus, we can confidently conclude that as a person's pain intensity changes, their negative sensory experience, the affective impact of the pain, and their activity limitations also change.

The form of the relationship between pain intensity and the 3 pain dimensions was best defined as curvilinear with a significant cubic component to each association. That is, the slope of the associations between the 3 scales and pain intensity was greater at both ends of the pain intensity scale and more flattened in the middle. For the sensory scale, the relationship was especially evident at the high end of the pain intensity scale (from about 70 to 100), whereas for the affective scale the slope appears to be steepest for the lower range of the pain intensity scale (0 to 30). Therefore, sensory pain appears to be related to higher levels of pain intensity, whereas emotional distress is reported even at lower levels of pain. For the activities limited scale, the association is stronger for both the low and high ranges of pain intensity but weaker for the middle range; thus, people restrict their activities at both low and high ends of the pain intensity scale. Whereas past literature has debated whether and how these pain dimensions are related,[8,40] we are unaware of any past research examining nonlinear models of the association of pain intensity with sensory characteristics, affective qualities, and activity limitations.

The strengths of this study include having several momentary assessments of pain (both intensity and related characteristics) per day during a period of 2 weeks. The PED data collection is very intensive, but the use of the electronic diary (as opposed to paper diaries) contributed to the excellent 94% compliance rate. A limitation is the fact that participants were required to have 1 of 4 rheumatologic diagnoses (fibromyalgia, rheumatoid arthritis, osteoarthritis [knee or hip], or ankylosing spondylitis). Therefore, the results cannot be generalized beyond these 4 diagnoses.

Despite this limitation, the findings of this article add to the pain assessment literature. Cross-sectional views of pain are adequate to answer questions about how pain differs among people. Previous between-person studies concluded that people reporting higher levels of pain also tend to report higher levels of sensory and affective characteristics.[8] With new technology making more intensive data collection feasible, researchers and clinicians can look at patients' fluctuations in pain and obtain more detailed information about their individual, overall pain experience. The results from this study enhance our understanding of the pain experience by showing that within-people, increases in pain are associated with increases in sensory symptoms, affective distress, and activity limitations. Pain research in behavioral medicine is moving toward experimental designs that are able to examine individual differences, which lend themselves to results that are more clinically applicable.[21] By understanding patients' pain experiences within their daily lives, clinicians will be better able to help patients manage their pain and enhance their quality of life.

Acknowledgements

We thank Pam Calvanese, Daniel Arnold, and Steven Choi for their assistance in running the study. In addition, we thank invivodata, inc for providing the software for the patient electronic diaries (PEDs).

References

1. Affleck G, Tennen H, Urrows S, Higgins P: Individual differences in the day-to-day experience of chronic pain: A prospective daily study of rheumatoid arthritis patients. Health Psychol 10:419-426, 1991

2. Affleck G, Zautra A, Tennen H, Armeli S: Multilevel daily process designs for consulting and clinical psychology: A preface for the perplexed. J Consult Clin Psychol 67:746-754, 1999

3. Bolton JE: Accuracy of recall of usual pain intensity in back pain patients. Pain 83:533-539, 1999

4. Doctor JN, Slater MA, Atkinson JH: The descriptor differential scale of pain intensity: An evaluation of item and scale properties. Pain 61:251-260, 1995

5. Farrar JT, Portenoy RK, Berlin JA, Kinman JL, Strom BL: Defining the clinically important difference in pain outcome measures. Pain 88:287-294, 2000

6. Fernandez E, Boyle GJ: Affective and evaluative descriptors of pain in the McGill Pain Questionnaire: Reduction and reorganization. J Pain 2:318-325, 2001

7. Fernandez E, Towery S: A parsimonious set of verbal descriptors of pain sensation derived from the McGill Pain Questionnaire. Pain 66:31-37, 1996

8. Fernandez E, Turk DC: Sensory and affective components of pain: Separation and synthesis. Psychol Bull 112:205-217, 1992

9. Gorin AA, Stone AA: Recall biases and cognitive errors in retrospective self-reports: A call for momentary assessments. In: Baum A, Revenson T, Singer J (eds): Handbook of Health Psychology. Hillsdale, NJ, Erlbaum, 2001, pp 405-413

10. Gracely RH, Dubner R: Reliability and validity of verbal descriptor scales of painfulness. Pain 29:175-185, 1987

11. Gustafsson M, Gaston-Johansson F, Aschenbrenner D, Merboth M: Pain, coping and analgesic medication usage in rheumatoid arthritis patients. Patient Education and Counseling 37:33-41, 1999

12. Holroyd KA, Talbot F, Holm JE, Pingel JD, Lake AE, Saper JR: Assessing the dimensions of pain: A multitrait-multimethod evaluation of seven measures. Pain 67:259-265, 1996

13. Hufford M, Shiffman S, Paty J, Stone A: Ecological momentary assessment: Real-world, real-time measurement of patient experience. In: Fahrenberg J, Myrtek M (eds): Progress in Ambulatory Assessment. Seattle, WA, Hogrefe & Huber, 2001, pp 69-92

