



# Mindfulness is associated with psychological health and moderates the impact of fibromyalgia

Brandon Pleman<sup>1</sup> · Michelle Park<sup>1</sup> · Xingyi Han<sup>1</sup> · Lori Lyn Price<sup>2,3</sup> · Raveendhara R. Bannuru<sup>1,4</sup> · William F. Harvey<sup>1</sup> · Jeffrey B. Driban<sup>1</sup> · Chenchen Wang<sup>1</sup>

Received: 6 September 2018 / Revised: 18 December 2018 / Accepted: 4 January 2019 / Published online: 14 January 2019  
© International League of Associations for Rheumatology (ILAR) 2019

## Abstract

**Objective** Previous studies suggest mindfulness is associated with pain and depression. However, its impact in individuals with fibromyalgia remains unclear. We examined associations between mindfulness and physical and psychological symptoms, pain interference, and quality of life in fibromyalgia patients.

**Methods** We performed a cross-sectional analysis on baseline data from a fibromyalgia clinical trial. Mindfulness was assessed using the Five Facet Mindfulness Questionnaire (FFMQ). Pearson's correlations and multivariable linear regression models were used to evaluate associations between mindfulness and fibromyalgia impact, pain interference, physical function, depression, anxiety, stress, self-efficacy, and health-related quality of life. We also examined whether mindfulness moderated associations between fibromyalgia impact and psychological outcomes.

**Results** A total of 177 participants (age  $52.0 \pm 12.2$  (SD) years; 93.2% women; 58.8% white; body mass index  $30.1 \pm 6.7$  kg/m<sup>2</sup>; FFMQ score  $131.3 \pm 20.7$ ; Revised Fibromyalgia Impact Questionnaire score  $57.0 \pm 19.4$ ) were included. Higher total mindfulness was significantly associated with lower fibromyalgia impact ( $r = -0.25$ ), pain interference ( $r = -0.31$ ), stress ( $r = -0.56$ ), anxiety ( $r = -0.58$ ), depression ( $r = -0.54$ ), and better mental health-related quality of life ( $r = 0.57$ ). Describing, Acting-with-awareness, and Non-judging facets of mindfulness were also associated with these outcomes. Mindfulness moderated the effect of fibromyalgia impact on anxiety (interaction  $P = 0.01$ ).

**Conclusion** Higher mindfulness is associated with less pain interference, lower impact of fibromyalgia, and better psychological health and quality of life in people with fibromyalgia. Mindfulness moderates the influence of fibromyalgia impact on anxiety, suggesting mindfulness may alter how patients cope with fibromyalgia. Future studies should assess how mind-body therapies aiming to cultivate mindfulness may impact the well-being of patients with fibromyalgia.

**Key points** • Higher mindfulness was associated with better psychological health and lower overall impact of fibromyalgia.

- Mindfulness moderated the relationship between overall fibromyalgia impact and anxiety.

**Keywords** Anxiety · Depression · Fibromyalgia · Mindfulness · Pain · Quality of life · Stress

---

✉ Chenchen Wang  
cwang2@tuftsmedicalcenter.org

<sup>1</sup> Center for Complementary and Integrative Medicine & Division of Rheumatology, Tufts Medical Center, Tufts University School of Medicine, 800 Washington Street, Box 406, Boston, MA 02111, USA

<sup>2</sup> The Institute for Clinical Research and Health Policy Studies, Tufts Medical Center, Boston, MA, USA

<sup>3</sup> Tufts Clinical and Translational Science Institute, Tufts University, Boston, MA, USA

<sup>4</sup> Center for Treatment Comparison and Integrative Analysis, Tufts Medical Center, Boston, MA, USA

## Introduction

Fibromyalgia is one of the most common chronic musculoskeletal pain conditions and the second most common rheumatic disorder in the USA, with women predominantly affected [1]. It is characterized by chronic widespread musculoskeletal pain, pervasive somatic and psychological distress, impairment of social and physical function, and reduced overall quality of life [2]. These diverse symptoms synergistically create greater overall symptom severity than individual symptoms would alone [3]. Fibromyalgia patients also report higher levels of emotional dysregulation compared to other patients experiencing similar levels of pain [2]. No treatments are

currently recommended for effectively managing these multi-dimensional symptoms of fibromyalgia.

Mindfulness is a state of increased self-regulated attention with an open, curious, and non-judgmental mind toward one's present experience. Higher levels of mindfulness are associated with better physical and psychological outcomes in clinical and community populations, including in patients with chronic pain [4–10], indicating that mindfulness may play a critical role in an individual's relationship with their physical and psychological distress. However, no study has investigated mindfulness as a moderator of psychological outcomes in fibromyalgia. Mindfulness has recently been characterized to be composed of five distinct dimensions: Observing, Describing, Acting-with-awareness, Non-judging, and Non-reacting [11, 12]. These facets of mindfulness differ in their associations with health outcomes [4–10, 13–17]. The Describing, Acting-with-awareness, and Non-judging facets are often similarly associated with better psychological health. Analyzing mindfulness by individual facet may help us further elucidate the mechanism by which mindfulness impacts health outcomes and will guide future implementation of mindfulness-based mind-body therapies.

The objective of this study is to evaluate how mindfulness is associated with physical and psychological outcomes in patients with fibromyalgia. We also investigate how mindfulness may improve one's ability to cope with the overall impact of fibromyalgia. We hypothesize that higher mindfulness, especially the Acting-with-awareness, Describing, and Non-judging facets, will be associated with better physical and psychological health, less pain interference, and better quality of life. We also hypothesize that mindfulness may moderate the effect of fibromyalgia impact on psychological health.

