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Effects of Meditation on Symptoms of Knee Osteoarthritis

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Abstract

Objective—The aim of this study was to investigate changes in knee pain, function, and related indices in older adults with osteoarthritis (OA) of the knee, following an 8-week meditation program.

Methods—Eleven community-dwelling adults with physician- confirmed knee OA were enrolled in the study. Core outcomes included recommended measures of knee pain (Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC] and 11-point numeric rating scale [NRS]), function (WOMAC), and perceived global status (patient global assessment). Additional outcomes included: perceived stress; stress hardness; mood; sleep; and sympathetic activation. Following baseline assessment, participants were trained briefly in mantra meditation and instructed to meditate for 15–20 minutes twice daily for 8 weeks, and to record each practice session on a daily log. Changes over time were analyzed using paired *t*-tests.

Results—Nine participants (82%) completed the study. Participants had statistically significant improvements in all core outcomes: knee pain (WOMAC: 47.7% $\pm$ 25.1% reduction, $P = 0.001$; NRS: 42.6% $\pm$ 34.6% reduction, $P < 0.01$); function (44.8% $\pm$ 29.9, $P = 0.001$); and global status (45.7% $\pm$ 36.5, $P = 0.01$); as well as knee stiffness ($P = 0.005$), mood ($P = 0.05$), and a WOMAC proxy for sleep disturbance ($P = 0.005$).

Conclusions—Findings from this pilot study suggest that a mantra meditation program may help reduce knee pain and dysfunction, as well as improving mood and related outcomes in adults with knee OA.

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Disclosure Statement

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Introduction

Osteoarthritis (OA) is a leading cause of disability in the United States,¹ affecting approximately 27 million adults over age 25,² with numbers projected to increase rapidly with the aging of the U.S. population.³ The hip, knee, and hand joints are commonly involved,² with the knee being the joint most frequently associated with disability.⁴ Up to 16% of U.S. adults (19% of women, 14% of men) ages 45 years have symptomatic knee OA,⁵ and the estimated lifetime risk is up to 45%.⁶

OA is associated with significant reductions in quality of life (QoL),^{7–10} increases in mood impairment, sleep disturbance,¹¹ medical comorbidity,⁸ risk for falls,¹² and mortality,¹³ and substantial economic and health care burdens.^{7,10} Past economic analyses estimate that OA would raise annual medical expenditures in the United States by at least \$185.5 billion, with costs expected to continue rising steeply in coming decades.^{14,15}

There is currently no cure for OA. Treatment strategies are aimed at symptom management. Pharmaceuticals are the treatment mainstay for up to 78% of patients with OA.^{16–18} Unfortunately, medications used to control OA pain can be costly and have significant side-effects for which older adults are at increased risk.^{1,19–21} Identifying safe, feasible self-management interventions that can address pain and dysfunction effectively, as well as relieving associated impairments in mood and sleep is thus of clear importance.

Clinical guidelines from the American College of Rheumatology (ACR) advise using nonpharmacologic therapies for first-line management of knee OA.²² In addition, Osteoarthritis Research Society International (OARSI) practice guidelines emphasize self-help strategies and patient-driven therapies in the initial stages of disease management.¹ Meditation, a nonpharmacologic, patient-driven therapy, may have particular promise for managing the symptoms associated with knee OA.

There is growing evidence that meditative techniques may reduce pain,^{23–26} improve mood,^{25,27–29} and enhance QoL^{24,28} in a broad range of both clinical and healthy populations, including adults with chronic low-back pain,²⁹ arthritis,²⁸ fibromyalgia,²⁷ and other chronic pain conditions.^{23–25,28} However, despite the promise and apparent therapeutic potential of meditation, few studies have focused on the effects of meditation in the elderly,^{30,31} there are few rigorous studies, and research on the effects of meditation in patients with OA is lacking.^{23,32,33} The objective of this pilot study was to investigate changes in knee pain, function, and related indices in older adults with knee OA, following an 8-week mantra meditation program.

