Evidence of a Symptom Cluster: The Impact of Mindfulness Meditation on Self-Reported Stress, Fatigue, Pain and Sleep Among U.S. Military Service Members and Veterans

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Abstract. Physical and behavioral symptoms of stress may occur in a consistent constellation of symptoms. The purpose of this study was to examine the impact of mindfulness meditation (MM) training on U.S. military service members and veterans' self-reported stress, fatigue, pain, and sleep disturbances, and to investigate whether changes in the outcome measures were uniform or independent of one another. Participants attended 8-weeks of MM training and completed the following pre/post evaluations: Perceived Stress Scale, Patient Health Questionnaire, Pittsburgh Sleep Quality Index. Data were separately analyzed for those experiencing pain at any level and for those experiencing high pain. Scores on each measure were significantly correlated at both measurement occasions ($p < .05$) and did not differ significantly across training ($p > .05$), suggesting that MM-related effects on the relationship between the four measures were congruent. These results suggest a symptom cluster, independent of self-reported pain level.

Keywords: Mindfulness · Meditation · Symptom cluster · Stress · Military · Pain · Sleep

1 Introduction

A symptom cluster is a consistent grouping of simultaneously occurring health symptoms that are related to one another, but independent of other symptoms [1]. Items in a symptom cluster may share covariance, a mutual etiology, or a common impact on patient outcomes [2, 3]. Historical methods for identifying symptom clusters include expert opinion, determining if change in one symptom is associated with a similar change in another (increase or decrease) [4], demonstration of shared variance [5], and showing that specific symptoms are correlated with one another [6]. Still other methods for detecting symptom clusters include factor analysis, which allows for the identification of underlying processes possibly accounting for the correlations between variables, mediation analysis [7], and cluster analysis [8] with a pre-set criteria for

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symptom correlations. Knowledge about symptom clusters allows clinicians to effectively manage integrated interventions for injuries, illnesses, or difficulties around which such clusters exist. Moreover, the presence of a symptom cluster may explain treatment outcomes. For example, the number and severity of symptoms within the cluster may impact outcomes, such as functional status or improvements over time, in a way that the original diagnosis did not. Research on symptoms with cancer patients have revealed that fatigue, insomnia, pain, and depression show evidence of symptom clustering [1, 7, 9], and symptom clusters have been examined for other illnesses and injuries including Post-Traumatic Stress Disorder [10, 11], HIV [12], and multiple sclerosis [13]. In addition, interventions have been evaluated as management tools for clusters of symptoms [14, 15].

Using a symptom cluster approach, Lengacher et al. [17] reported significant reductions in breast cancer survivors self-reported fatigue and disturbed sleep (both elements of a shared fatigue symptom cluster) relative to a control group following a 6-week Mindfulness-based Stress Reduction (MBSR) training program. The authors reported that, although pain and distress loaded on a different symptom cluster (cognitive/psychological cluster), no significant differences were found within that cluster following MBSR training.

A study in our laboratory on Mindfulness Meditation (MM) offered an opportunity to examine symptom clusters surrounding pain. The demands associated with U.S. military service, such as exposure to battle, injuries and death, can be extremely challenging, resulting in symptoms similar to those in cancer-based symptom clustering, such as high levels of stress, sleep disorders, pain, and fatigue. Mindfulness meditation training [16] focuses on heightening awareness of participant's physical, cognitive, and emotional states, as well as the circumstances and events they are experiencing in the present moment. MM/teaches participants to recognize their own state-of-being and their reactions to their internal and external environment, without judgement. With practice, participants learn to recognize their own response patterns and respond deliberately, instead of 'mindlessly reacting'. Pre/post studies of mindfulness training have found reductions in stress [18–21], pain [19, 20, 22], and fatigue [18, 21], and improvements in sleep [18].

In the present study, we investigated a possible cluster of symptoms (stress, fatigue, pain, and sleep) in active duty military and veterans prior to and following MM instruction by examining the shared variance of bivariate correlations between specific symptoms. Should a cluster of symptoms exist, the relationship between the symptom measures should remain constant in the two assessments (pre- and post-training). On the other hand, if MM training promotes independent changes in self-reported states, then associations between the measures should differ significantly between pre- and post-testing sessions. We also investigated the presence of a clustering of symptoms by examining whether change in one symptom was associated with change in another symptom. If the symptom cluster perspective is correct, then changes in one symptom should be accompanied by concurrent shifts in the other symptoms. For example, if participants report lower perceived stress following MM training, they should likewise report lower fatigue, pain, and stress.

