

**MODIFIED MINDFULNESS-BASED STRESS REDUCTION INTERVENTION IN
CHRONIC OBSTRUCTIVE PULMONARY DISEASE**

by

Roxane Raffin Chan

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Doctoral Committee:

Professor Janet Louise Larson, Chair
Assistant Professor Nicholas Giardino
Associate Professor Denise Saint Arnault
Assistant Professor Barbara-Jean Sullivan

DEDICATION

This dissertation is dedicated to my wonderful husband who has encouraged me from the moment we met, and to the children that we raised and/or acquired along the way who kept me surrounded by love, Patrick, Jacob, Kelly, Gina and Paul. I also want to thank the family that got me started in life, my mother and father (Adeline and Roland Raffin), my sister (Liah) and my brother (Louis). Nothing is done of substance without great love.

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Chapter I

Introduction

Significance of proposed study

The goals of the study are to explore the use of expiratory time as a measure of anxiety and meditation intervention uptake and to investigate the perceived benefits and essential interventional components of meditation as an intervention for persons with COPD. Outcome information from this study will provide persons with COPD an accessible tool to self-monitor anxiety levels and provide a safe and effective meditation practice to address their anxiety that will result in improved ability to participate in chronic disease self-management activities and enhance their quality of life.

The use of expiration time as a measure of anxiety in persons with COPD is significant in that it provides a proactive measure of well being that will allow them to take positive action prior to experiencing functional or emotional decline. The use of lung functions parameters such as FEV 1% predicted and six-minute walk distance does not allow for preventive measures to be applied early enough in the relapse time frame. FEV1% predicted in particular has not been proven to provide useful clinical information (O'Donnell, et al., 2007; Ries, et al., 2007). The

investigation into the use of the sensation of dyspnea as a measurement of treatment needs and effectiveness is currently being encouraged (O'Donnell, et al., 2007; Unkown, 1999). This is perhaps a viable option for those patients with COPD in early stages of the disease who are not experiencing anxiety. However for those at the later stages of the disease or for those with anxiety, their ability to accurately gauge their dyspnea level in relation to their ability to compensate is impaired and encouraging them to focus on the sensation of dyspnea may in itself lead to further panic and exacerbate their feelings of dyspnea (Abrams, Dorflinger, Zvolensky, Galatix, Blank, & Eissenberg, 2008; Livermore, Butler, Sharpe, McBain, Gandevia, & McKenzie, 2008; Pei-Ying & Davenport, 2010). As an alternative, the assessment of the length of expiratory time and the presence of an expiratory pause could be used as a non-traumatizing measure that could be taken at rest and during daily activities and accurately measured by both patients and health care providers in persons at any stage of COPD (Wienthes, Grossman, & Gaillard, 1998b; Rafferty & Gardner, 1996; Donaldson, 1992; Peng, et al., 2002).

Meditation is a multi-component intervention that is difficult to quantify. Researchers struggle with an ability to measure interventional uptake in a quantitative manner. To date researchers have been focusing on developing a numerous self-report tools that will measure a change in ones degree of mindfulness during the experience of meditation or during the course of everyday life. Mindfulness is a dynamic characteristic that can be present at birth or developed over the life span from childhood experiences such as a brush with environmental challenges or through seeking formal spiritual training and has

been shown to negatively co-vary with anxiety levels(Davidson, 2010). However the dynamic, multifaceted nature of mindfulness, which one may not always be consciously aware of, impacts our ability to successfully quantify if a particular intervention actually increased a subjects level of mindfulness (Davidson, 2010). A more novel approach would be to assess a change in breathing pattern parameters both while in active meditation and when not meditating. Based on current research on respiratory pattern changes shown to occur as a result of an active practice of meditation, one would expect that expiration time would lengthen, abdominal excursion would predominate over chest excursion and one would perhaps see an reappearance of expiratory pause, increased ability to breath hold comfortably and more accurately estimate respiratory load (Allison, 1970; Wolkove, Kreisman, Darragh, Cohen, & Frank, 1984; Spicuzza, Gabuttti, Porta, Montano, & Bernardi, 2000; Villien, Yu, Barthelemy, & Jammes, 2005; Wallace, Benson, & Wilson, 1971; Bernardi, et al., 2007). This study will document the occurrences of these changes and investigate their correlation with measures of mindfulness, anxiety levels, self-report dyspnea ratings and respiratory quality of life.

