Does Mindfulness Correlate With Physical Function and Pain Intensity in Patients With Upper Extremity Illness?

HAND
2018, Vol. 13(2) 237–243
© The Author(s) 2017
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1558944717697429
hand.sagepub.com

Reinier B. Beks¹, Jos J. Mellema¹, Mariano E. Menendez¹, Neal C. Chen¹,
David Ring², and Ana Maria Vranceanu¹

Abstract

Background: Mindfulness skills training interventions seem efficacious in increasing physical function and decreasing pain intensity in patients with chronic pain. The relationship of mindfulness and upper extremity complaints in patients presenting to orthopedic surgical practices is not known. The aim of this study was to assess if mindfulness has a relationship to physical function and pain intensity in patients with upper extremity illness. **Methods:** In this cross-sectional study, a total of 126 patients with a nontraumatic upper extremity condition were asked to fill out questionnaires assessing the 5 facets of mindfulness, pain intensity, and upper extremity physical function, along with clinical and demographic variables prior to their visit with the surgeon. **Results:** Nonreactivity to inner experiences was the only facet of mindfulness that was correlated with upper extremity physical function and pain intensity. The overall mindfulness score was correlated with pain intensity only. In multivariable analyses, mindfulness was not associated with either physical function or with pain intensity. Pain interference was the most important predictor of both pain intensity and physical function. **Conclusions:** Greater overall mindfulness was associated with lower pain intensity, and greater ability to be nonreactive to inner experiences was associated with both pain intensity and upper extremity physical function in bivariate but not multivariable analyses. Pain interference was the most important predictor of both pain intensity and upper extremity physical function. Psychosocial interventions focused on improving physical function and decreasing pain intensity in this population should focus primarily on reducing pain interference, and secondarily on teaching patients mindfulness skills.

Keywords: mindfulness, physical function, pain intensity, upper extremity illness

Introduction

Mindfulness is a mental state of awareness, focus, and openness, which allows individuals to engage fully in the present moment. In a state of mindfulness, difficult thoughts, feelings, and sensations are nonjudgmentally observed and not allowed to have any impact on behavior. Baer et al³ proposed 5 facets of mindfulness: (1) *observing*, defined as noticing or attending to internal and external experiences; (2) *describing*, defined as labeling internal experiences with words; (3) *acting with awareness*, defined as attending to one's activities of the moment (opposite of acting on automatic pilot); (4) *nonjudging of inner experience*, defined as taking a nonevaluative stance toward thoughts and feelings; and (5) *nonreactivity to inner experience*, defined as of allowing thoughts and feelings to come and go, rather than entertaining or ruminating on them.

A large body of research has shown that mindfulness skills training interventions are efficacious in increasing

physical function and decreasing pain intensity in patients with chronic pain.^{4,7,9,16,21} By engaging in mindfulness, patients become aware of their thoughts, feelings, and pain sensations without judgment or attempts to control or escape them; by not entertaining the pain-related thoughts, the pain-related threat is decreased and patients are successful in engaging in activities in spite of pain. In other words, a mindful patient with arthritis of the thumb who starts to notice pain will be able to nonjudgmentally observe and accept pain-related thoughts and sensations while staying in the present moment, thus being less inclined to catastrophic

¹Massachusetts General Hospital, Boston, USA

²Dell Medical School, Austin, TX, USA

Corresponding Author:

David Ring, Department of Surgery and Perioperative Care, Dell Medical School, 1400 Barbara Jordan Boulevard, Suite 1.114AC, MC: R1800, Austin, TX 78723, USA.

Email: david.ring@austin.utexas.edu

thoughts (ie, misinterpretation or overinterpretation of nociception). The role of mindfulness in reports of physical function and pain intensity in patients with hand and upper extremity patients in surgical practices is not known. A recent study in this population²⁵ found that greater awareness of the present moment as measured by a subscale of the Philadelphia Mindfulness Scale⁸ was significantly associated with lower physical function and was not associated with pain. Results of this study are spurious, due to incorrect sample size calculations and errors in the statistical analyses. Further study of mindfulness in hand surgery practice might help clarify the role of mindfulness in illness behavior of patients with upper extremity complaints.