## Patients and methods

### Study design

We performed a secondary, cross-sectional analysis of data obtained from a baseline screening evaluation in a single center, randomized clinical trial comparing Tai Chi to a standardized aerobic exercise regimen for participants with fibromyalgia. All data were collected at Tufts Medical Center, an academic, urban tertiary hospital located in Boston, Massachusetts. This study was approved by Tufts Medical Center Institutional Review Board and granted by the National Center for Complementary and Integrative Health of the National Institutes of Health. Signed informed consent was obtained from each study participant. A detailed protocol was previously published in reference to recruitment, intervention, and follow-up procedures [18].

### Eligibility criteria

Eligible participants were (1) aged 21 years or older and (2) fulfilled the American College of Rheumatology (ACR) 1990 classification criteria and the ACR 2010 diagnostic criteria for fibromyalgia [19, 20]. Individuals were excluded if they had (1) prior experience with Tai Chi training or similar types of complementary and alternative medicine (e.g., Qi Gong or yoga) in the past year; (2) serious medical conditions limiting ability to participate in the Tai Chi or aerobic exercise program including dementia, neurological disease, cancer, cardiovascular disease, pulmonary disease, metabolic disease, renal disease, and liver disease; (3) diagnosed medical conditions that are known to contribute to fibromyalgia symptomatology, such as thyroid disease, inflammatory arthritis, systemic lupus erythematosus, rheumatoid arthritis, myositis, vasculitis, or Sjogren's syndrome; (4) an inability to pass the Physical Activity Readiness Questionnaire (PAR-Q); (5) scored less than 24 on the Mini-Mental Status Examination [21]; (6) plans to relocate from the region during the trial period; (7) verbal confirmation of pregnancy or planned pregnancy during the study period; or (8) were non-English speaking.

### Screening procedures

At the baseline screening evaluation, participants completed a pre-randomization assessment battery consisting of standardized measures that evaluated general health and functional status and physical, psychological, and psychosocial functioning measures. In addition, a rheumatologist completed a manual tender point survey to confirm diagnosis. All randomized participants who completed the Five Facet Mindfulness Questionnaire (FFMQ) were included in this study.

### Measures

#### Mindfulness

Mindfulness was measured by the FFMQ, a validated 39-question instrument that assesses overall mindfulness as well as its five subscales (Observing, Describing, Acting-with-awareness, Non-judging, and Non-reactivity) on a 5-point Likert scale where higher scores reflect higher mindfulness [5, 11, 17]. Total scores range from 39 to 195. The subscales are as follows: the Observing facet (8-items, range 8–40) measures the capacity to attend to internal or external experiences, such as sensations, thoughts, and emotions; the Describing facet (8-items, range 8–40) measures the aptitude to convey internal experiences with words; the Acting-with-awareness facet (8-items, range 8–40) measures the ability to intentionally attend to activities that are unfolding in the moment; the Non-judging of inner experience facet (8-items, range 8–40) measures the propensity to apply a non-evaluative stance

toward thoughts and feelings; and the Non-reactivity to inner experience facet (7-items, range 7–35) measures the inclination to allow thoughts and feelings to oscillate without becoming engrossed in them [11].

### Fibromyalgia impact

Fibromyalgia impact was measured by the Revised Fibromyalgia Impact Questionnaire (FIQR). The FIQR is a 21-item, validated self-report instrument that assesses function, overall impact, and symptoms over the past 7 days [22]. The total scores, calculated from the three subscales, range from 0 to 100. Higher scores indicate greater dysfunction.

### Pain interference

Pain interference was assessed using the PROMIS Adult Short Form: Pain Interference version 1.0 instrument. PROMIS-Pain Interference measures the extent to which pain interferes with a patient's physical, mental, emotional, and social activities in the past 7 days and is highly reliable [23]. It consists of 6 items measured on a 5-point Likert scale. Raw scores were converted into *t* scores, ranging from 41 to 78.3, with higher scores representing greater pain interference [24].

### Symptom severity

The Symptom Severity Scale (SS) is a widely used, two-part instrument that enables assessment of fibromyalgia-related symptoms over the past week [20]. The SS score is the sum of the scaled severity of symptoms and the extent of somatic symptoms in general. The final score ranges between 0 and 12, with higher scores indicating greater symptom severity [20].

### Patient's global assessment

The Patient's Global Assessment is a visual analogue scale (VAS) completed by the participant, with scores ranging from 0 to 10. Higher scores represent increased severity of fibromyalgia symptoms. This is a common tool for assessment of rheumatic conditions [25, 26].

### Stress

The Perceived Stress Scale (PSS) is an internally reliable, widely used inventory used to measure perceptions of stress [27]. This 10-item scale is designed to assess the extent to which one's life feels unpredictable, uncontrollable, and/or overloaded in the past month. Total scores range from 0 to 40, and higher scores reflect greater perceived levels of stress.

### Anxiety and depression

The Hospital Anxiety and Depression Scale (HADS) is a validated, 14-question, self-report inventory that measures levels of anxiety and depression with separate 7-question subscales [28, 29]. Scores range from 0 to 21 and higher scores indicate worse symptoms.

### Coping strategies

The Coping Strategies Questionnaire (CSQ) is a 7-item, well-validated, self-report scale used to assess the use of pain coping mechanisms through seven subscales—one behavioral and six cognitive—scored from 0 to 6, where higher scores indicate better coping strategies [30, 31].