Materials and Methods

Participants

Potential participants learned of this University of Virginia's institutional review board–approved study through newspaper advertisements, brochures, and/or study flyers posted in public places in the Charlottesville, Virginia, area. Interested individuals meeting the eligibility requirements provided written informed consent and were enrolled in the study.

Participants were eligible if they met the following inclusion criteria: at least age 50; physician-confirmed diagnosis of OA of the knee (based on ACR clinical or radiographic diagnostic criteria); for most days in the month prior to enrollment, a knee-pain severity of 3 on an 11-point numeric pain rating scale; knee pain of at least 6 months' duration; and willingness and ability to abide by the protocol. In addition, study participants were encouraged to: (1) continue stable use of any supplements/medications that were currently being taken for knee pain, and (2) avoid beginning any new drugs or treatments for knee pain during the study period.

Exclusion criteria were as follows: began or stopped medications, physical therapy, or supplements for the knee within 2 months preceding study enrollment; intra-articular corticosteroid or hyaluronic-acid injection into the knee within 3 months preceding study; significant injury to the knee within the past 6 months; arthroscopy of the knee within the past year; use of assistive devices other than a cane or knee brace; uncontrolled concomitant disease affecting the knee (e.g., rheumatoid arthritis, psoriatic arthritis); disease of spine or other lower-extremity joints or poor general health interfering with compliance or assessment; a regular meditation practice within the past year; and/or history of psychotic or schizophrenic episodes.

Intervention

Immediately following baseline assessment, participants received 30–45 minutes of in-person meditation training from a long-term meditator with more than 25 years of experience and certified to teach a number of meditative practices. The meditation technique taught to the participants was a basic, easy-to-learn form of mantra meditation. Participants were given written instructions that included a list of mantras (i.e., sounds and words), and each participant was allowed to select a mantra to use for the 8 weeks of the study. Participants were instructed to select a mantra based on its sound or vibrational quality and to avoid any mantras that they felt might precipitate trains of thought or emotional responses. Each participant was also given a meditation compact disc, which included detailed instructions, along with a 15-minute and a 20-minute meditation track. All participants were encouraged to begin the program with the 15-minute version and move on to the 20-minute version when they felt comfortable. They were instructed to:

- Select a quiet environment where there would be no disturbances for ~ 20 minutes, and turn off the phone if possible
- Sit comfortably with the spine straight, close the eyes, and relax
- Take a few deep breaths, releasing any stress or tension during exhalation
- Once settled, begin silently repeating the chosen mantra, gently letting go of all other thoughts for 15–20 minutes.

Emphasis was placed on the practice being easy and effortless. After 15–20 minutes had passed, the participants were to stop repeating their mantras, sit quietly for ~ 2 minutes before opening their eyes, and take as much time as needed to return gently to full alertness before standing up and resuming normal activities. Participants were asked to complete this practice twice daily, every day for 8 weeks (for a total of 112 sessions), and to record each

meditation time, along with any comments the participants might have about their practice sessions, on the meditation logs that had been provided to them.

Instruments

All instruments were administered at baseline and again at postintervention. Results recorded on the three Outcome Measures in Rheumatology (OMERACT)–recommended coreset outcomes (pain, function, and patient global assessment³⁴) were assessed, as were some additional outcomes as described below. Two instruments were used to measure knee pain: a numeric rating scale (NRS) and the Western Ontario and Mc-Master Universities Osteoarthritis Index (WOMAC).