The purpose of this study was to assess the relationship of mindfulness with physical function and pain intensity in patients with upper extremity illness. We tested the null hypothesis that: (1) there is no correlation between mindfulness and upper extremity physical function, while also accounting for demographic (eg, age, sex), condition-related (eg, diagnosis, interval between onset and visit), and psychosocial factors (depression and pain interference), and (2) there is no correlation between mindfulness and pain intensity, while also accounting for demographic (eg, age, sex), condition-related (eg, diagnosis, interval between onset and visit), and psychosocial factors (depression and pain interference).

Patient and Methods

Study Design and Patient Selection

After approval from our institutional review board, patients visiting the outpatient clinic of 2 hand and upper extremity surgeons in an urban academic hospital were asked to participate in this cross-sectional study between May 2015 and August 2015. Inclusion criteria were as follows: (1) age 18 years or older, (2) nontraumatic upper extremity condition (eg, no fracture, sprain, dislocation, laceration, or infection), (3) English fluency, and (4) ability to provide informed consent. Pregnant women were excluded. A total of 129 eligible patients were approached for participation. Three patients (2%) declined participation, and 126 patients provided informed consent and were included in the study.

Data Collection

Patients were asked to fill out questionnaires prior to their visit with the surgeon. In addition to the outcome measures and psychological questionnaires, the following patient characteristics were obtained: sex, race, smoking habit, marital status, education in years, work status, diagnosis, prior treatment, affected side, type of visit (new patient or follow-up), presence of other pain conditions, and duration of symptoms in weeks. Data were collected through

Assessment Center (<http://www.assessmentcenter.net>), an online research tool for capturing participant data with computer adaptive testing (CAT) capabilities, using a tablet computer.

Outcome Measures

The primary outcome measure was upper extremity physical function as measured by the Patient Reported Outcomes Measurement Information System (PROMIS) Upper Extremity CAT questionnaire.²⁰ Using CAT, which is based on item response theory, questionnaire administration is optimized by distributing only patient-relevant items based on individual previous responses.^{10,12} Every item tests the examinee's level of ability (the outcome) based on correctness of the answer, and every answer contributes to measuring the ability to some extent. Based on the previous responses, an algorithm is used to create a tailor-made questionnaire measuring the ability where fewer questions are needed and higher accuracy is achieved compared with standard fixed tests. The PROMIS Upper Extremity CAT is a reliable tool to measure upper extremity physical function.¹⁵ A higher PROMIS score represents better physical function.

The secondary outcome measure was pain intensity as measured by the Numerical Rating Scale, an 11-point ordinal scale where 0 means no pain at all and 10 the most intense pain one can imagine.

Explanatory Measures

The short form of the Five Facet Mindfulness Questionnaire (FFMQ-SF) was used to measure mindfulness. The FFMQ-SF is a validated questionnaire consisting of 24 statements about everyday experiences.⁵ Every statement is answered using a 1 to 5 scale ranging from never or very rarely true to very often or always true. The questionnaire provides a score for each of the 5 mindfulness facets: (1) nonreact, (2) observe, (3) act aware, (4) describe, and (5) nonjudge. Facet scores range from 4 to 25, with higher scores indicating more mindfulness. A total score comprising all facets was also computed.

The PROMIS Pain Interference CAT measures the self-reported consequences of pain (not specifically upper extremity pain) on common aspects of daily life over the past 7 days.¹ The PROMIS Pain Interference CAT uses questions from the full item bank, which consists of 40 items in total. A PROMIS Pain Interference CAT score of 50 represents the average for the United States general population, with a standard deviation (SD) of 10 points. A higher PROMIS Pain Interference CAT score indicates a stronger restriction on daily activities due to pain.

The PROMIS Depression CAT questionnaire measures symptoms of depression over the past 7 days using the full

item bank, which consists of 28 items in total.^{18,23,24} A PROMIS Depression CAT score of 50 represents the average for the US general population, with a SD of 10 points. A higher PROMIS Depression CAT score indicates more symptoms of depression.

Statistical Analysis

An a priori power analysis for multivariable linear regression was performed. For a model with a maximum of 10 predictors for upper extremity physical function, a sample size of 126 patients was needed to detect a moderate effect of 0.15 with 90% power at an alpha level of 0.05.