### Health-related quality of life

Health-Related Quality of Life was assessed using the 36-Item Short Form Health Survey (SF-36), a broad measure of health status with well-documented psychometric properties [32]. The SF-36 consists of 36 items measured on Likert-type scales and are related to eight dimensions of well-being: vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health. Questions are transformed into a point scale ranging from 0 to 100, and higher scores indicate better perceived health status. Two aggregate scores were obtained: the Physical Component Summary (PCS) score and the Mental Component Summary (MCS) score. The SF-36 has high internal consistency of domains and is valid in groups reporting different levels of ill-health [33].

### Self-efficacy

Self-efficacy is the perception that one has the power to produce a desired outcome [34]. Participants' confidence in their ability to manage their fibromyalgia symptoms was assessed using the validated 8-item Arthritis Self-Efficacy Scale (ASES-8) [35]. Eight questions were rated on a 10-point Likert scale, and the total score is the average of the eight responses. Higher scores indicate greater self-efficacy.

### Functional testing

The 6-min walking test is an accepted measure of physical functional ability [36]. Participants are directed to walk as far as possible in 6 min and are urged throughout its duration to travel as far as possible. The total distance covered is recorded in meters.

**Table 1** Demographic and clinical characteristics of participants ( $n = 177$ )

Variables	Mean $\pm$ SD
Age, years	52.0 $\pm$ 12.2
Sex, $n$ (%)	
Female	165 (93.2)
Race, $n$ (%)	
White	104 (58.8)
Black	43 (24.3)
Other	30 (16.9)
Level of education, $n$ (%)	
High school or less	67 (16.3)
Trade, technical school or some college	29 (45.5)
College or graduate degree	81 (38.2)
Body mass index, $\text{kg}/\text{m}^2$	30.1 $\pm$ 6.7
Duration of disease, years	13.1 $\pm$ 10.1
Revised Fibromyalgia Impact Questionnaire (range 0–100)*	57.0 $\pm$ 19.4
PROMIS Pain Interference (range 41–78.3)*†	65.2 $\pm$ 5.9
Symptom severity (range 0–12)*	8.7 $\pm$ 2.0
Global Visual Analogue Scale (range 0–10)*	6.1 $\pm$ 2.0
Perceived Stress Scale (range 0–40)*	20.0 $\pm$ 7.1
Hospital Anxiety and Depression Scale (range 0–21)*	
Anxiety	8.9 $\pm$ 4.1
Depression	7.6 $\pm$ 4.1
Coping Strategies Questionnaire (range 0–42)	15.4 $\pm$ 9.0
Short Form-36 (range 0–100)	
Physical Component Summary	29.9 $\pm$ 7.4
Mental Component Summary	40.5 $\pm$ 10.9
Arthritis Self-Efficacy Scale-8 (range 1–10)	5.2 $\pm$ 2.1
6-Minute Walking Test (meters)	394.7 $\pm$ 83.4
Five Facet Mindfulness Questionnaire	
Total (range 39–195)	131.3 $\pm$ 20.7
Observing (range 8–40)	29.5 $\pm$ 5.7
Describing (range 8–40)	27.8 $\pm$ 6.2
Acting-with-awareness (range 8–40)	24.9 $\pm$ 6.8
Non-judging (range 8–40)	27.4 $\pm$ 7.5
Non-reacting (range 7–35)	21.7 $\pm$ 4.9

\*Designates tests with higher scores indicating worse outcomes; better outcomes unmarked

†PROMIS Pain Interference reported in  $t$  scores

## Statistical analysis

All data were initially examined visually and statistically for normality of distribution, and values are presented as means  $\pm$  standard deviation (SD) unless otherwise stated. Pearson's correlation was performed to assess associations between mindfulness and measures of physical and psychological health and quality of life. Multivariable linear regression was conducted to examine the relationships between facets of mindfulness and health outcomes. Analyses were controlled for age, gender, race, body mass index (BMI), and education. These variables were selected as potential confounders based

on similar studies of mindfulness and chronic pain conditions. Model diagnostics were performed to identify potential influential points. Model assumptions and appropriateness were examined graphically and analytically. We also performed interaction analysis to determine whether mindfulness operated as a moderator in the relationship between fibromyalgia impact and anxiety, depression, and perceived stress. Interaction software was used to create the interaction analysis plot [37]. Mindfulness was divided into three groups for the interaction analyses based on total FFMQ values: total scores one standard deviation above the mean (High), below the mean (Low), or within one standard deviation of the mean (Med). SAS 9.4