An 11-point NRS with the anchors 0 (“no pain”) and 10 (“worst pain possible”) was used to rate current, average, least, and worst pain for the week prior to enrollment (baseline measures were completed on the day each participant enrolled in the study). This type of scale has demonstrated excellent reliability and validity for a range of populations,^{35–38} is easier to use, and has a lower failure rate than the visual analog scale (VAS), particularly in older populations.^{37,39} A 2-point or 30% reduction in score on this measure is generally considered to be a clinically important difference in a clinical trial.^{40,41}

The WOMAC is a self-administered, condition-specific questionnaire recommended by the OMERACT guidelines as an outcome measure for clinical trials of OA of the hip or knee.³⁴ The 11-point NRS version of this 24-item, valid, reliable, and responsive instrument^{42–46} was used to measure knee pain and function.

The patients’ global assessment of their disease activity was measured using an 11-point NRS, patient global assessment (PGA).⁴⁴ This PGA included the following item: “Considering all the ways your knee arthritis affects you, circle the number that best describes your condition over the last week.”

For these three core outcomes, the minimum change required on a 0–100-mm scale for patients to consider themselves improved (the minimal clinically important improvement [MCII]) and the score below which patients consider themselves well (the patient acceptable symptom state [PASS]) score have been described for patients with knee OA as follows:

- A 19.9-mm absolute or 40.8% relative improvement from baseline (final value – baseline value)/baseline value) is the MCII for pain, with a PASS of 32.3 mm
- A 9.1-mm absolute or 26.0% relative improvement is the MCII for WOMAC function, with a PASS of 31.0 mm
- An 18.3-mm absolute or 39.0% relative change for PGA with a PASS of 32.0 mm.^{47,48}

For the 0–10 point pain and PGA scales and the 0–170 point WOMAC function scale used in the current study, the MCII absolute and PASS values were converted as follows: pain, 1.99 and 3.23 points; function, 15.5 and 52.7 points; and PGA, 1.83 and 3.2 points, respectively. The following outcomes were also measured: knee stiffness and general knee condition (WOM-AC); perceived stress (Perceived Stress Scale [PSS])⁴⁹; stress hardness

(Dispositional Resilience Scale [DRS])⁵⁰; mood and affect (Profile of Mood States [POMS])⁵¹; Positive and Negative Affect Schedule (PANAS)⁵²; and self-compassion (Self-Compassion Scale [SCS]).⁵³

These self-report instruments are well-established scales that have been used in a wide range of older populations, and have been shown to be sensitive to short-term mind–body and other behavioral interventions.^{51,54–63} In addition, as indicators of sympathetic activation, blood pressure (BP) and heart rate were measured three times and the average calculated using an automated BP monitor (Omron, Model HEM-780). Finally, to assess the potentially confounding influence of a change in activity level, each participant completed the Physical Activity Scale for the Elderly (PASE).^{64–65}

Data Analysis

Data were analyzed using SPSS, version 20.0. Paired samples *t*-tests were used to assess change over time (baseline to 8 weeks) in all outcome measures. Missing values were replaced with the mean of the subscale as per the WOMAC instructions. The conservative, last value carried forward method was used to impute missing data for the other scales. Because this was a small exploratory study, the significance level of 0.05 was used for all tests and trends were examined. Effect sizes were assessed using Cohen's *d* (mean change/baseline standard deviation [SD]).⁶⁶ In addition, the percent change of the core outcomes was calculated as follows:

$$[(\text{final value} - \text{baseline value}) / \text{baseline value}] * 100$$

To evaluate compliance with the study protocol, calculations were made for the total number of meditation sessions performed and the mean number of meditation sessions completed per week, based on data recorded daily on the home-practice logs.

Results

Eleven participants (10 female, 1 male) ranging in age from 51 to 74 (mean = 61.45, SD = 6.7) enrolled in the study. The group had an average body mass index of 29.3 lbs/in² (range: 23.6–36.6). Nine participants were non-Hispanic white, 1 identified as being more than one race, and 1 did not report race. More than half of the participants (6/11) had at least 4 years of college. At baseline, participants reported their average pain for the previous week had been in the moderate range (NRS average pain, mean = 5.00 ± 0.5).