Continuous variables were described using means with SDs, and categorical variables were presented with frequencies and percentages. In bivariate analysis, the association of the outcome measures (PROMIS Upper Extremity and pain intensity) with explanatory variables was assessed using the unpaired *t* test for dichotomous explanatory variables (sex, smoking, prior treatment, affected side, type of visit, and presence of other pain conditions), one-way analysis of variance (ANOVA) for categorical explanatory variables (race, marital status, work status, and diagnosis), and Pearson or Spearman correlation coefficient for normally or non-normally distributed continuous explanatory variables (age, education, duration of symptoms, depression, pain interference, and 5 facets of mindfulness), respectively. Variables with a *P* value below .05 in bivariate analysis were entered into a multivariable linear regression model, without any further selection, to assess their ability to explain the variation in the outcome measures. As collinear covariates inflate the standard error and lead to false negative results, separate multivariable linear regression models were built excluding either the FFMQ-SF total score or FFMQ-SF subscale scores. A *P* value of less than .05 was considered significant.

Patient Characteristics

The majority of patients were women (71, 56%), with a mean age of 53 years (range, 21-88) and mean education of 16 years (range, 12-28; Table 1). Carpal tunnel syndrome was the most common diagnosis (23%) followed by nonspecific arm pain (21%), and osteoarthritis (11%). The mean duration of symptoms was 149 weeks (range, 2-2080). The mean score for the PROMIS Upper Extremity was 37 (SD 9.7), for PROMIS Depression 51 (SD 8.6), and for PROMIS Pain Interference 58 (SD 7.7). The scores of the respective facets of mindfulness are shown in Table 2.

Results

A greater ability to be nonreactive as measured by the mindfulness facet nonreact (*P* = .045) was associated with higher

Table 1. Patient Characteristics (n = 126).

Age, mean (SD), y	53 (17)
Sex, n (%)	
Men	55 (44)
Women	71 (56)
Race, n (%)	
White	100 (79)
Black	7 (5.6)
Hispanic	7 (5.6)
Asian	7 (5.6)
Other	5 (4.0)
Smoking status, n (%)	
Yes	10 (7.9)
No	116 (92)
Marital status, n (%)	
Married	67 (53)
Single	34 (27)
Separated/divorced	15 (12)
Widowed	7 (5.6)
Living with partner	3 (2.4)
Education, mean (SD), y	16 (3.2)
Work status, n (%)	
Full-time	71 (56)
Retired	30 (24)
Unemployed, able to work	11 (8.7)
Part-time	10 (7.9)
Unemployed, unable to work	4 (3.2)
Diagnosis, n (%)	
Carpal tunnel syndrome/cubital tunnel	29 (23)
Nonspecific arm pain	27 (21)
Osteoarthritis	14 (11)
Trigger finger	14 (11)
Tumor/cyst/lump	13 (10)
Dupuytren	7 (5.6)
De Quervain	4 (3.2)
Other	18 (14)
Prior treatment, n (%)	
Yes	42 (33)
No	84 (67)
Affected side, n (%)	
Dominant	80 (63)
Nondominant	46 (37)
Type of visit, n (%)	
New	79 (63)
Follow-up	47 (37)
Multiple pain conditions, n (%)	
Yes	44 (35)
No	82 (65)
Duration of symptoms, median (IQR), wk	44 (12-104)
Pain score, mean (SD)	3.0 (2.6)
PROMIS Upper Extremity, mean (SD)	37 (9.7)
PROMIS Depression, mean (SD)	51 (8.6)
PROMIS Pain Interference, mean (SD)	58 (7.7)

Note. SD = standard deviation; IQR = interquartile range; PROMIS = Patient Reported Outcomes Measurement Information System.

upper extremity physical function in bivariate analysis. Men (*P* = .005) and nonsmokers (*P* = .010) reported better physical function than women and smokers, respectively. Patients

Table 2. Five Facet Mindfulness Questionnaires (n = 126).