**Table 2** Pearson correlation coefficients between mindfulness facets and health measures

Mindfulness (total FFMQ and facets), <i>r</i> ( <i>p</i> value)						
	Total	Observing	Describing	Acting-with-awareness	Non-judging	Non-reacting
FIQR*	- 0.25 (< 0.001)	0.07 (0.33)	- 0.17 (0.02)	- 0.24 (0.001)	- 0.30 (< 0.001)	- 0.13 (0.10)
PROMIS Pain*	- 0.31 (< 0.001)	- 0.04 (0.55)	- 0.26 (< 0.001)	- 0.25 (0.001)	- 0.26 (< 0.001)	- 0.19 (0.01)
Symptom Severity*	- 0.33 (< 0.001)	0.01 (0.93)	- 0.21 (0.005)	- 0.37 (< 0.001)	- 0.30 (< 0.001)	- 0.14 (0.06)
Patient’s Global Assessment*	- 0.11 (0.16)	- 0.01 (0.94)	- 0.08 (0.27)	- 0.06 (0.45)	- 0.12 (0.11)	- 0.07 (0.34)
PSS*	- 0.56 (< 0.001)	- 0.07 (0.38)	- 0.37 (< 0.001)	- 0.56 (< 0.001)	- 0.50 (< 0.001)	- 0.28 (< 0.001)
HADS-Anxiety*	- 0.58 (< 0.001)	- 0.11 (0.14)	- 0.33 (< 0.001)	- 0.54 (< 0.001)	- 0.57 (< 0.001)	- 0.28 (0.001)
HADS-Depression*	- 0.54 (< 0.001)	- 0.19 (0.01)	- 0.38 (< 0.001)	- 0.47 (< 0.001)	- 0.40 (< 0.001)	- 0.30 (< 0.001)
CSQ	- 0.40 (< 0.001)	- 0.02 (0.75)	- 0.28 (< 0.001)	- 0.33 (< 0.001)	- 0.43 (< 0.001)	- 0.17 (0.02)
SF-36-PCS	- 0.09 (0.21)	- 0.09 (0.25)	- 0.07 (0.39)	- 0.04 (0.62)	- 0.06 (0.46)	- 0.08 (0.32)
SF-36-MCS	0.57 (< 0.001)	0.14 (0.06)	0.35 (< 0.001)	0.48 (< 0.001)	0.51 (< 0.001)	0.34 (< 0.001)
ASES-8	0.29 (< 0.001)	0.20 (0.008)	0.17 (0.02)	0.22 (0.003)	0.13 (0.09)	0.26 (< 0.001)
6-Minute Walk	0.05 (0.54)	0.08 (0.28)	0.09 (0.22)	- 0.08 (0.33)	0.03 (0.69)	0.04 (0.60)

*FFMQ* Five Facet Mindfulness Questionnaire, *FIQR* Revised Fibromyalgia Impact Questionnaire, *PROMIS Pain* PROMIS Pain Interference Short Form, *PSS* Perceived Stress Scale, *HADS* Hospital Anxiety and Depression Scale (Anxiety and Depression components), *CSQ* Coping Strategies Questionnaire, *SF-36* Medical Outcomes Short Form-36 (*PCS* Physical Component Summary, *MCS* Mental Component Summary), *ASES-8* Arthritis Self-Efficacy Scale, and *6-Minute Walk* 6-Minute Walking Test

Italic items met statistical significance

\*Indicates tests with higher scores indicating worse outcomes; better outcomes unmarked

was used for all other analyses. Significance level was set at  $P \leq 0.05$ . No correction was made for multiple testing.

## Results

Baseline demographics and clinical characteristics of the 177 participants are presented in Table 1. The mean ± SD age was 52.0 ± 12.2 years; 93.2% were female; 58.8% were white; 38.2% had at least a college degree, and the average BMI was 30.1 ± 6.7 kg/m<sup>2</sup>. The mean disease duration was 13.1 ± 10.1 years. FIQR scores demonstrated moderate to severe fibromyalgia in most participants with an average score of 57.0 (SD = 19.4). The mean total mindfulness was 131.3 (SD = 20.7), with mean scores of five individual facets ranging from 21.7 to 29.5.

Table 2 shows that higher mindfulness was significantly associated with lower fibromyalgia impact ( $r = -0.25$ ,  $P < 0.001$ ), less pain interference ( $r = -0.31$ ,  $P < 0.001$ ), less stress ( $r = -0.56$ ,  $P < 0.001$ ), less anxiety ( $r = -0.58$ ,  $P < 0.001$ ), and less depression ( $r = -0.54$ ,  $P < 0.001$ ). Higher mindfulness was also associated with better coping skills ( $r = -0.40$ ,  $P < 0.001$ ), better self-efficacy ( $r = 0.29$ ,  $P = 0.001$ ), and better mental component of quality of life ( $r = 0.57$ ,  $P < 0.001$ ). Of the five facets of mindfulness, the Non-reacting and Observing facets were not significantly associated with overall fibromyalgia impact. The Observing facet was also not associated with stress and anxiety. No facets of mindfulness were associated with the Patient’s Global

Assessment, physical component of quality of life, and the 6-min walking test.

Table 3 shows that most associations among mindfulness and outcomes remained unchanged after adjusting for age, gender, race, education, and BMI. However, the association between Observing and SF-36-MCS became significant ( $P = 0.02$ ), and Non-reacting and coping skills became non-significant ( $P = 0.15$ ).

## Moderation effects

We found that the relationship between fibromyalgia impact and anxiety was moderated by mindfulness ( $P = 0.01$ ), as illustrated by the difference in slope between the three mindfulness groups (Fig. 1). Of note, participants with greater fibromyalgia impact were likely to have more anxiety, regardless of mindfulness score. However, participants in the higher mindfulness group tended to have lower anxiety than those in lower mindfulness groups. The difference in anxiety between low and high mindfulness groups was greatest at high degrees of fibromyalgia impact.

We found the associations between fibromyalgia impact and depression ( $P = 0.82$ ) (Fig. 2a) or stress ( $P = 0.94$ ) (Fig. 2b) were not moderated by mindfulness. Furthermore, no significant moderation by mindfulness was found for the associations between pain interference and anxiety, depression, or stress. Similarly, no significant moderation by mindfulness was found for the associations between Patient’s Global Assessment and anxiety, depression, or stress (data not shown).