Nine participants (82%) completed the study (8 women, 1 man); 1 participant could not complete the program because of an illness unrelated to the study, and the other participant left to attend to a child who was diagnosed with a serious medical condition. Compliance with the twice-daily meditation program was excellent (mean = 102.4 ± 13.0 total sessions [of 112] and mean = 12.8 ± 1.6 meditation sessions/week [of 14] completed).

As shown in Table 1, the remaining participants (*N* = 9) had clinically important and statistically significant reductions in knee pain as measured by the NRS average pain scale (−42.6% ± 34.6, *P* < 0.01), the NRS worst pain scale (−35.9% ± 29.6, *P* < 0.01), and the

WOMAC pain subscale ($-47.7\% \pm 25.1$, $P = 0.001$) following the 8-week intervention. Effect sizes were large (Cohen's d of 4.22, 4.62, and 1.73, respectively). Baseline values for current and least pain were low, and reductions did not reach statistical significance (Table 1).

Postintervention improvements in the other core outcomes were also clinically important and statistically significant, as follows: a $44.8\% \pm 29.9$ improvement in knee function (WOMAC function subscale, $P = 0.001$) and a $45.7\% \pm 36.5$ improvement in knee OA global status (PGA, $P = 0.012$; see Table 1). Notably, postintervention scores for all three core outcomes fell within the PASS, suggesting that patients considered themselves well in these core domains.

Additional outcomes that also had statistically significant improvements following the 8-week intervention included: the WOMAC total score; stiffness domain; proxy for sleep disturbance (all $P \leq 0.005$); and mood, both overall and in the specific domains of confusion, anger/hostility, and fatigue (POMS, all $P \leq 0.05$; see Table 1). All other outcomes yielded nonsignificant results (P -value > 0.05); however, the following measures had marginal improvement: stress hardness ($P = 0.06$) and negative affect ($P = 0.06$). There was no significant change in physical activity relative to baseline (PASE mean change $= 11.41 \pm 42.55$, $P = 0.44$). No serious adverse events were reported.

Discussion

In the present study, completion of a simple 8-week meditation program was associated with statistically significant and clinically important reductions in all core outcomes, as well as significant improvements in mood and a proxy for sleep disturbance. Furthermore, effect sizes for the three core outcomes were large, ranging from a Cohen's d of 1.32 for function to 4.22 for average pain. Moreover, the PASS was also reached in these core domains.

To the current authors' knowledge, this is the first study to explore the effects of a simple meditation practice on recommended core outcomes in patients with OA of the knee. The findings appear comparable or superior to those reported in studies of other nonpharmacologic therapies for knee OA, including acupuncture,⁶⁷ yoga,⁶⁸ *t'ai chi*,^{69,70} and other forms of exercise.⁷¹ Likewise, the observed reductions in pain and overall improvements in function were also similar to or greater than those reported in previous trials of medications commonly prescribed for OA, including nonsteroidal anti-inflammatory drugs,^{72,73} acetaminophen,⁷² and opioids.⁷⁴ Notably, the authors of a Cochrane review concluded that the small-to-moderate effects of non-tramadol opioids were outweighed by the potential side-effects and advised clinicians to discuss alternative treatments with patients.⁷⁴

While the mechanisms of action underlying meditation techniques are unclear, there is some evidence to suggest that these techniques reduce stress hormones (e.g., epinephrine, norepinephrine, and cortisol),^{75,76} increase nitric-oxide levels,⁷⁶ influence distinct changes in gene expression,⁷⁷ and reduce pain-intensifying factors such as stress reactivity, trait anxiety, and sympathetic arousal.^{78,79} Thus, meditation may be particularly beneficial for

the elderly, whose capacity to respond to the stress of persistent pain may be lessened because of depletion of reserves. This noninvasive therapy has no known side-effects, such as renal and hepatic toxicity and gastrointestinal distress commonly seen following the use of anti-inflammatory medications, and can be practiced even by very elderly, ill, or disabled individuals.⁸⁰

Meditation can be practiced independently of a therapist and actively engages the participant in self-management of health and well-being, which is consistent with OARSI recommendations.¹ Meditation is easy to learn, is gentle, and places no physical demands on practitioners, making it well-suited to elderly patients with knee OA. Meditation typically brings immediate positive benefits, including feelings of relaxation and tranquility, and even short term (5-day–8-week) programs have yielded significant reductions in chronic pain and other distressful symptoms,^{23,25,81,82} helping to encourage continued practice.

