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Mindful Meditation for Individuals with Asthma and Anxiety: Promising Results from a Multiple Baseline Study

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Abstract

Asthma is a disease that affects the overall health and quality of life of millions of children and adults in the U.S. In addition to the physical symptoms and the limitations, many people with asthma also experience anxiety. Psychological interventions used in conjunction with standard treatment have successfully reduced anxiety, as well as improved lung functioning among people with asthma. Mindfulness techniques have been shown to reduce anxiety among children, adolescents and adults. This study sought to determine if mindfulness meditation might reduce anxiety and also improve lung functioning. It was found that lung functioning was moderately improved, especially on the day of the sessions, pre and post treatment. Anxiety was also substantially improved during the pre and post in-session treatment.

Keywords: Asthma; Mindfulness; Meditation; Anxiety

Introduction

Asthma is a chronic respiratory disease that over 25 million Americans are currently diagnosed with, including eight percent of adults [1] and over nine percent of children [2]. The rates of asthma diagnosis have been rising over the past three decades in the U.S., and are expected to continue to increase [3]. The financial cost to society is also very high [4]. Further, for those who suffer from asthma directly, this condition resulted in an annual total of 1.8 million emergency room visits [5] and an average of 3.6 nights stay in the hospital upon admission [6]. In addition to emergency situations, asthmatic symptoms may regularly cause discomfort and negatively impact physical functioning [3]. Additionally, maintenance visits and daily care often result in missed work for adults and missed class time among children and adolescents [7].

Aside from the physical ailments associated with the disease, children and adults with asthma frequently experience co-occurring anxiety [8], which further adds to the impact that asthma can have on an individual's functioning. The symptoms of asthma can increase an individual's anxiety, just as the symptoms of anxiety can increase an individual's asthmatic reaction [9]. Therefore, the two conditions often work against each other to further complicate life for the afflicted individual.

Psychologically based treatments for asthma

Given the relationship between psychological and physical health, many techniques have been developed to specifically target psychological constructs, assuming that positive changes in the mind will influence positive changes in the body. Below is a review of the contemporary psychological and alternative treatment literature regarding asthma symptoms and overall respiratory functioning.

Alternative psychological and mind-body techniques used along with standard treatment (e.g., inhaled corticosteroids) have successfully reduced anxiety and improved lung functioning. Positive psychological and physical effects among individuals with asthma have resulted from interventions including written emotional expression [10], yoga [11], relaxation and guided imagery [12] and passive music therapy [13].

Treatment techniques that focus on psychological interventions for asthma include cognitive behavioral therapy [14], art therapy to encourage expression, discussion and problem solving [15], music therapy in both passively listening to, and actively selecting music choices [16] and written emotional expression, or disclosure therapies [10,17].

Educationally-focused interventions for asthma are implemented with the intention to impart preventative knowledge or information on the management of skills that help reduce asthma symptoms. Bruzzese et al. [18] tested the feasibility of a short-term educational intervention in the public schools that provided information to both non-asthmatic family members and their children with asthma. Similar programs have focused on peer support [19] and academic counseling [20], both of which included peer and professional led information sessions and peer-centered positive social interactions. Srof et al. [21] tested a coping skills training program with five small groups of teens. Their findings indicated that teaching proper coping skills for asthma-related issues improved individual self-efficacy, social support and perceived quality of life. However, a similar study was not as successful [22] and further research should be conducted.

More contemporary forms of self-guided support and self-management techniques have been tested as well. Joseph et al. [23] implemented a web-based self-management intervention called "Puff City" with high-school-aged adolescents. The results were positive and most participants indicated fewer symptoms, fewer school absences, and less restricted activity than students in the control condition. Similar programs exist for younger students to help them develop positive attitudes about prevention and treatment behaviors [24]. Web-based social support interventions have also demonstrated positive

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treatment effects [25] and individuals who felt isolated or excluded socially benefitted greatly from this form of treatment. However, treatment effects were not found to be persistent over time in a similar study. Gains were maintained at three months after the treatment commenced, but a year later the effects were considered non-significant [26].

Mindfulness as a treatment for physical symptoms

For both healthy and clinical populations, it appears that the practice of mindfulness is effective in promoting health. In addition to improving a range of variables related to psychosocial dimensions and quality of life [27-30], research indicates that mindfulness-based interventions (MBIs) can alleviate physical symptoms for sufferers of some disorders [29,31,32]. Grossman et al. [29] meta-analysis found moderate-to-large effect sizes on physical variables in both controlled and observational studies. A more recent meta-analysis failed to replicate the robustness of that finding, but authors were able to detect a small effect size on physical health variables, which included immune system markers and hormonal indices, as well as self-reported symptoms of cardiopulmonary, gastrointestinal, and central nervous system distress [30]. The authors suggest that one reason for the substantially smaller effects may lie in the 2004 study's reliance on self-report data as the sole outcome measure [30], while more recent studies are increasingly reporting on physiological parameters.

Currently, little is known about the mechanisms of physiological changes when they do occur [33,34]. Some have suggested that reductions in symptomatology may arise out of improved emotional regulation, metacognitive skills and/or coping abilities that allow people to modulate their experiences [33,35]. Moreover, a number of studies appear to indicate that the practice of mindfulness can directly influence physiological parameters, promote immunity and improve the recovery prognosis in some cases [27,36,37].