**Table 3** Multivariable analyses of mindfulness facets and health outcomes

Dependent variable (score range)	Independent variable (FFMQ total and facets) beta coefficient, (95% confidence intervals)					
	Total	Observing	Describing	Acting-with-awareness	Non-judging	Non-reacting
FIQR (0–100)*	-0.19 (-0.32, -0.07)	0.17 (-0.30, 0.63)	-0.50 (-0.93, -0.07)	-0.67 (-1.05, -0.28)	-0.59 (-0.94, -0.23)	-0.27 (-0.82, 0.28)
PROMIS Pain (41–78.3)*†	-0.08 (-0.12, -0.04)	-0.09 (-0.24, 0.06)	-0.24 (-0.38, -0.11)	-0.20 (-0.33, -0.08)	-0.17 (-0.28, -0.06)	-0.18 (-0.35, -0.005)
Symptom Severity (0–12)*	-0.03 (-0.04, -0.02)	-0.005 (-0.06, 0.05)	-0.07 (-0.12, -0.02)	-0.11 (-0.15, -0.07)	-0.07 (-0.11, -0.03)	-0.05 (-0.11, 0.01)
Patient's Global (0–10)*	-0.005 (-0.02, 0.01)	-0.007 (-0.06, 0.04)	-0.02 (-0.07, 0.02)	-0.009 (-0.05, 0.03)	-0.009 (-0.05, 0.03)	-0.01 (-0.07, 0.05)
PSS (0–40)*	-0.18 (-0.22, -0.14)	-0.14 (-0.31, 0.04)	-0.38 (-0.53, -0.22)	-0.55 (-0.68, -0.43)	-0.45 (-0.57, -0.32)	-0.34 (-0.55, -0.14)
HADS-A (0–21)*	-0.11 (-0.14, -0.09)	-0.09 (-0.20, 0.01)	-0.21 (-0.31, -0.12)	-0.34 (-0.41, -0.26)	-0.31 (-0.37, -0.24)	-0.20 (-0.32, -0.07)
HADS-D (0–21)*	-0.10 (-0.13, -0.08)	-0.16 (-0.26, -0.06)	-0.26 (-0.34, -0.17)	-0.29 (-0.36, -0.21)	-0.20 (-0.28, -0.13)	-0.19 (-0.31, -0.08)
CSQ (0–42)	-0.14 (-0.20, -0.09)	-0.04 (-0.26, 0.18)	-0.33 (-0.53, -0.13)	-0.42 (-0.59, -0.24)	-0.43 (-0.59, -0.27)	-0.19 (-0.45, 0.07)
SF-36-PCS (0–100)	-0.04 (-0.09, 0.02)	-0.07 (-0.26, 0.13)	-0.07 (-0.25, 0.11)	-0.06 (-0.22, 0.11)	-0.07 (-0.22, 0.08)	-0.19 (-0.42, 0.04)
SF-36-MCS (0–100)	0.31 (0.24, 0.37)	0.33 (0.05, 0.61)	0.66 (0.41, 0.91)	0.81 (0.61, 1.02)	0.73 (0.54, 0.93)	0.70 (0.38, 1.03)
ASES-8 (0–10)	0.03 (0.02, 0.05)	0.09 (0.04, 0.14)	0.07 (0.02, 0.12)	0.06 (0.02, 0.11)	0.04 (-0.006, 0.08)	0.11 (0.04, 0.17)
6-min walking test (meters)	-0.01 (-0.61, 0.58)	1.13 (-0.99, 3.25)	0.58 (-1.37, 2.53)	-0.79 (-2.60, 1.03)	-0.85 (-2.49, 0.80)	0.65 (-1.83, 3.13)

*FFMQ* Five Facet Mindfulness Questionnaire, *PROMIS* PROMIS Pain Interference Short Form, *FIQR* Revised Fibromyalgia Impact Questionnaire, *PSS* Perceived Stress Scale, *HADS* Hospital Anxiety and Depression Scale (Anxiety and Depression components), *CSQ* Coping Strategies Questionnaire, *SF-36* Medical Outcomes Short Form-36 (*PCS* Physical Component Summary, *MCS* Mental Component Summary), and *ASES-8* Arthritis Self-Efficacy Scale

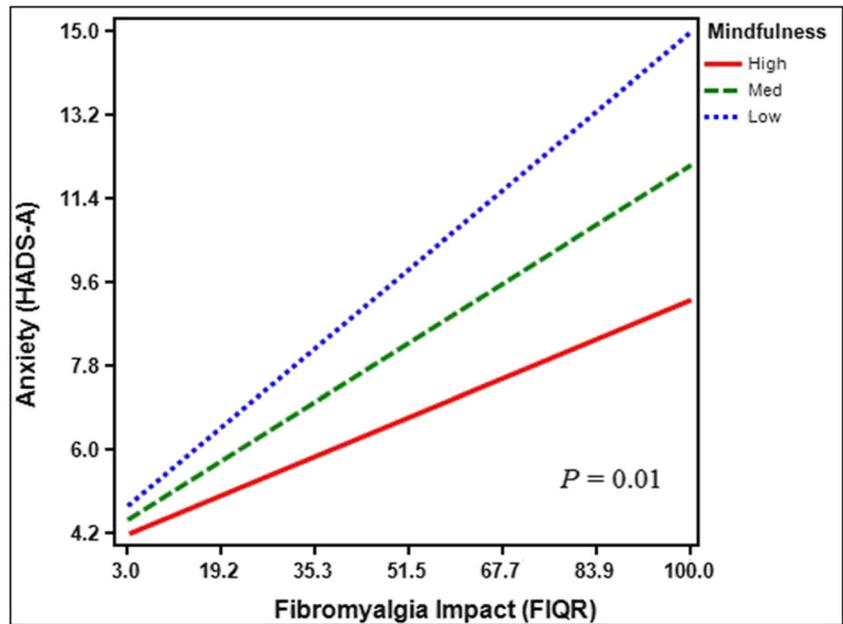
All models were adjusted for age, sex, race, BMI, and education