	No. of items	Mean	SD
Facets of mindfulness			
Total score	24	85	10
Nonreact	5	17	3.3
Observe	4	15	3.4
Act aware	5	16	1.5
Describe	5	20	3.5
Nonjudge	5	17	3.9

Note. SD = standard deviation.

who are single and patients who work full-time reported better physical function than patients with another marital status ($P = .040$) or work status ($P = .019$), respectively. Follow-up patients ($P = .014$) and those who did not report other pain conditions ($P = .001$) reported better physical function. Younger ($P = .009$) and higher educated ($P < .001$) patients reported better physical function. Patients with less depression ($P = .046$) and less pain interference ($P < .001$) reported better physical function (Table 3). In multivariable linear regression analysis, only male sex ($\beta = 3.8$; 95% confidence interval [CI], 1.3-6.3; $P = .004$), higher education ($\beta = 0.42$; 95% CI, 0.015-0.83; $P = .042$), and pain interference ($\beta = -0.83$; 95% CI, -1.0 to -0.65; $P < .001$) were independently associated with upper extremity physical function (Table 4).

A greater ability to be mindful as measured by the total score on FFMQ-SF ($P = .029$) and a greater ability to be nonreactive to inner experiences as measured by the nonreact subscale of the FFMQ-SF ($P = .010$) were associated with lower pain intensity in patients with upper extremity illness in bivariate analysis. Patients with higher education ($P = .004$), shorter duration of symptoms ($P = .024$), less symptoms of depression ($P = .049$), and lower pain interference ($P < .001$) reported a lower pain intensity. All other demographic variables had no relationship with pain intensity or physical function (Table 3). In multivariable linear regression analyses, only pain interference was independently associated with pain intensity ($\beta = 0.21$; 95% CI, 0.16-0.26; $P < .001$; Table 4).

Discussion

Mindfulness skills training has been associated with increased physical function and decreased pain intensity across patients with chronic pain conditions.^{4,7,9,16,21} We aimed to assess the relationship of mindfulness with physical function and pain intensity in patients with upper extremity illness in a surgical practice. We found that non-reactivity to inner experiences was the only facet of mindfulness that was correlated with upper extremity physical function and pain intensity. The overall mindfulness score was correlated with pain intensity only. In multivariable

Table 3. Bivariate Analysis: Factors Associated With Physical Function and Pain Intensity (n = 126).

	PROMIS Upper Extremity		Pain intensity	
	Mean (SD)	P value	Mean (SD)	P value
Sex				
Male	40 (9.8)	.005	2.7 (2.5)	.28
Female	35 (9.0)		3.3 (2.6)	
Race				
White	38 (9.6)	.49	2.9 (2.7)	.86
Black	31 (2.8)		3.6 (1.9)	
Hispanic	39 (15)		3.4 (3.4)	
Asian	37 (7.9)		2.9 (2.1)	
Other	39 (11)		4.0 (1.7)	
Smoking status				
Yes	33 (10)	.010	4.0 (3.8)	.22
No	38 (9.6)		2.9 (2.5)	
Marital status				
Married	37 (10)	.040	3.3 (2.6)	.19
Single	41 (8.2)		2.4 (2.3)	
Separated/divorced	32 (5.8)		3.5 (2.7)	
Widowed	38 (12)		1.7 (2.4)	
Living with a partner	35 (6.6)		4.7 (3.2)	
Work status				
Full-time	40 (9.6)	.019	2.7 (2.3)	.17
Part-time	33 (9.7)		3.6 (2.5)	
Retired	36 (8.9)		3.7 (3.1)	
Unemployed, able to work	32 (9.1)		3.5 (2.2)	
Unemployed, unable to work	35 (8.0)		1.3 (2.5)	
Diagnosis				
Carpal tunnel syndrome/cubital tunnel	36 (9.3)	.11	3.7 (2.7)	.17
Nonspecific arm pain	36 (8.8)		3.3 (2.6)	
Osteoarthritis	33 (7.5)		3.9 (2.4)	
Trigger finger	37 (8.7)		2.0 (2.4)	
Tumor/cyst/lump	42 (10)		1.9 (2.4)	
Dupuytren	41 (9.0)		2.0 (2.2)	
De Quervain	34 (5.8)		4.0 (2.9)	
Other	41 (12)		2.7 (2.5)	
Prior treatment				
Yes	36 (9.3)	.15	3.3 (2.8)	.48
No	38 (9.7)		2.9 (2.8)	
Affected side				
Dominant	37 (9.2)	.58	3.2 (2.6)	.50
Nondominant	38 (10)		2.8 (2.6)	
Type of visit				
New	35 (9.1)	.014	3.3 (2.3)	.38
Follow-up	39 (9.7)		2.9 (2.7)	

(continued)

Table 3. (continued)