As results cannot be generalized across clinical populations, the efficacy of MBI is being explored with a wide range of medical disorders, including cancer, HIV, chronic pain, psoriasis, heart disease, irritable bowel syndrome, diabetes, epilepsy, autoimmune diseases, such as multiple sclerosis, rheumatoid arthritis, and fibromyalgia, among others. However, more research assessing physiological parameters is needed to yield convincing evidence and further existing knowledge about the impact of MBIs on these and other chronic health conditions [30].

Mindfulness to treat anxiety

Mindfulness may be an obvious choice of treatment for people with anxiety [38,39], given its focus on acceptance and living in the present moment [40]. A recent review of 19 studies using a mindfulness-based treatment approach for various anxiety disorders found large effect sizes for improvements on both anxiety and depression, and a moderate effect on quality of life [41]. Participants of mindfulness-based treatments have also been very receptive to the use of these techniques for treating their anxiety [42-44] and have continued to practice mindfulness techniques at a three-year follow-up [45].

Though many interventionists incorporate a mindfulness philosophy or meditation practice into their program, the most prevalent program in the literature on anxiety is mindfulness-based stress reduction (MBSR) [46]. MBSR is intended to help people reconnect with themselves, to observe their thoughts and feelings without judgment, and to accept themselves and their circumstances so that they can begin to respond effectively to stressors [46]. It involves group-based sessions with mindfulness meditation, yoga and discussion, with audio CDs and a manual that participants can use to complete the homework exercises. Mindfulness techniques are intended to become a way of life that empowers one to experience the process of thoughts and problems, and to react to them with minimal stress.

Mindfulness-based stress reduction for anxiety

Mindfulness-Based Stress Reduction has been shown to reduce depression [41,47], improve self-esteem [47,48] and reduce anxiety [41,47]. The founder of the MBSR program and his colleagues conducted the earliest known study published on MBSR as a treatment for anxiety [46]. This study involved 22 participants with primary generalized anxiety disorder or panic disorder. They found significant reductions in panic attacks from pretreatment to post treatment, and fewer reports of panic attacks at a three-month follow-up. The researchers also reported significant improvements in anxiety and depression at posttest, which were also maintained at the three-month follow-up [46]. Three years after this study was completed, 18 of the original 22 participants provided additional follow-up data. These analyses showed continued maintenance of gains for anxiety scales and panic scales, as well as for depression [45].

Goldin and Gross [48] demonstrated that MBSR may help people with social anxiety disorder address their negative self-beliefs, rather than avoid them, while also exercising improved self-regulation of emotions. Goldin et al. [47] also found that participants were less avoidant of negative social trait adjectives stimuli after an MBSR program, and suggested that participants' overall self-view had improved. The authors speculated that this may be a result of the MBSR focus on observing, rather than evaluating, which likely reduced the rumination that is common among individuals with social anxiety [47]. When applied to multiple anxiety disorders, MBSR resulted in moderate to large effects on various measures of anxiety and depression at posttest, and gains were maintained at a 6 month follow-up [41]. The nature of mindfulness training is such that participants are encouraged to practice independently, so that participants build the skills they need to practice mindfulness well beyond the completion of the course. Some speculate that this may be why further clinical improvements are often observed from post treatment to follow-up [42].

Rationale for the use of mindfulness for asthma and anxiety

The relationship between the physical and psychological expressions of asthma and anxiety, along with the success of psychologically-based interventions on both anxiety and lung functioning, suggest that mindful meditation would also be an effective approach to reducing the symptoms of these conditions [49,50]. In addition, mindfulness techniques, including meditation, have been used to increase acceptance and living in the present moment [40], which has resulted in reduced stress and anxiety among children [51], adolescents [52-54] and adults [38,43,46,55]. This study sought to explore the potential relationship between mindful meditation and both the symptoms of anxiety and asthma.

Method

Participants and setting

This study took place on the campus of a large northeastern university. Three adult volunteers with chronic asthma and the presence of co-occurring anxiety symptoms participated in the study. Two of the participants were female graduate students and the third was a male staff member at the host university. Each participant was required to

present the study team with documentation of a current, medically diagnosed chronic asthma condition. The presence of co-occurring anxiety symptoms was identified through the State-Trait Anxiety Inventory (STAI) [56]. Participants were required to meet the cutoff of one standard deviation above the mean on the Trait form.

All study meetings took place in the same office suite at the university. Participants were provided with two heavy yoga blankets to sit or lay on during the guided meditation sessions, though one participant chose to sit at the desk instead. Participants also had the option of listening to the guided meditations via headphones or through a laptop, and the lights were turned off to help create a relaxing environment.

Measures

All measures of lung functioning were gathered through the use of a spirometer that was connected to a computer via SpiroCard and Office Medic software (v5.4/5.5). This software was at its then current version in full compliance with the American Thoracic Society's (ATS; 2005) spirometer standards (D. McGrath, Customer Care Manager, QRS. Personal Communication, June 18, 2013). All possible steps were taken to ensure that every element of the Spirometer was properly calibrated, measuring accurately and otherwise valid and in compliance with these standards. This equipment gathered data as participants breathed and forcibly exhaled into a mouthpiece. This measure was used at each baseline session, before and after each intervention session and at follow-up.