*Italic* items met statistical significance

\*Indicates tests with higher scores indicating worse outcomes

†PROMIS Pain Interference reported in *t* scores

**Fig. 1** Interaction between fibromyalgia impact and anxiety (interaction  $P = 0.01$ ). FIQR Revised Fibromyalgia Impact Questionnaire, HADS-A Hospital Anxiety and Depression Scale anxiety subscale. Higher scores reflect worse symptoms

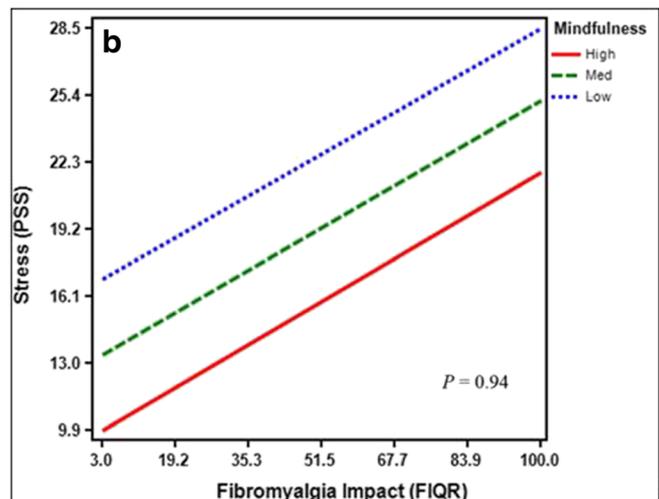
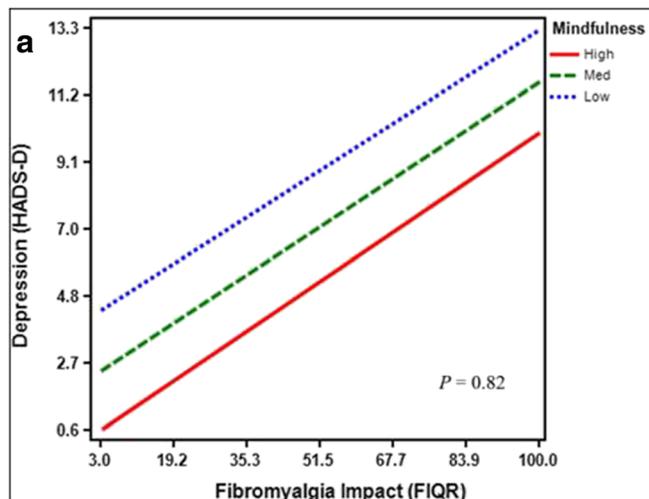


**Discussion**

This is the first study to examine the role of mindfulness in pain interference, physical function, psychological health outcomes, and overall quality of life of individuals with fibromyalgia. Our results suggest that higher levels of mindfulness tend to be associated with less pain interference, lower fibromyalgia impact, and better psychological health, coping skills, and mental health-related quality of life. We also found significant associations between these health outcomes and three facets of mindfulness: Describing, Acting-with-awareness, and Non-judging. Of note, the Observing facet was only significantly associated with depression, mental component of quality of life, and self-efficacy.

We also found that mindfulness significantly moderated the effect of overall fibromyalgia impact on anxiety. This suggests that mindfulness may serve to weaken the relationship between fibromyalgia impact and the development of anxiety, particularly, in patients with greater fibromyalgia impact. This finding indicates that patients with higher mindfulness may better cope with high levels of overall fibromyalgia impact, leading to better psychological symptoms [38].

Our findings are largely consistent with current literature exploring the relationships between mindfulness and psychological health [5, 6, 8, 16, 39]. For example, several previous studies reported that mindfulness and its five facets were significantly associated with better mental component of quality of life and less depression, stress, and anxiety [4, 7, 8, 10, 16].



**Fig. 2 a** Interaction between fibromyalgia impact and depression (interaction  $P = 0.82$ ). **b** Interaction between fibromyalgia impact and stress (interaction  $P = 0.94$ ). FIQR Revised Fibromyalgia Impact

Questionnaire, HADS-D Hospital Anxiety and Depression Scale depression subscale, PSS Perceived Stress Scale. Higher scores reflect worse symptoms

Our results also align with the recent finding that mindfulness has significant associations with perceived stress in people with fibromyalgia [40]. In addition, the results agree with our previous study which found three facets of mindfulness (Describing, Acting-with-awareness, and Non-judging) were associated with better psychological outcomes, and mindfulness moderated the effect of pain on a negative psychological outcome in patients with knee osteoarthritis [8].

Contrary to our results, one study of patients seeking treatment for mood disorders and anxiety found the Acting-with-awareness facet was not significantly related to anxiety or depression [14]. In addition, other studies have implicated stress as a mediator of the effect of psychological health factors on fibromyalgia symptoms, but the association between fibromyalgia impact and stress was not moderated by mindfulness in our study [41, 42]. There is also conflicting evidence on the associations between the Observing facet of mindfulness and fibromyalgia symptoms, which our study found to be insignificant [15, 39, 43]. Overall, these discrepancies highlight the need for more studies examining the true associations between mindfulness in fibromyalgia and other chronic pain populations.