14. Jamison RN, Brown GK: Validation of hourly pain intensity profiles with chronic pain patients. Pain 45:123-128, 1991

15. Jamison RN, Gracely RH, Raymond SA, Levine JG, Marino B, Herrmann TJ, Daly M, Fram D, Katz NP: Comparative study of electronic vs paper VAS ratings: A randomized, crossover trial using healthy volunteers. Pain 99:341-347, 2002

16. Jensen M, Karoly P, Harris P: Assessing the affective component of chronic pain: Development of the Pain Discomfort Scale. J Psychosom Res 35:149-154, 1991

17. Jensen MP, Chen C, Brugger AM: Postsurgical pain outcome assessment. Pain 99:101-109, 2002

18. Jensen MP, Turner JA, Romano JM, Fisher LD: Comparative reliability and validity of chronic pain intensity measures. Pain 83:157-162, 1999

19. Jensen MP, Turner LR, Turner JA, Romano JM: The use of multiple-item scales for pain intensity measurement in chronic pain patients. Pain 67:35-40, 1996

20. Kane RL, Bershadsky B, Lin W, Rockwood T, Wood K: Efforts to standardize the reporting of pain. J Clin Epidemiol 55:105-110, 2002

21. Keefe FJ, Lumley MA, Buffington ALH, Carson JW, Studts JL, Edwards CL, Macklem DJ, Aspnes AK, Fox L, Steffey D: Changing face of pain: Evolution of pain research in psychosomatic medicine. Psychosom Med 64:921-938, 2002

22. Kremer E, Atkinson JH: Pain measurement: Construct validity of the affective dimension of the McGill Pain Questionnaire with chronic benign pain patients. Pain 11: 93-100, 1981

23. Linton SJ: The relationship between activity and chronic back pain. Pain 21:289-294, 1985

24. Littell RC, Pendergast J, Natarajan R: Modelling covariance structure in the analysis of repeated measures data. Stat Med 19:1793-1819, 2000

25. McDowell I, Newell C: Measuring health: A guide to rating scales and questionnaires. New York, NY, Oxford University Press, 1996

26. Melzack R: The short-form McGill Pain Questionnaire. Pain 30:191-197, 1987

27. Miller J, Pinnington M, Stanley I: The early stages of low back pain: A pilot study of patient diaries as a source of data. Fam Pract 16:395-401, 1999

28. Moore A, Moore O, McQuay H, Gavaghan D: Deriving dichotomous outcome measures from continuous data in randomized controlled trials of analgesics: Use of pain intensity and visual analogue scale. Pain 69:311-315, 1997

29. Morley S, Pallin V: Scaling the affective domain of pain: A study of the dimensionality of verbal descriptors. Pain 62:39-49, 1995

30. Ogon M, Krismer M, Sollner W, Kantner-Rumplmair W, Lampe A: Chronic low back pain measurement with visual analogue scales in different settings. Pain 64:425-428, 1996

31. Peters ML, Sorbi MJ, Kruise DA, Kerssens JJ, Verhaak PFM, Bensing JM: Electronic diary assessment of pain, disability and psychological adaptation in patients differing in duration of pain. Pain 84:181-192, 2000

32. Porter LS, Gil KM, Sedway JA, Ready J, Workman E, Thompson RJ: Pain and stress in sickle cell disease: An analysis of daily pain records. Int J Behav Med 5:185-203, 1998

33. Price DD, Harkins SW, Baker C: Sensory-affective relationships among different types of clinical and experimental pain. Pain 28:297-307, 1987

34. Schwartz JE, Stone AA: Strategies for analyzing ecological momentary assessment data. Health Psychol 17:6-16, 1998

35. Stone AA, Broderick JE, Schwartz JE, Shiffman SS, Litcher-Kelly L, Calvanese P: Intensive momentary reporting of pain with an electronic diary: Reactivity, compliance, and patient satisfaction. Pain 104:343-351, 2003

36. Stone AA, Broderick JE, Shiffman SS, Schwartz JE: Understanding recall of weekly pain from a momentary assessment perspective: Absolute accuracy, between- and within-person consistency, and judged change in weekly pain. Pain, 107:61-69, 2004

37. Stone AA, Shiffman S: Ecological momentary assessment (EMA) in behavioral medicine. Ann Behav Med 16:199-202, 1994

38. Stone AA, Shiffman S, Schwartz JE, Broderick JE, Hufford MR: Patient non-compliance with paper diaries. BMJ 324:1193-1194, 2002

39. Tamburini M, Selmi A, De Conno F, Ventafridda V: Semantic descriptors of pain. Pain 25:187-193, 1987

40. Vendrig AA, Lousberg R: Within-person relationships among pain intensity, mood and physical activity in chronic pain: A naturalistic approach. Pain 73:71-76, 1997