The STAI (State-Trait Anxiety Inventory) [56] was used to measure trait and state-related anxiety. The State form consisted of 20 items measuring anxiety as a transient state. The Trait form, also 20 items, is intended to provide a more stable measure of anxiety. Cronbach's alphas for internal consistency were reported to range from 0.86 to 0.95 [56]. This measure also has adequate content validity, as compared with the Taylor Manifest Anxiety Scale (r=0.73) and the Cattell and Scheier's Anxiety Scale Questionnaire (r=0.85). The State form was administered at each baseline session, before and after each intervention session, and at follow-up. The Trait form was administered prior to baseline and at the end of treatment.

The AQLQ (Asthma Quality of Life Questionnaire) [57] is designed to measure several factors related to overall quality of life for people with asthma. For many people who experience chronic asthma, their quality of life is negatively impacted. The AQLQ has high test-retest reliability (>0.95) and has adequate construct validity when compared to related measures. This scale was administered prior to baseline and at the end of treatment. This measure has adequate psychometric properties.

Participants were also asked to keep a daily asthma log for the purpose of recording their asthma symptoms and severity, the occurrence of asthma attacks, and the frequency and type of asthma medication used. In addition, participants were asked to keep a practice log of when they listened to the recordings outside of the sessions baseline with intervention. Study team members also maintained a treatment fidelity checklist. This form was used during each intervention session to ensure that every component of both data collection and intervention occurred. Lastly, a brief exit interview was conducted at the close of the intervention phase. Participants were provided with the following statements on a paper form, and asked to rate their agreement with each one based on the scale 1-Strongly Disagree, 2-Disagree, 3-Neither Agree nor Disagree, 4-Agree and 5-Strongly Agree: a) I found the mindfulness practices to be helpful with my asthma symptoms; b) I found the mindfulness practices to be helpful with my feelings of anxiety; c) I would recommend the mindfulness practices to a friend; d) I intend to continue using the mindfulness practices I learned through participation in this study.

Procedures

Study procedures were administered by one of the four investigators (e.g., study team members) including a full professor, and, at the time of data collection, three advanced graduate students. The lead student investigator had completed the MBSR program out of the University of Massachusetts Medical School. This experience and training in these techniques, in tandem with the empirical research cited previously, ensured that all four researchers had adequate knowledge to facilitate the intervention.

Baseline

Baseline data were collected across 3, 5 and 8 sessions for Participants 1, 2 and 3, respectively. Baseline sessions occurred once per week for Participant 1, though they were spread out as probes for Participants 2 and 3 to avoid unnecessary additional sessions during a prolonged baseline period. At the first baseline session, each participant completed the Asthma Quality of Life Questionnaire (AQLQ) [57] as well as the Trait form of the STAI [58]. At each baseline session, each participant completed the STAI State form [58] and a spirometry reading. Each participant was also asked to complete a paper and pencil daily asthma log throughout the baseline and intervention phases. This log consisted of the date, the type of medication used, notes on asthma symptom severity and any asthma attacks. Participants were not asked to discontinue, or otherwise alter in any way, the medications they were currently taking for any medical condition, including asthma.

Intervention

Treatment sessions were delivered once weekly for five weeks for each participant. The first component was a pre-recorded 45 min body scan. The second component was a pre-recorded 45 min seated meditation. These recorded meditations were facilitated by the study team using audio recordings which were available online through the MBSR program at the University of California, San Diego (UCSD Center for Mindfulness, 2016). Each participant had a brief check-in with study team personnel and an opportunity for a break between the first and second components of the intervention. Before and after each treatment session, participants completed the STAI State form and a spirometry reading.

Follow-up

Follow-up data were collected for all 3 participants at 2 weeks, 6 weeks and 3 months after their last treatment session. For each follow-up session, participants completed the STAI State and Trait forms and a spirometry reading. On the first follow-up session, each participant also completed an AQLQ form. On the last follow-up session, each participant completed an exit interview.

Design

This study employed a single subject, multiple baseline design across 3 participants. Single subject designs allow researchers to observe changes in each participant in response to an intervention [59]. These designs are characterized by a high degree of internal validity approximating that of a group design, which permits the conclusion that observed changes are the result of the treatment variable [59]. External validity is achieved through replication of the study with each successive participant. Compared to other single subject designs, a major advantage of the multiple baseline approach is that there is no

need to withdraw a potentially beneficial treatment in order to observe the treatment effect, which thereby increases its ethical soundness [59]. Multiple baseline designs are also used when reverting to the pre-intervention state is simply not possible, such as when new behaviors are learned, as is the case in this study.

Analysis

All data were graphed for both intervention and treatment phases by group, as well as for each individual participant, showing STAI measures before and after each session and lung functioning as measured by the spirometer. Data was analyzed using visual analysis for changes in level and trend, as well as variability [60]. Effect sizes were also calculated by using the standard mean difference [61].