	PROMIS Upper Extremity		Pain intensity	
	Mean (SD)	<i>P</i> value	Mean (SD)	<i>P</i> value
Multiple pain conditions				
Yes	34 (8.2)	.001	3.6 (2.6)	.055
No	39 (9.8)		2.7 (2.5)	
	Coefficient	<i>P</i> value	Coefficient	<i>P</i> value
Age	-0.23	.009	0.17	.061
Education	0.34	<.001	-0.25	.004
Duration of symptoms	-0.11	.24	0.20	.024
PROMIS Depression	-0.18	.046	0.18	.049
PROMIS Pain Interference	-0.72	<.001	0.63	<.001
Five Facet Mindfulness				
Total score	0.040	.62	-0.19	.029
Nonreact	0.18	.045	-0.23	.010
Observe	-0.11	.21	-0.065	.46
Act aware	-0.06	.53	-0.12	.18
Describe	-0.010	.91	-0.079	.38
Nonjudge	0.07	.47	-0.12	.17

Note. A bold *P* value indicates significance. PROMIS = Patient Reported Outcomes Measurement Information System; SD = standard deviation.

analyses, mindfulness was not associated with either physical function or pain intensity. Consistent with prior research, pain interference was the most important predictor of both pain intensity and physical function.^{6,13,14,23,26,27}

Our study results should be interpreted in the light of a number of limitations. First, this study was performed at one academic urban-based hospital and results may therefore not be generalizable to patients in other settings. Second, the findings may not apply to patient groups with traumatic upper extremity conditions as we included non-traumatic upper extremity conditions only. Third, our sample size was relatively small as it was based to detect a moderate effect as defined by Cohen.¹¹ Therefore, we might not have been able to detect a smaller still relevant association in our study population. This finding is substantiated by the near significant *P* values of depression and total mindfulness scale in the regression predicting physical function, which may have reached significance level with a larger sample. Fourth, in our study, we used a general pain score without differentiating the origin of the reported pain. Therefore, it could be possible that not all pain can be attributed to the upper extremity illness of the patient. We did however account other pain conditions in our analyses. Finally, the FFMQ-SF has been validated in a Dutch sample of patients with depressive symptoms recruited by self-selection.⁵ However, it showed good

psychometric properties and the use of short forms has been recommended in clinical settings as it seems more efficient and less of a burden for patients compared with original questionnaires.

We found that nonreactivity to the inner experiences subscale was the only mindfulness facet that was correlated with upper extremity physical function. This is not surprising as higher nonreactivity to inner experience prevents getting carried away by thoughts and feelings that make one protect and prepare for the worst, which is a natural response to pain that can lead to disability. However, in the multivariable analyses, its relationship with physical function became nonsignificant. Voskuil and Ring²⁵ showed in patients presenting to a hand surgeon that greater awareness, a subscale of the Philadelphia Mindfulness Scale, resulted in lower physical function. Prior studies in patients with chronic pain showed greater mindfulness to be correlated with higher physical function.^{9,22} It may be that mindfulness may become important in later stages of an orthopedic illness (eg, chronic pain), whereas pain interference takes precedent in the early stages of illness. This is consistent with the evidence from studies of patients in orthopedic surgical practices (eg, where patients with relatively recent illness are primarily seen) that inadequate coping strategies usually explain more of the variation in physical function than other factors, including measures of psychological distress.^{6,13,14,23,26,27}

In addition, our study showed that both the nonreactivity to inner experience facet and the total mindfulness scale were correlated with pain intensity. As with upper extremity physical function, mindfulness was not significantly associated with pain intensity in the multivariable regression, and pain interference explained most of the variation of this outcome measure. Other studies have shown mindfulness-based therapies to be effective in patients with a wide variety of pain conditions but also pain following surgical and invasive medical procedures.^{2,17,19} We did not include any form of mindfulness training in this study and were not able to find an association of level of mindfulness and our outcome measures.

In conclusion, mindfulness was correlated with upper extremity physical function and pain intensity in unadjusted analysis. However, greater mindfulness, as measured with the FFMQ-SF, was not independently associated with both physical function and pain intensity in patients with upper extremity illness. Pain interference explains most of the variation in physical function and pain. Therefore, therapies to address physical function and pain in patients with chronic upper extremity illness should focus on improving coping strategies.