In addition, many adults with arthritis currently use meditation to help manage their symptoms. Of 2140 respondents to a survey regarding the use of complementary and alternative therapies for musculoskeletal conditions, ~ 35% of respondents with OA had reported using meditation to self-manage the condition,⁸³ suggesting that meditation may offer an attractive and acceptable alternative for patients who have OA.

Although OA of the knee is a complex condition that is still poorly understood,^{84,85} many interrelated factors probably contribute to OA symptoms, including both physical/ physiologic (e.g., joint degeneration, muscle weakness/atrophy, obesity, and inflammation) and psychosocial factors (e.g., stress, sleep disturbance, depression, pain-related fear, and reduced social interaction and support). OA pain and dysfunction have been strongly linked to distressful states and maladaptive behaviors, including sleep deficits,^{86–88} psychologic stress,^{89,90} depression and anxiety,^{91,92} fatigue,⁸⁷ pain-related fear,^{93,94} and catastrophizing.^{91,95}

Consistent with the biopsychosocial model of pain,^{96,97} these relationships are strongly reciprocal, contributing to a vicious cycle of increasing pain and pain sensitivity, sleep disturbance, distress, and physical dysfunction, and increasing risks for disability, morbidity, and mortality further.^{91,94,98,99} Thus, treatments, such as meditation, which address these key psychosocial dimensions of knee OA—which are, in turn, strong determinants of OA pain and dysfunction—may provide significant benefits to patients who have this serious and common chronic pain disorder.

Strengths of this exploratory pre–post study include the community-based approach and the use of valid, reliable instruments recommended by international panels for measuring core outcomes in clinical trials of OA. Also, a simple meditation technique was tested for the intervention, as opposed to a multicomponent therapy such as Mindfulness-Based Stress Reduction (MBSR), facilitating interpretation of findings. As detailed in past reviews by the current authors³³ and others,²³ research regarding the effects of meditation alone, without the addition of other components, on chronic pain remains sparse, and studies investigating the efficacy of meditation for alleviating symptoms of OA are lacking. This small pilot study was a step toward addressing both of those gaps in the literature.

Major limitations of the current study included the small sample size and lack of a control group. However, despite the limited power of the study, nonetheless striking and significant improvement was observed for all core outcomes. In addition, observed effect sizes were well in excess of the control group changes reported in previous placebo-controlled trials,^{72–74} suggesting that placebo effects were unlikely to explain the large effect sizes observed in this study. The study population was predominantly female, non-Hispanic white, and older, limiting generalizability to other populations. Clearly, larger controlled trials in multiethnic populations are needed to confirm and extend these findings, to determine the cost-effectiveness of meditation versus other commonly used treatments for OA, and to investigate potential underlying mechanisms.

Conclusion

Following an 8-week mantra meditation program, patients with knee OA reported both statistically significant and clinically important reductions in knee pain, dysfunction, and perceived OA activity, as well as significant improvements in several domains of mood. Findings of this preliminary study suggest that meditation may be a safe, effective, and acceptable therapy for adults with knee OA, and warrant confirmation in larger, randomized controlled trials.