Results

Pulmonary function and state anxiety

FEV_1, FEF_{25-75} and STAI State effect sizes were calculated using the standard mean difference, Approach One: No Assumptions method [61]. During the intervention phase, FEV_1, FEF_{25-75} and STAI State data were collected pre- and post-treatment. Consequently, effect sizes were calculated for baseline to intervention post-treatment (pre to post intervention as a whole) values as well as intervention pre-treatment to intervention post-treatment (before and after daily sessions) values. Specifically, the effect size was derived by calculating the difference between the mean post-treatment value and the mean baseline/pre-treatment value divided by the standard deviation of the baseline. For follow-up effect size, the difference between the mean follow-up value and the mean baseline value divided by the baseline standard deviation was calculated. Figure 1 for FEV_1, Figure 2 for FEV_{25-35} and Figure 3 for STAI State depict the data across baseline, intervention, and follow-up phases.

During the intervention phase, FEV_1 effect sizes between baseline and post-treatment for Participant 1, 2 and 3 were -6.13, -0.73 and -0.68, respectively. Additionally, pre- and post-treatment effect sizes during the intervention phase were 0.04, -0.28 and 1.09 for Participant 1, 2 and 3, respectively. For the follow-up phase, FEV1 effect sizes were 2.16, -1.13 and -1.63 for Participant 1, 2 and 3, respectively (Table 1).

Participant 1 averaged an FEV_1 (Figure 1) of 119% predicted (range 188-120) during baseline. The mean decreased to 110% (range 104-119) predicted post-treatment during the intervention phase. Pre-treatment

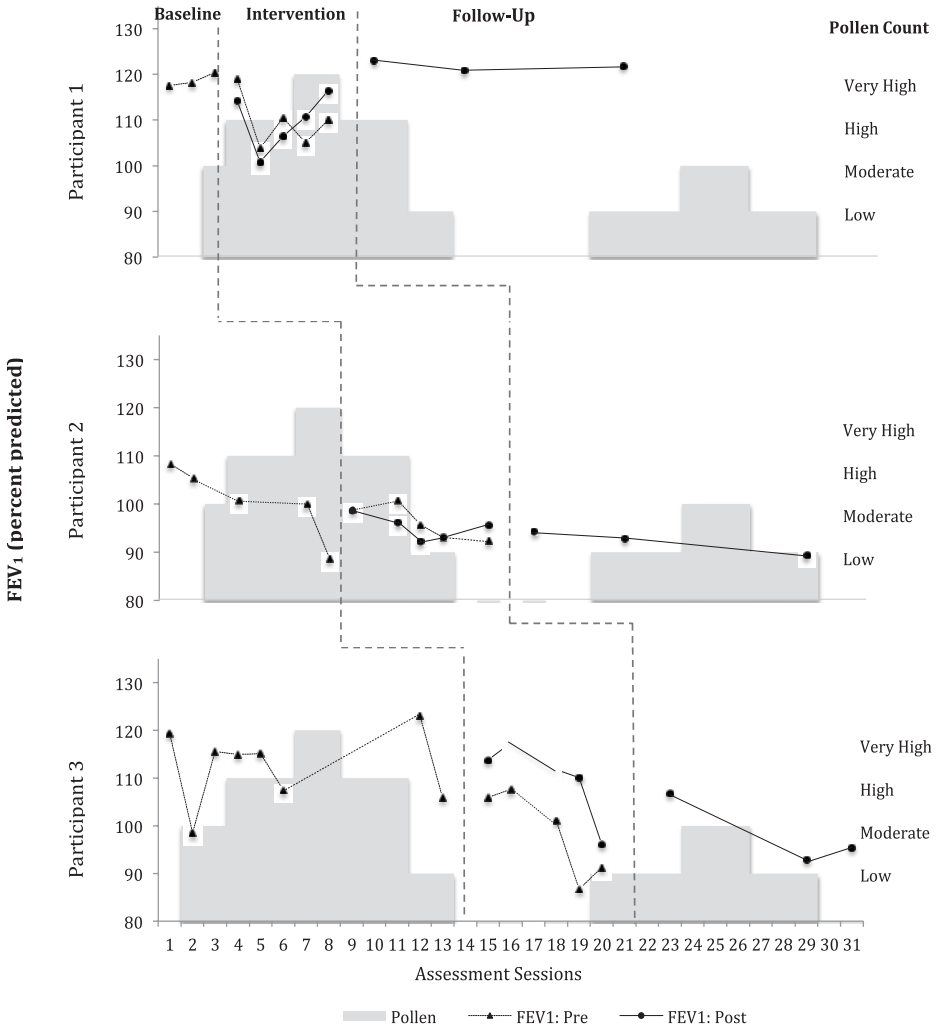

Figure 1: FEV_1 (percent predicted) observed across participants and phases.