Ethical Approval

The institutional review board of our institution (Massachusetts General Hospital) approved this study under protocol 2009P001019/ MGH.

Table 4. Multivariable Analysis: Factors Independently Associated With Physical Function and Pain Intensity (n = 126).

	Coefficient	Standard error	95% CI		P value	Partial R ²
Model 1: Multivariable linear regression model for PROMIS Upper Extremity (adjusted R ² = .56)						
Sex (ref: female)						
Male	3.8	1.3	1.3	6.3	.004	.075
Smoking status (ref: yes)						
No	0.85	2.5	-5.9	4.2	.74	.001
Marital status (ref: single)						
Married	-0.061	1.6	-3.2	3.1	.97	.000
Separated/divorced	-0.38	2.3	-4.9	4.2	.87	.000
Widowed	0.83	3.2	-5.4	7.1	.79	.000
Living with partner	-1.1	4.1	-9.2	7.0	.79	.000
Work status (ref: full-time)						
Part-time	-3.2	2.3	-7.7	1.3	.17	.018
Retired	-0.86	2.0	-4.8	3.1	.67	.002
Unemployed, able to work	-2.7	2.3	-7.1	1.8	.24	.013
Unemployed, unable to work	0.48	3.6	-6.7	7.7	.89	.000
Type of visit (ref: follow-up)						
New	0.71	1.2	-3.2	1.7	.57	.003
Multiple pain conditions (ref: no)						
Yes	0.60	1.5	-3.2	1.7	.69	.001
Age	-0.098	0.056	-0.21	0.013	.084	.027
Education	0.42	0.21	0.015	0.83	.042	.038
PROMIS Depression	0.072	0.083	-0.092	0.24	.39	.007
PROMIS Pain Interference	-0.83	0.092	-1.0	-0.65	<.001	.431
Five Facet Mindfulness						
Nonreact	-0.083	0.20	-0.48	0.31	.69	.002
Model 2: Multivariable linear regression model for pain intensity excluding mindfulness facet nonreact (adjusted R ² = .44)						
Education	-0.093	0.057	-0.21	0.021	.11	.021
Duration of symptoms	0.001	0.00056	-0.000070	0.0021	.066	.028
PROMIS Depression	-0.044	0.025	-0.094	0.0050	.078	.026
PROMIS Pain Interference	0.21	0.025	0.16	0.26	<.001	.374
Five Facet Mindfulness						
Total score	-0.036	0.020	-0.076	0.0044	.081	.025
Model 3: Multivariable linear regression model for pain intensity excluding total score FFMQ-SF (adjusted R ² = .43)						
Education	-0.10	0.058	-0.22	0.013	.081	.025
Duration of symptoms	0.001	0.00057	-0.00011	0.0021	.076	.026
PROMIS Depression	-0.031	0.024	-0.078	0.016	.19	.014
PROMIS Pain Interference	0.21	0.025	0.16	0.26	<.001	.358
Five Facet Mindfulness						
Nonreact	-0.052	0.060	-0.17	0.067	.39	.006