2 Methods

2.1 Participants

U.S. military active duty service members and veterans (n = 101) were recruited as research volunteers from Joint Base San Antonio and the surrounding vicinity. Volunteers were recruited for a larger study focusing on the effectiveness of MM training offered in-person and over a virtual world. The study was approved by an Institutional Review Board and research volunteers read and completed an informed consent form prior to participation. Participants were not compensated for their participation.

2.2 Instruments

Demographic Survey: The demographic survey included questions about participants' age, race/ethnicity, gender, education, marital status, military status, military branch, deployment (i.e. whether they had deployed), and time-in-service (the amount of time the respondent was in the military). Participants answered the questions using a computerized questionnaire created with Microsoft Access.

Perceived Stress Scale (PSS): The PSS is a 10-item instrument that uses a five-point Likert response scale (0 = never, 1 = Almost Always, 2 = Sometimes, 3 = Fairly Often 4 = Very Often) to quantify respondents stress levels. It also gives potential insight into the factors contributing to the respondent's experience of stress [23, 24].

Patient Health Care Questionnaire (PHQ15): The PHQ15 is a somatic symptom subscale derived from the full PHQ. It is a self-administered version of the PRIME-MD diagnostic instrument [25]. The PHQ15 includes 14 of the 15 most prevalent DSM-IV somatization disorder somatic symptoms [25] and is rated on a three point scale (0 = not bothered at all; 1 = bothered a little; 2 = bothered a lot). The questionnaire asks participants to rate the extent to which they have experienced somatic symptoms "during the past 4 weeks" [25]. For the current study, responses to item 14 ("Feeling tired or having low energy") served as a measure of self-reported fatigue and the sum total of responses to items one – six ("stomach pain", "back pain", pain in your arms, legs or joints", "menstrual cramps", "headaches", and "chest pain") served as a measure of self-reported pain.

Pittsburgh Sleep Quality Index (PSQI): The PSQI is a self-rated sleep questionnaire that assesses sleep quality and disturbances over a 1-month time interval [26]. The 10-item questionnaire generates one global score and seven component scores including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction [26].

2.3 Procedure

After completing the informed consent form, volunteers were assigned to either a training group or a control group (control data are not presented in this paper). Pre- and post-training evaluations included the outcome measures listed above, along with other subjective and objective measures – to be reported in follow-on papers. Those receiving MM training completed training in one of two ways, either receiving traditional in-person Mindfulness-Based Stress Reduction training or an abbreviated version of the training offered over the Virtual World of Second Life. The training was identical in terms of topics for discussion, meditation practices and homework; but differed in length of time per class (In-person = ~2 to 2½ h per class with a 7 h. silent retreat between classes 5 and 7, Virtual World = 1½ h per class with a 3 h. silent retreat between classes 5 and 7). Training classes were taught by experienced, trained MM instructors. For the purposes of this analysis, both training groups were consolidated into one group. A/wait-list control group (not included in the present analyses) received no MM training.

2.4 Statistics

Data analyses were conducted with the IBM SPSS Statistics for Windows (Version 21, Armonk, NY: IBM Corp, Released 2012). Descriptive statistics and frequency analyses were used to analyze the demographic data. Dependent-samples T-Test were used to examine mean differences in stress, fatigue, pain, and sleep disturbance scores. Pearson Product Moment correlations were used to examine the relationships between stress, fatigue, pain, and sleep disturbance scores. A p-value of 0.05 was used to determine significance.

Significance testing of pre- and post-training correlation coefficients were conducted using COCOR (www. Comparingcorrelations.org) developed by Diedenhofen and Musch [27]. Briefly, significance testing for dependent correlations compares two correlation coefficients obtained from the same sample to establish if they are statistically similar or different from one another. The z-score values were obtained from COCOR's output of a modification of Dunn and Clark's z (1969) [28] using a back-transformed average z procedure.

It should be noted that some volunteers self-reported pain fell below the median score for all participants (4.00) during initial (pre-training) assessments. In order to determine if MM training had a beneficial effect on the symptom cluster for those that self-reported higher levels of pain, a second, separate set of analyses were conducted on the pre/post-training stress, fatigue, pain, and sleep disturbance scores of a subset of people from the original sample that met or exceeded the median pain rating for all volunteers.

3 Results

Data from six volunteers (8.9%) were omitted from the final analysis because their pain rating was zero (i.e., no self-reported pain). The final total number of volunteers was 94.

3.1 Volunteer Demographics

Analysis of the demographics of the volunteers are shown in Table 1.

Table 1. Frequency distribution of participant demographics.