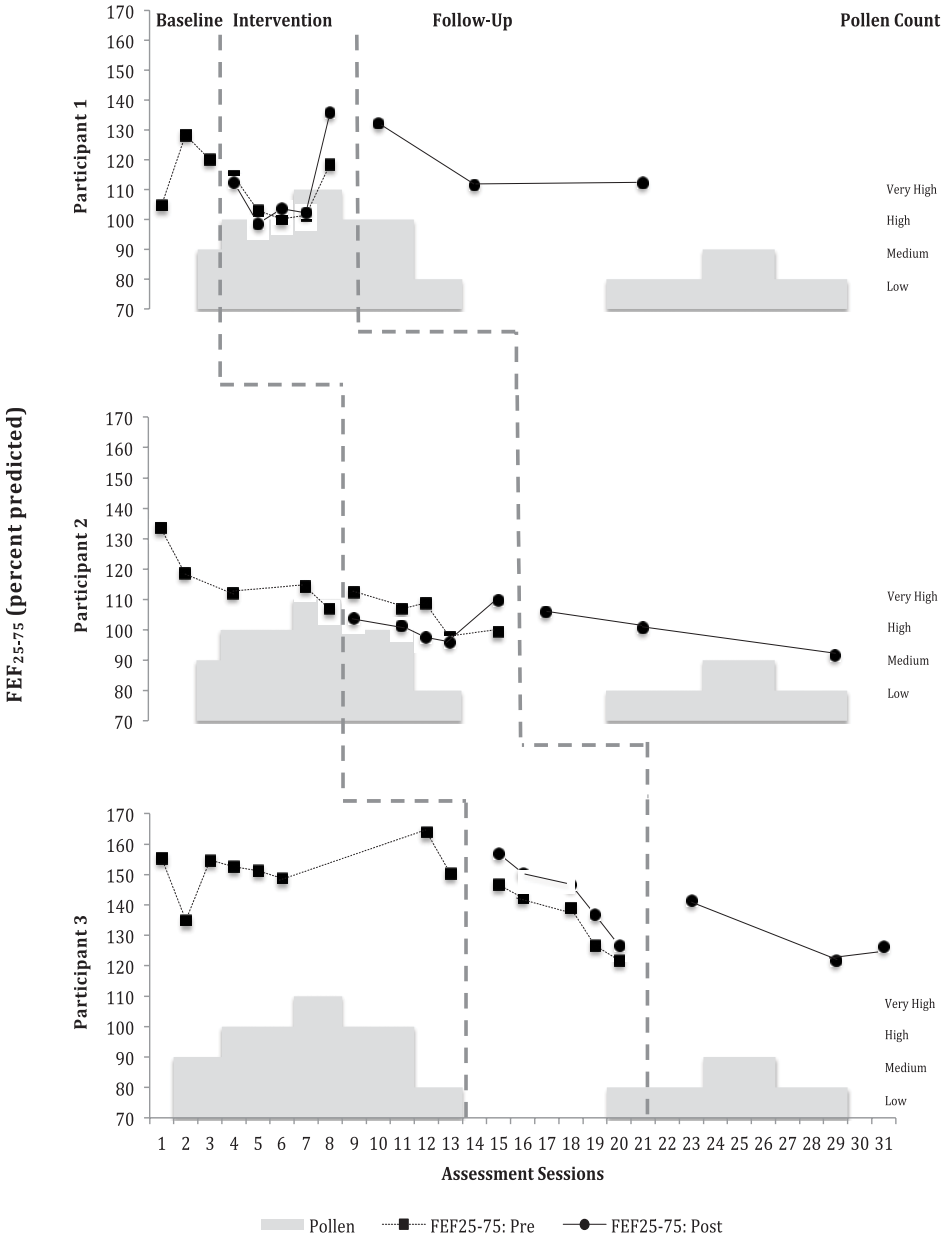

Figure 2: FEF25-75 (percent predicted) observed across participants and phases.

	Mean Baseline	Mean Treatment: Pre	Mean Treatment: Post	Mean Follow-up	Standard Deviation Baseline/	Standard Deviation Treatment Pre	Standard Deviation Follow-up	Effect Size Baseline/ Post	Effect Size Pre/Post	Effect Size Follow-up
Participant 1	118.73	109.66	109.72	121.90	1.47	6.00	1.05	-6.13	0.04	2.16
Participant 2	100.62	96.16	95.14	92.17	7.49	3.60	2.51	-0.73	-0.28	-1.13
Participant 3	112.51	97.72	107.04	99.50	7.99	8.55	6.32	-0.68	1.09	-1.63

Table 1: Effect sizes FEV_1 (percent predicted).

and post-treatment FEV_1 measurements during the intervention phase remained stable at 110% (range 104-119) predicted to 110% (range 101-115) predicted during the intervention phase. At follow-up, Participant 1 averaged 122% (range 121-123) predicted, higher than both the baseline phase and intervention phase means.

During baseline, Participant 2 averaged a FEV_1 of 101% (range 100-108) predicted, which decreased to 95% (range 93-98) post-treatment during the intervention phase. Participant 2 did not demonstrate an improvement in FEV_1 between pre-treatment and post-treatment during the intervention phase: 96% (range=92-101) and 95% (range 92-98) predicted. At follow-up, Participant 2 averaged 92% (range 89-94) predicted, lower than both the baseline phase and intervention phase means.