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Change Over Time in Indices of Knee Pain, Knee Function, Psychosocial Status, & Sympathetic Activation in Older Adults with Knee OA ($N = 9$)

Table 1

Scales	Baseline (Mean $\pm$ SD)	Post-treatment (Mean $\pm$ SD)	P^*	% Change ^d	Effect size ^e
Measures of knee pain & function					
<i>WOMAC</i>					
Total (0–240)	102.11 $\pm$ 29.53	56.56 $\pm$ 34.80	0.001	–45.2% $\pm$ 28.7	1.54
Pain (0–50)	18.78 $\pm$ 5.02	10.11 $\pm$ 6.21	0.001	–47.7% $\pm$ 25.1	1.73
Stiffness (0–20)	10.44 $\pm$ 4.39	5.33 $\pm$ 3.28	0.005	–40.3% $\pm$ 56.0	1.16
Knee function (0–170)	72.89 $\pm$ 23.99	41.11 $\pm$ 28.12	0.001	–44.8% $\pm$ 29.9	1.32
<i>Numeric Rating Scale (0–10)</i>					
Average	5.00 $\pm$ 0.50	2.89 $\pm$ 1.90	0.007	–42.6% $\pm$ 34.6	4.22
Current	2.22 $\pm$ 1.56	1.33 $\pm$ 1.32	0.09	–23.3% $\pm$ 81.1 ^b	0.57
Worst	7.89 $\pm$ 0.60	5.11 $\pm$ 2.57	0.007	–35.9% $\pm$ 29.6	4.62
Least	2.00 $\pm$ 1.12	1.11 $\pm$ 1.36	0.07	–45.8% $\pm$ 53.3 ^b	0.81
Patient Global Assessment (0–10)	5.00 $\pm$ 1.32	2.78 $\pm$ 2.28	0.01	–45.7% $\pm$ 36.5	1.68
Stress, sleep, & mood					
Perceived Stress Scale	13.22 $\pm$ 7.41	12.67 $\pm$ 7.47	0.73		0.07
Dispositional Resilience Scale	27.00 $\pm$ 4.12	29.67 $\pm$ 5.57	0.055		0.65
WOMAC Pain disturbing sleep	2.33 $\pm$ 1.66	0.78 $\pm$ 1.09	0.005		0.94
<i>Profile of Mood States</i>					
Total	27.44 $\pm$ 43.48	3.78 $\pm$ 27.56	0.05		0.54
Tension/anxiety	5.33 $\pm$ 7.04	1.89 $\pm$ 5.40	0.06		0.49
Confusion	5.33 $\pm$ 6.36	1.44 $\pm$ 4.45	0.02		0.61
Depression	11.44 $\pm$ 12.66	7.33 $\pm$ 7.26	0.29		0.32
Anger/hostility	9.22 $\pm$ 8.36	5.11 $\pm$ 5.71	0.04		0.49
Vigor	18.11 $\pm$ 6.95	20.11 $\pm$ 5.06	0.15		0.29
Fatigue	14.22 $\pm$ 7.74	8.11 $\pm$ 4.28	0.02		0.79
<i>Positive and Negative Affect Scale</i>					
Positive affect	32.67 $\pm$ 8.53	36.22 $\pm$ 6.44	0.13		0.42

Scales	Baseline (Mean ± SD)	Post-treatment (Mean ± SD)	P^*	% Change ^d	Effect size [‡]
Negative affect	16.56 ± 6.33	14.11 ± 5.46	0.06		0.39
Self-Compassion Scale	78.67 ± 10.09	72.22 ± 17.08	0.09		0.64
Sympathetic activation					
Systolic BP	125.33 ± 19.08	121.44 ± 19.03	0.32		0.20
Diastolic BP	76.33 ± 11.92	77.78 ± 14.86	0.56		0.12
HR	68.89 ± 8.65	67.44 ± 8.06	0.08		0.17

* Paired samples *t*-test;

[‡]Cohen's *d*.

^d % Change = (Final value – baseline value)/baseline value) * 100.

^b Based on *n* = 8, because of inability to divide by baseline value of 0 reported by one participant.

OA, osteoarthritis; SD, standard deviation; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; BP, blood pressure; HR, heart rate.