	Mean/#	%
Age (years)	50.96	–
Gender		
Male	49	52.1
Female	45	47.9
Race		
African American	19	20.2
Native American	2	2.1
Caucasian	54	57.4
Hispanic	16	17.0
Asian	2	2.1
Other	1	1.1
Education		
GED/High school	7	7.4
Some college/AA	28	29.8
Bachelor's degree	24	25.5
MA/Ph.D.	31	33.0
Other	4	4.3
Marital status		
Married	58	67.1
Divorced	15	16.0
Widowed	1	1.1
Single/Separated	17	18.1
Partnered with sig other	3	3.2
Self-reported health rating (5 points max)	3.37	–
Military service		
Active service members	24	25.5
Veteran service members	70	74.5
Time in service (years)	15.72	–
Years since deployment	13.82	–
Months deployed	9.29	–
Deployed in harm's way		
0	22	32.4
1 time	27	39.7
2 times	6	8.8
3 times	7	10.3
4 times	3	4.4
5 + times	3	4.4

3.2 Results with All Volunteers

Correlational analyses of volunteers pre-and post-MM training scores (Tables 2 and 3) showed significant positive relationships between the measures.

Table 2. Pearson correlations among the measures (pre-MM Training).

	PSS	Fatigue	Pain	Sleep disturbance
PSS	1	.54**	.47**	.42**
Fatigue		1	.49**	.44**
Pain			1	.47**
Sleep disturbance				1

PSS = Perceived Stress Scale.
**p < .01

Table 3. Pearson correlations among the measures (post-MM Training).

	PSS	Fatigue	Pain	Sleep disturbance
PSS	1	.54**	.52**	.44**
Fatigue		1	.56**	.49**
Pain			1	.40**
Sleep disturbance				1

PSS = Perceived Stress Scale.
**p < .01, *p < .05

As shown in Table 4, statistically significant differences were found in volunteer's pre- and post- MM training stress, fatigue, and sleep disturbance scores.

Table 4. Means, standard deviations, n's, and paired t-test results for the four measures between testing sessions.

	Pre-MM			Post-MM training			*t*	*df*	*sig.*
	n	*Mean*	*SD*	*n*	*Mean*	*SD*			
PSS	94	19.31	7.76	86	16.49	7.53	4.200	85[a]	.0001
Fatigue	94	1.41	.68	86	1.15	.73	3.531	85	.001
Pain	94	4.45	2.37	93	4.04	2.82	1.651	92	.102
Sleep disturbance	93	1.71	.64	70	1.09	.79	5.850	69	.0001

PSS = Perceived Stress Scale.
[a] Post- MM Training PSS scores were missing for eight volunteers.

Table 5 presents the z-score values obtained from COCOR's output. Pre- and post-training correlations between the stress, fatigue, pain, and sleep disturbance measures did not differ significantly, suggesting that changes in the relationship between the measures were uniform across conditions. Because the significance test requires the pre and post sample matches, only those individuals who completed the study were included in this analysis.

Table 5. Z-score values for the significance test for the dependent correlations.

	PSS	Fatigue	Pain	Sleep disturbance
PSS	1	.000	−.6610	−.1837
Fatigue		1	−.9504	−.4730
Pain			1	.6459
Sleep disturbance				1

PSS = Perceived Stress Scale.

3.3 Results with Volunteers Who Self-Reported Pain Above the Median Level of All Participants

It should be noted that 37.23% (n = 35) of volunteers self-reported pain below the median score for all participants (4.00) during initial (pre-training) assessments. In order to determine if MM training had a beneficial effect on the symptom cluster for those who self-reported higher levels of pain, a separate set of analyses were conducted on the pre/post training stress, fatigue, pain, and sleep disturbance scores of a subset of people from the original sample that met or exceeded the median pain rating for all volunteers (n = 59, 62.77%).

Table 6. Pearson correlations among the measures (pre-MM Training) for volunteers that reported pain greater than the median threshold.

Measure	PSS	Fatigue	Pain	Sleep disturbance
PSS	1	.45**	.50**	.30*
Fatigue		1	.40**	.20
Pain			1	.36**
Sleep disturbance				1

PSS = Perceived Stress Scale.
**p < .01, *p < .05

As with Tables 2, 3, 6, and 7 show significant positive correlations between the scores on the measures before and to a greater extent following MM training.

As can be seen in Table 8, outcomes from the first set of analyses were replicated and extended, to the extent that there were significantly lower levels of self-reported perceived stress, fatigue, and sleep disturbances, as well as a nearly significant trend towards lower levels of self-reported pain following MM training. Mean post-training self-reported pain scores were .67 points lower than pre-training scores.

Table 7. Pearson correlations among the measures (post- MM Training) for volunteers that reported pain greater than the median threshold.