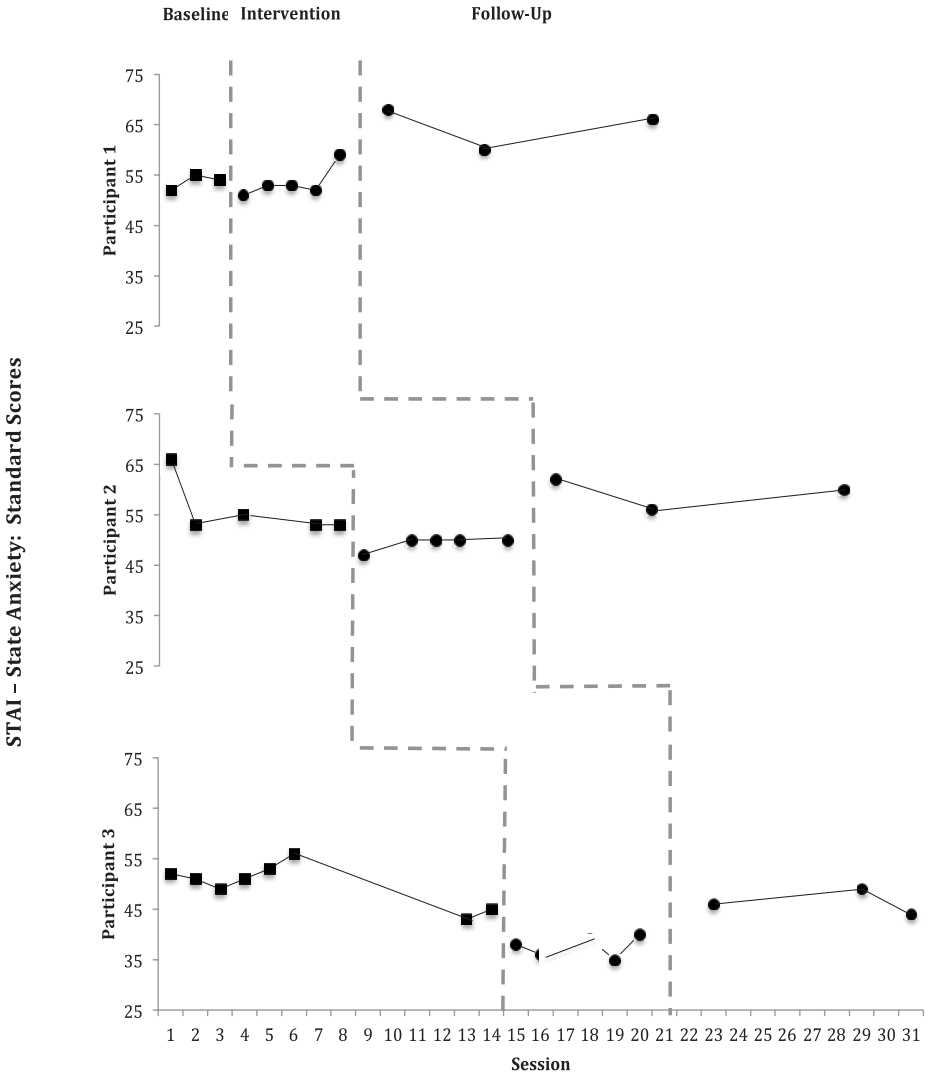

Figure 3: STAI- State Anxiety observed across participants and phases.

Participant 3 had an average baseline FEV_1 of 113% (range 98-123) predicted. This decreased to 107% (range 96-117) predicted post-treatment during the intervention phase. Participant 3 demonstrated an improvement in FEV_1 of a mean of 98% (range 91-108) predicted pre-treatment to 107% (range 96-117) predicted during the intervention phase. Participant 3 averaged 100% (range 96-107) predicted during the follow-up phase, which was a decrease from baseline phase but an increase from pre-treatment during the intervention phase.

During the intervention phase, FEF_{25-75} effect sizes (Figure 2) between baseline and post-treatment for Participant 1, 2, and 3 were -0.50, -1.52 and -0.96, respectively. Additionally, pre- and post-treatment effect sizes during the intervention phase were 0.36, -0.52 and 0.77 for Participant 1, 2 and 3, respectively. For the follow-up phase, FEF_{25-75} effect sizes were 0.09, -1.74 and -2.63 for Participant 1, 2 and 3, respectively (Table 2).

Participant 1 averaged a FEF_{25-75} (Figure 2) of 118% predicted (range 105-128) during baseline. This decreased to 110% (range 99-135) predicted post-treatment during the intervention phase. Participant 1 demonstrated an improvement in FEF_{25-75} of a mean of 108% (range 100-188) predicted pre-treatment to 110% (range 99-135) predicted during the intervention phase. At follow-up, Participant 1 averaged 119% (range 112-132) predicted, demonstrating an increase in FEF_{25-75} over baseline and intervention phases.

During baseline, Participant 2 averaged a FEF_{25-75} of 117% (range 107-134) predicted, which decreased to 102% (range 96-110) post-treatment during the intervention phase. However, Participant 2 demonstrated an improvement in FEF_{25-75} during the intervention phases between pre-treatment values and post-treatment values: 102% (range 96-110) predicted to 105% (range 98-112) predicted, respectively. At follow-up, Participant 2 averaged 99% (range 92-106) predicted, demonstrating an overall decrease in FEF_{22-75} from baseline and intervention phases.