Our study has limitations. First, the cross-sectional design restricts our ability to infer causality about the associations between mindfulness and health outcomes. While we found significant associations between mindfulness and fibromyalgia impact, it remains unknown whether higher mindfulness causes lower fibromyalgia impact, or vice versa [15]. Due to the secondary nature of our analysis, our results should be confirmed in prospective studies designed to evaluate the association between mindfulness and these health outcomes in fibromyalgia patients. Second, our study sample was not epidemiologically representative of all fibromyalgia patients. Our sample had higher average total Five Facet Mindfulness Questionnaire (FFMQ) scores than other community and clinical samples in studies that measured FFMQ [5, 7, 10, 13, 15, 17] and also had lower fibromyalgia impact scores than participants in two online fibromyalgia studies [15, 44]. It is unclear how high mindfulness and lower fibromyalgia impact in our study sample impacted our findings. Despite these differences, the participants were representative of fibromyalgia patients likely to be encountered in a clinical setting. There are some concerns that the FFMQ may not be sensitive to changes between interventions in a randomized trial [45]. Unfortunately, we were unable to answer this question as our parent trial was not designed to test the validation of FFMQ and the right variables were not collected. This is an analysis of secondary outcome; therefore, we did not power the study to detect any differences between treatment arms for FFMQ.

In conclusion, this study found that higher mindfulness is associated with better psychological well-being, less pain interference, and lower overall impact in patients with fibromyalgia. Three facets of mindfulness (Acting-with-awareness,

Describing, and Non-judging) were strongly associated with less fibromyalgia impact, anxiety, depression, stress, and better quality of life. Furthermore, our results suggest that mindfulness may reduce the degree of anxiety that develops as a result of increasing fibromyalgia impact severity. In conjunction, these findings may inform how mind-body therapies are utilized to increase mindfulness in those with fibromyalgia. Further studies are needed to assess whether the cultivation of mindfulness may lead to improved coping with the physical and psychological symptoms of fibromyalgia.

**Author contributions** All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Chenchen Wang had full access to all of the data in the study and takes responsibility for the integrity of the data.

**Funding** This work was supported by the National Center for Complementary and Integrative Health of the National Institutes of Health (NCCIH) [R01AT006367, K24AT007323, K23AT009374]; the National Center for Research Resources, National Institutes of Health [UL1RR025752]; and the National Center for Advancing Translational Sciences, National Institutes of Health [UL1TR000073, UL1TR001064]. The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official views of the NCCIH. The investigators are solely responsible for the content of the manuscript and the decision to submit for publication.

## Compliance with ethical standards

**Disclosures** None.

**Publisher's note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

## References

1. Clauw DJ (2014) Fibromyalgia. *JAMA* 311:1547
2. Burckhardt CS, Clark SR, Bennett RM (1993) Fibromyalgia and quality of life: a comparative analysis. *J Rheumatol* 20:475–479
3. Sephton SE, Paul S, Weissbecker I, Ulmer C, Floyd A, Hoover K et al (2007) Mindfulness meditation alleviates depressive symptoms in women with fibromyalgia: results of a randomized clinical trial. *Arthritis Rheum* 57:77–85
4. Schütze R, Rees C, Preece M, Schütze M (2010) Low mindfulness predicts pain catastrophizing in a fear-avoidance model of chronic pain. *Pain* 148:120–127
5. Baer RA, Smith GT, Lykins E, Button D, Krietemeyer J, Sauer S et al (2008) Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment* 15: 329–342
6. Bränström R, Duncan LG, Moskowitz JT (2011) The association between dispositional mindfulness, psychological well-being, and perceived health in a Swedish population-based sample. *Br J Health Psychol* 16:300–316
7. Bränström R, Kvillemo P, Brandberg Y, Moskowitz JT (2010) Self-report mindfulness as a mediator of psychological well-being in a stress reduction intervention for cancer patients—a randomized study. *Ann Behav Med* 39:151–161