Note. A bold P value indicates significance. CI = confidence interval; PROMIS = Patient Reported Outcomes Measurement Information System; FFMQ-SF = Short form of the Five Facet Mindfulness Questionnaire.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Informed consent was obtained from all patients for being included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Amtmann D, Cook KF, Jensen MP, et al. Development of a PROMIS item bank to measure pain interference. *Pain*. 2010;150(1):173-182.
2. Astin JA. Mind-body therapies for the management of pain. *Clin J Pain*. 2004;20(1):27-32.
3. Baer RA, Smith GT, Hopkins J, et al. Using self-report assessment methods to explore facets of mindfulness. *Assessment*. 2006;13(1):27-45.
4. Bogosian A, Chadwick P, Windgassen S, et al. Distress improves after mindfulness training for progressive MS: a pilot randomised trial. *Mult Scler*. 2015;21(9):1184-1194.
5. Bohlmeijer E, ten Klooster PM, Fledderus M, et al. Psychometric properties of the five facet mindfulness questionnaire in depressed adults and development of a short form. *Assessment*. 2011;18(3):308-320.
6. Bot AG, Souer JS, van Dijk CN, et al. Association between individual DASH tasks and restricted wrist flexion and extension after volar plate fixation of a fracture of the distal radius. *Hand*. 2012;7(4):407-412.
7. Brown CA, Jones AK. Psychobiological correlates of improved mental health in patients with musculoskeletal pain after a mindfulness-based pain management program. *Clin J Pain*. 2013;29(3):233-244.
8. Cardaciotto L, Herbert JD, Forman EM, et al. The assessment of present-moment awareness and acceptance: the Philadelphia Mindfulness Scale. *Assessment*. 2008;15(2):204-223.
9. Cassidy EL, Atherton RJ, Robertson N, et al. Mindfulness, functioning and catastrophizing after multidisciplinary pain management for chronic low back pain. *Pain*. 2012;153(3):644-650.
10. Cella D, Chang CH. A discussion of item response theory and its applications in health status assessment. *Med Care*. 2000;38(9)(suppl):II66-II72.
11. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum: London, United Kingdom; 1988.
12. Cook KF, O'Malley KJ, Roddey TS. Dynamic assessment of health outcomes: time to let the CAT out of the bag? *Health Serv Res*. 2005;40(5, pt 2):1694-1711.
13. Das De S, Vranceanu AM, Ring DC. Contribution of kinesiophobia and catastrophic thinking to upper-extremity-specific disability. *J Bone Joint Surg Am*. 2013;95(1):76-81.
14. Domenech J, Sanchis-Alfonso V, Espejo B. Changes in catastrophizing and kinesiophobia are predictive of changes in disability and pain after treatment in patients with anterior knee pain. *Knee Surg Sports Traumatol Arthrosc*. 2014;22(10):2295-2300.
15. Doring AC, Nota SP, Hageman MG, et al. Measurement of upper extremity disability using the Patient-Reported Outcomes Measurement Information System. *J Hand Surg Am*. 2014;39(6):1160-1165.
16. Dowd H, Hogan MJ, McGuire BE, et al. Comparison of an online mindfulness-based cognitive therapy intervention with online pain management psychoeducation: a randomized controlled study. *Clin J Pain*. 2015;31(6):517-527.
17. Fouladbakhsh J. Complementary and alternative modalities to relieve osteoarthritis symptoms: a review of the evidence on several therapies often used for osteoarthritis management. *Orthop Nurs*. 2012;31(2):115-121.
18. Gibbons LE, Feldman BJ, Crane HM, et al. Migrating from a legacy fixed-format measure to CAT administration: calibrating the PHQ-9 to the PROMIS depression measures. *Qual Life Res*. 2011;20(9):1349-1357.
19. Hassed C. Mind-body therapies—use in chronic pain management. *Aust Fam Physician*. 2013;42(3):112-117.
20. Hays RD, Spritzer KL, Amtmann D, et al. Upper-extremity and mobility subdomains from the Patient-Reported Outcomes Measurement Information System (PROMIS) adult physical functioning item bank. *Arch Phys Med Rehabil*. 2013;94(11):2291-2296.
21. Ludwig DS, Kabat-Zinn J. Mindfulness in medicine. *JAMA*. 2008;300(11):1350-1352.
22. McCracken LM, Gauntlett-Gilbert J, Vowles KE. The role of mindfulness in a contextual cognitive-behavioral analysis of chronic pain-related suffering and disability. *Pain*. 2007;131(1-2):63-69.
23. Nickel MC, Lindenhovius AL, Watson JB, et al. Correlation of DASH and QuickDASH with measures of psychological distress. *J Hand Surg Am*. 2009;34(8):1499-1505.
24. Pilkonis PA, Choi SW, Reise SP, et al. Item banks for measuring emotional distress from the Patient-Reported Outcomes Measurement Information System (PROMIS(R)): depression, anxiety, and anger. *Assessment*. 2011;18(3):263-283.
25. Voskuil T, Ring D. The influence of mindfulness on upper extremity illness. *Hand (N Y)*. 2014;9(2):225-229.
26. Vranceanu AM, Bachoura A, Weening A, et al. Psychological factors predict disability and pain intensity after skeletal trauma. *J Bone Joint Surg Am*. 2014;96(3):e20.
27. Wertli MM, Eugster R, Held U, et al. Catastrophizing—a prognostic factor for outcome in patients with low back pain: a systematic review. *Spine J*. 2014;14(11):2639-2657.