Participant 3 had an average baseline FEV_1 of 151% (range 135-164) predicted. This decreased to 143% (range 127-157) predicted post-treatment during the intervention phase. Participant 3 demonstrated an improvement in FEF_{25-75} of a mean of 135% (range 122-147) predicted pre-treatment to 143% (range 125-157) predicted during the intervention phase. Participant 3 averaged 130% (range 123-

	Mean Baseline	Mean Treatment: Pre	Mean Treatment: Post	Mean Follow-up	Standard Deviation Baseline/	Standard Deviation Treatment Pre	Standard Deviation Follow-up	Effect Size Baseline/Post	Effect Size Pre/Post	Effect Size Follow-up
Participant 1	117.73	107.48	110.48	118.77	11.93	8.37	11.82	-0.60	0.36	0.09
Participant 2	117.16	104.96	101.70	99.43	10.19	6.23	7.25	-1.52	-0.52	-1.74
Participant 3	151.34	135.24	143.46	129.83	8.18	10.58	10.27	-0.96	0.77	-2.63

Table 2: Effect sizes FEV_{25-75} (percent predicted).

	Mean Baseline	Mean Treatment: Pre	Mean Treatment: Post	Mean Follow-up	Standard Deviation Baseline	Standard Deviation Treatment Pre	Standard Deviation Follow-up	Effect Size Baseline/ Post	Effect Size Treatment Pre/Post	Effect Size Follow-up
Participant 1	53.67	58.60	53.60	64.7	1.53	3.51	4.16	-0.05	-1.42	7.21
Participant 2	53.60	49.67	47.4	56.67	5.37	0.82	2.52	-1.15	-2.77	0.57
Participant 3	50.00	48.80	37.60	47.33	4.24	3.96	1.53	-2.92	-2.83	-0.63

Table 3: Effect sizes STAI: S-anxiety.

141) predicted during the follow-up phase, demonstrating an overall decrease in FEF_{25-75} from baseline and intervention phases.

During the intervention phase, STAI S-Anxiety [58] effect sizes between baseline and post-treatment for Participant 1, 2, and 3 were -0.05, -1.15 and -2.92, respectively. Additionally, pre- and post-treatment effect sizes during the intervention phase were -1.42, -2.77 and -2.92 for Participant 1, 2 and 3, respectively. For the follow-up phase, STAI S-Anxiety effect sizes were 7.21, 0.57 and -0.63 for Participant 1, 2 and 3, respectively (Table 3).

Participant 1 averaged a STAI State (Table 3) of 54 (range 52-55) during baseline. This remained stable at 54 (range 51-59) post-treatment during the intervention phase. At follow-up, Participant 1 did not maintain the effect and demonstrated an overall increase over baseline and intervention phases to a mean T-score of 65 (range 60-68).

During baseline, Participant 2 averaged a STAI State T-score of 54 (range 50-63) and demonstrated a significant decrease to 48 (range 45-58) post-treatment during the intervention phase. At follow-up, Participant 2 demonstrated an increase in STAI State beyond baseline and intervention to a T-score of 57 (range 54-59).

Participant 3 had an average baseline STAI State of 50 (range 43-56). This decreased dramatically to a mean of 38 (range 35-46) post-treatment during the intervention phase. Participant 3's STAI State remained below baseline at follow-up, but increased above the intervention phase to a mean of 48 (range 46-49), it did not return to the baseline mean.

Pollen counts throughout phases

Data were collected during the winter, spring, and fall when significant changes in pollen counts occurred [62]. At the beginning of the study, pollen counts were in the *no count* range (Figures 1 and 2). At Week 3, pollen counts rose into the *moderate concentration* range and over the next five weeks continued to rise, reaching the *very high concentration* range. At Week 12, the pollen counts tapered off into to the *low concentration* range again and returned to the *no count* range during Week 14. At Week 20, pollen counts were measurable in the *low concentration* range, increasing to *moderate concentration* range during Weeks 24-26. They returned to the *low concentration* range for Weeks 27-29 and tapered back to *no count* for the remainder of the study.

State and trait anxiety

STAI State and Trait scores [58] are shown in Table 4. State scores are also displayed in Figure 3. Trait anxiety decreased for two of the three participants over the course of the study.