8. Lee AC, Harvey WF, Price LL, Morgan LPK, Morgan NL, Wang C (2017) Mindfulness is associated with psychological health and moderates pain in knee osteoarthritis. *Osteoarthritis Cartilage* 25:824–831
9. Poulin PA, Romanow HC, Rahbari N, Small R, Smyth CE, Hatchard T et al (2016) The relationship between mindfulness, pain intensity, pain catastrophizing, depression, and quality of life among cancer survivors living with chronic neuropathic pain. *Support Care Cancer* 24:4167–4175
10. van Son J, Nyklíček I, Nefs G, Speight J, Pop VJ, Pouwer F (2015) The association between mindfulness and emotional distress in adults with diabetes: could mindfulness serve as a buffer? Results from Diabetes MILES: the Netherlands. *J Behav Med* 38:251–260
11. Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L (2006) Using self-report assessment methods to explore facets of mindfulness. *Assessment* 13:27–45
12. Marikar Bawa FL, Mercer SW, Atherton RJ, Clague F, Keen A, Scott NW et al (2015) Does mindfulness improve outcomes in patients with chronic pain? Systematic review and meta-analysis. *Br J Gen Pract* 65:e387–e400
13. Curtis K, Osadchuk A, Katz J (2011) An eight-week yoga intervention is associated with improvements in pain, psychological functioning and mindfulness, and changes in cortisol levels in women with fibromyalgia. *J Pain Res* 4:189–201
14. Desrosiers A, Klemanski DH, Nolen-Hoeksema S (2013) Mapping mindfulness facets onto dimensions of anxiety and depression. *Behav Ther* 44:373–384
15. Jones KD, Mist SD, Casselberry MA, Ali A, Christopher MS (2015) Fibromyalgia impact and mindfulness characteristics in 4986 people with fibromyalgia. *Explor J Sci Health* 11:304–309
16. Kraemer KM, McLeish AC, Johnson AL (2015) Associations between mindfulness and panic symptoms among young adults with asthma. *Psychol Health Med* 20:322–331
17. Veehof MM, Oskam MJ, Schreurs KMG, Bohlmeijer ET (2011) Acceptance-based interventions for the treatment of chronic pain: a systematic review and meta-analysis. *Pain* 152:533–542
18. Wang C, McAlindon T, Fielding RA, Harvey WF, Driban JB, Price LL et al (2015) A novel comparative effectiveness study of Tai Chi versus aerobic exercise for fibromyalgia: study protocol for a randomized controlled trial. *Trials* 16:34
19. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL et al (1990) The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia. Report of the multicenter criteria committee. *Arthritis Rheum* 33:160–172
20. Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Katz RS, Mease P et al (2010) The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care Res* 62:600–610
21. Folstein MF, Folstein SE, McHugh PR (1975) 'Mini-mental state'. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 12:189–198
22. Bennett RM, Friend R, Jones KD, Ward R, Han BK, Ross RL (2009) The Revised Fibromyalgia Impact Questionnaire (FIQR): validation and psychometric properties. *Arthritis Res Ther* 11:R120
23. Amtmann D, Cook KF, Jensen MP, Chen WH, Choi S, Revicki D et al (2010) Development of a PROMIS item bank to measure pain interference. *Pain* 150:173–182
24. Crins MHP, Roorda LD, Smits N, De Vet HCW, Westhovens R, Cella D et al (2015) Calibration and validation of the Dutch-Flemish PROMIS pain interference item Bank in patients with chronic pain. *PLoS One* 10. <https://doi.org/10.1371/journal.pone.0134094>
25. Anderson J, Caplan L, Yazdany J, Robbins ML, Neogi T, Michaud K et al (2012) Rheumatoid arthritis disease activity measures: American College of Rheumatology recommendations for use in clinical practice. *Arthritis Care Res (Hoboken)* 64:640–647
26. Hawker GA, Mian S, Kendzerska T, French M (2011) Measures of adult pain: Visual Analog Scale for pain (VAS pain), Numeric Rating Scale for pain (NRS pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF). *Arthritis Care Res* 63. <https://doi.org/10.1002/acr.20543>
27. Cohen S, Kamarck T, Mermelstein R (1983) A global measure of perceived stress. *J Health Soc Behav* 24:385
28. Härter M, Reuter K, Gross-Hardt K, Bengel J (2001) Screening for anxiety, depressive and somatoform disorders in rehabilitation—validity of HADS and GHQ-12 in patients with musculoskeletal disease. *Disabil Rehabil* 23:737–744
29. Zigmond AS, Snaith RP (1983) The Hospital Anxiety and Depression Scale. *Acta Psychiatr Scand* 67:361–370
30. Burckhardt CS, Henriksson C (2001) The coping strategies questionnaire—Swedish version: evidence of reliability and validity in patients with fibromyalgia. *Scand J Behav Ther* 30:97–107
31. Rosenstiel AK, Keefe FJ (1983) The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. *Pain* 17:33–44
32. McHorney CA, Ware JE, Rachel Lu JF, Sherbourne CD (1994) The MOS 36-Item Short-Form Health Survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. *Med Care* 32:40–66
33. Jenkinson C, Wright L, Coulter A (1994) Criterion validity and reliability of the SF-36 in a population sample. *Qual Life Res* 3:7–12
34. Bandura A (1997) *Self-efficacy: the exercise of control*. Freeman, New York. <https://doi.org/10.5860/CHOICE.35-1826>
35. Lorig K, Chastain RL, Ung E, Shoor S, Holman HR (1989) Development and evaluation of a scale to measure perceived self-efficacy in people with arthritis. *Arthritis Rheum* 32:37–44
36. Harada ND, Chiu V, Stewart AL (1999) Mobility-related function in older adults: assessment with a 6-minute walk test. *Arch Phys Med Rehabil* 80:837–841
37. Interaction [computer program]. Version 1.17. Fullerton, CA: Soper D; 2013
38. Bergomi C, Ströhle G, Michalak J, Funke F, Berking M (2013) Facing the dreaded: does mindfulness facilitate coping with distressing experiences? A moderator analysis. *Cogn Behav Ther* 42:21–30
39. Christopher MS, Neuser NJ, Michael PG, Baitmangalkar A (2012) Exploring the psychometric properties of the five facet mindfulness questionnaire. *Mindfulness (N Y)* 3:124–131
40. Brooks JM, Muller V, Sánchez J, Johnson ET, Chiu C-Y, Cotton BP et al (2017) Mindfulness as a protective factor against depressive symptoms in people with fibromyalgia. *J Ment Health* 1–7. <https://doi.org/10.1080/09638237.2017.1417555>
41. Cash E, Salmon P, Weissbecker I, Rebolz WN, Bayley-Veloso R, Zimmaro LA et al (2015) Mindfulness meditation alleviates fibromyalgia symptoms in women: results of a randomized clinical trial. *Ann Behav Med* 49:319–330
42. Malin K, Littlejohn GO (2016) Psychological factors mediate key symptoms of fibromyalgia through their influence on stress. *Clin Rheumatol* 35:2353–2357
43. de Bruin EI, Topper M, Muskens JGAM, Bögels SM, Kamphuis JH (2012) Psychometric properties of the five facets mindfulness questionnaire (FFMQ) in a meditating and a non-meditating sample. *Assessment* 19:187–197
44. Davis MC, Zautra AJ (2013) An online mindfulness intervention targeting socioemotional regulation in fibromyalgia: results of a randomized controlled trial. *Ann Behav Med* 46:273–284
45. Goldberg SB, Wielgosz J, Dahl C, Schuyler B, MacCoon DS, Rosenkranz M, Lutz A, Sebranek CA, Davidson RJ (2015) Does the five facet mindfulness questionnaire measure what we think it does? Construct validity evidence from an active controlled randomized clinical trial. *Psychol Assess* 28(8):1009–1014