Measure	PSS	Fatigue	Pain	Sleep disturbance
PSS	1	.59**	.46**	.43**
Fatigue		1	.48**	.44**
Pain			1	.38*
Sleep disturbance				1

PSS = Perceived Stress Scale.
**p < .01, *p < .05

Table 8. Mean's, standard deviations, and paired t-test results for the four measures between training sessions for volunteers that reported pain greater than the median threshold.

Measure	Pre-MM training			Post-MM training			*t*	*df*	*sig*
	n	*Mean*	*SD*	*n*	*Mean*	*SD*			
PSS	59	21.20	6.74	54	18.94	7.25	2.462	53	.017
Fatigue	59	1.59	.56	54	1.33	.70	2.574	53	.013
Pain	59	5.83	1.82	58	5.16	2.69	2.002	57	.050
Sleep disturbance	58	1.86	.61	41	1.22	.82	4.068	40	.000

PSS = Perceived Stress Scale.

Significance Testing of Pre- and Post- Mindfulness Training Correlation Coefficients. As with our previous analyses, pre- and post-training correlation coefficients were compared to determine if they differed significantly. No significant differences were observed, suggesting that training-related changes in the relationship between the measures were uniform (Table 9).

Table 9. Z-score values for the significance test for the dependent correlations for volunteers that reported pain greater than the median threshold.

Measure	PSS	Fatigue	Pain	Sleep disturbance
PSS	1	−1.2566	.3269	−.8602
Fatigue		1	−.6331	−1.9569
Pain			1	−.1236
Sleep disturbance				1

PSS = Perceived Stress Scale.

4 Discussion

In the present study we compared self-reported stress, fatigue, pain, and sleep disturbances among active and veteran U.S. Military service members that reported experiencing pain before and after completing an eight week MM training program. Preliminary analyses revealed significant differences in the volunteer's self-reported state scores with higher pre- training scores relative to post-training scores, except for pain. However, subsequent analyses with individuals that reported higher levels of pain replicated and extended our initial analyses by showing a marginally significant trend toward lower pain following MM training. In addition, significant associations were found between pre- and post-training scores on the measures. Further testing showed that the pre-training correlations did not differ significantly from post-training correlations. Collectively, these findings appear to support the notion of a symptom cluster among service members that report experiencing pain.

MM training prompted marked improvement in volunteers' self-reported stress, fatigue, and sleep disturbances. This finding is consistent with previous research that has shown the beneficial effects of mindfulness meditation training in both military and non-military samples [16, 18, 19]. More recently Serpa et al. [29] reported that MBSR training promoted improvement in military veteran's anxiety, depression, and suicidal idealization, but not experienced pain. Our results mirror those findings, to the extent that lower levels of self-reported pain were observed from pre- to post- testing, but statistical significance was not reached. Nevertheless, it should be noted that whereas the Serpa et al. [29] study included only veterans, the current sample included both active and veteran service members who self-reported experiencing pain (as measured by the PHQ scale).

Prior research in both clinical and non-clinical samples supports the presence of a symptom cluster of fatigue, pain, sleep, and psychological states [1, 6, 30]. In the present study, we found pre- to post- changes after MM training in self-rated stress, fatigue, sleep, but not for pain among the entire volunteer population. For those experiencing higher levels of self-reported pain, reductions in stress, fatigue, sleep and pain (marginally at .05) were seen following mindfulness training. These findings demonstrate that a cluster exists between stress, fatigue and sleep, separate from pain; however when pain is high the symptom cluster appears to include pain.

Stress, fatigue, sleep and pain influence one another. For example, high stress can be accompanied by constricted muscles, pain, and insomnia, and pain can produce fatigue. Sleep impairments predict both new episodes of pain, as well as exacerbations of pain [31], sleep disturbances are present in 67–88% of chronic pain disorders [32], and 50% of those with insomnia also reporting chronic pain [33]. However, the directionality (which comes first, stress, sleep, or pain?) and the mechanisms of association remain in question.

5 Limitations

One limitation of the current study is that it did not include direct measures of pain and fatigue. Instead, items from the Patient Health Questionnaire that queried about fatigue and pain were used. Future researchers are encouraged to use other measures of pain and fatigue. A second limitation is the study population, U.S. military service members and veterans who self-reported pain. Care should be taken in generalizing these results to other populations.

6 Conclusions

This research demonstrated a symptom cluster between stress, fatigue, sleep and marginally – pain, independent of a specific clinical diagnosis. One advantage of MM training over other treatment approaches is that it enhances multiple facets of well-being (e.g., stress, fatigue, pain, and sleep), rather than individual complaints (e.g., stress-only). This is important when the source of a health issue is vague or difficult to isolate. Future studies could explore the application of MM training in treating chronic health conditions that involve symptom clusters.

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