Criteria	Phase	Participant 1	Participant 2	Participant 3
STAI T-Anxiety Scale				
Key: Mean=50; +1 Standard Deviation=57.5; +2 Standard Deviations=65; +3 Standard Deviations=72.5				
	Baseline	69	76	61
	Follow-up	72	59	47
AQLQ				
Key: 1=Totally Limited; 2=Extremely Limited; 3=Very Limited; 4=Moderate Limitation; 5=Some Limitation; 6=A Little Limitation; 7=Not at all Limited				
Symptoms	Baseline	5.25	4.33	4.33
	Follow-up	4.50	[a]5.83	[a]5.50
Quality of Life	Baseline	4.36	5.55	4.73
	Follow-up	[a]5.00	[a]6.00	[a]5.44
Emotional Function	Baseline	4.80	4.60	4.40
	Follow-up	4.00	[a]5.20	[a]5.80
Environmental Stimuli	Baseline	2.25	6.00	4.25
	Follow-up	[a]3.50	6.00	[a]4.50
Daily Asthma Diary				
Key: 0=No Symptoms; 1=Mild Symptoms; 2=Moderate Symptoms; 3=Severe Symptoms				
Shortness of Breath	Baseline	1.00	1.02	0.36
	Intervention	1.00	1.07	0.19
Chest Tightness	Baseline	0.33	0.07	1.07
	Intervention	0.29	1.00	1.24
Wheezing	Baseline	1.00	0.20	0.94
	Intervention	0.95	0.14	0.57
Dry Cough	Baseline	1.05	0.30	0.73
	Intervention	1.00	0	0.86
Asthma Attack	Baseline	0	0	0
	Intervention	0	0	0

Note: [a]Minimal important difference reached (an average change in score of 0.5 per item per domain and for overall quality of life, indicating an important improvement as opposed to a trivial change

Table 4: Participants' baseline and follow-up scores on the Criteria of STAI T-anxiety scale, AQLQ and the daily asthma diary.

Quality of life

Scores on the AQLQ are displayed in Table 4. Participant 3 reported a minimal important difference of improvement across all four domains. For Participant 2, a minimal important difference was reached on three of the four domains: Symptoms, Quality of Life and Emotional Function. Finally, Participant 1 reached a minimal important difference in Quality of Life and Environment Stimuli.

Medications and symptoms

An examination of the Daily Asthma Diaries [63] indicated that

participants maintained constant usage of long-term asthma control medications across phases. Table 4 displays the across phases mean scores for self-rated asthma symptoms on the Daily Asthma Diary. The mean score for Chest Tightness, Wheezing and Dry Cough decreased for Participant 1. Participant 2 reported a decrease in Wheezing and Participant 3 experienced a decrease in Shortness of Breath and Wheezing.

Treatment integrity

At the completion of each session, the data collectors completed the Treatment Integrity Checklist. The elements of the treatment were implemented with 100% integrity across participants.

Social validity

The participants were satisfied with the intervention, as demonstrated by a mean score of four on a five-point Likert-scale exit interview.

Discussion

Asthma is a condition that can be initiated and exacerbated by both environmental and psychological triggers. The participants in the current study had lung functioning values that were somewhat positively altered by the psychologically-based treatment. Participant 3, in particular, did better relative to the others. Anxiety was an initial problem in this participant and it was lowered by the end of the study: State anxiety was lowered the most for Participant 3. Trait anxiety at baseline was decreased especially for Participants 2 and 3. Though, more robust results are found in the inspection of data from before and after each session. Participants 2 and 3 showed a decrease in overall asthmatic symptoms and all three participants had improvements in quality of life scores. However, pollen counts serve as a confounding variable in this study. It appears as though the full effects of the intervention may not have been realized because of the effect that the pollen had on participants' asthma symptoms during the time of the study. The mind-body connection is quite evident in individuals that have asthma and emotional triggers. Lung functioning has been shown to be altered by the reduction of stress, anxiety and depression. The current study demonstrates a need for additional research to determine if the results can be replicated and expanded upon.

Limitations

This study had some limitations that may have affected the outcomes. For instance, the participants in this study had highly controlled asthma, meaning that the effects may have been different for those in greater need of intervention. Therefore, it is possible that the results were affected by a ceiling effect, where the extent of observed improvements was limited by how much the participants could improve. Also, while we were able to consider the effect that pollen count may have had on participants' asthma, we cannot be sure to what extent this actually impacted their lung functioning or the effects of the intervention. While dose was controlled for in the number and frequency of sessions provided, we did not control for the number or frequency of times that participants practiced at home, in between sessions. In addition, just two components of the MBSR program were utilized among individual participants. The results may also have been more positive has participants engaged in the full program.

Perhaps the most significant limitations are related to characteristics of the participants. Two participants were female graduate students, and one was a male staff member working at the university. The two students likely experienced varying levels of stress in regards to the academic calendar, which could have also impacted their anxiety. Differences of any kind among participants in a single subject design are not ideal. Finally, given the nature of the data collected, participants were not entirely blind to the purpose of the study.

Conclusion

Asthma and anxiety are relatively common and commonly co-occurring conditions that can negatively impact an individual's functioning. Given the positive effects that have been observed as a result of psychologically-based interventions on both asthma and anxiety and the positive effects that mindfulness interventions have had on both anxiety and other physical ailments, it seems logical that mindfulness interventions would positively impact the symptoms of both asthma and anxiety in individuals who are impacted by both conditions. Particularly, since the symptoms of the two conditions can have an impact on one another.

Future studies might consider increasing the dosage of the intervention, perhaps through a stronger commitment on the part of the participants to practice outside of the study sessions and to diligently track those additional sessions. Future studies might also consider screening for individuals whose asthma is affected by environmental triggers, such that pollen count would have a lesser impact on the effectiveness of the intervention. Although the effects in this study were not as robust as we had hoped, we still believe mindful meditation to be a promising intervention for individuals with asthma and anxiety.

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