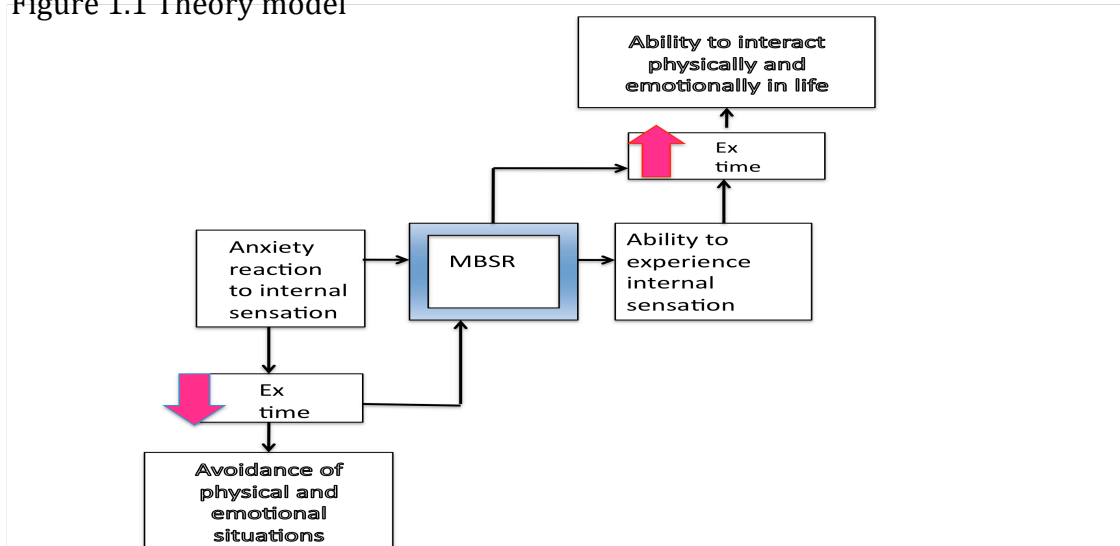
The last area of significance this study will address is to expand our knowledge of the experience one has when integrating meditation into a program of rehabilitation for persons with COPD. Persons with COPD and anxiety are vigilantly focused on respiratory sensations at the expense of awareness to all other stimuli causing them to overestimate danger and underestimate their ability to cope (Orsillo, Roemer, & Holowka, 2005). Meditation as an intervention

proposes to change their world view by opening them up a more comprehensive awareness of themselves and the world around them that necessitates questioning some their beliefs and facing their fears. As we begin to apply this spiritually based intervention within our secular based American health care system many personal, social and philosophical questions arise. The gathering of preliminary information regarding the acceptability of this style of intervention is imperative. Persons with chronic disease such as COPD already maintain a high level of self-care needs. Any additional interventions will need to be acceptable, accomplishable and affective.

Theoretical Framework

The theoretical framework for this research is a situation specific biological framework that identifies and matches key components in the pathophysiology of COPD, the components of anxiety and the components of mindfulness meditation. The specific relevant factors for persons with COPD are the additional anxiety compounding an already compromised system that creates a negative feedback loop further compromising physical conditioning, cognitive function and participation in daily life activities (see Figure 1.1).

Figure 1.1 Theory model



A program of mindfulness-based meditation will impact this cycle at the level of additional anxiety therefore having a physiological and psychological impact on the disease. The essential components of mindfulness, paying attention in the present moment with nonjudgement utilizing a focus on the breath will utilize the person's current symptoms of dyspnea and avoidance of physical and emotional situations as new points of reference for improved symptom awareness. This will enable the person with COPD to meet the physical, cognitive and emotional challenges of life without triggering the anticipatory anxiety cycle producing a more balanced autonomic system, lessening the impact of stress on the disease process and improving the person's ability to participate in rehabilitative activities.

Structure of the Dissertation

This is a manuscript-style dissertation. Three manuscript-style papers are presented in the next three chapters. Chapter II presents a systematic review of various meditation interventions in persons with chronic disease. This review focuses on the effect of a meditation intervention on the anxiety level, depression level and level of chronic disease symptoms in persons with chronic disease. Chapter III describes the baseline respiratory timing parameters in the COPD population. Baseline respiratory timing parameters are measured with a new inductive plethysmography system by the Clev-Med company and data reduction is conducted by Vivosense software from the Vivonoetics co. These baseline measures were then examined together with measures of anxiety sensitivity, mindfulness, an overall coping style and specific chronic disease symptoms such as dyspnea, fatigue, mastery of chronic disease care and an overall level of anxiety and depression. Chapter four describes the major research project. This chapter will describe the significance, methods and results of the effect of a meditation intervention in persons with COPD. The final chapter (chapter V) provides a summary and conclusion for chapters II, III and IV.

Bibliography

- Abrams, K., Dorflinger, L., Zvolensky, M., Galatix, A., Blank, M., & Eissenberg, T. (2008). Fear reactivity to bodily sensations among heavy smokers and non smokers. *Experimental and clinical psychopharmacology*, *16* (3), 230-239.
- Allison, J. (1970). Respiratory changes during transcendental meditation. *Lancet*, *1*, 833.
- Bernardi, L., Passino, C., Spaducini, G., Bonfichi, M., Arcaini, L., Malcovati, L., et al. (2007). Reduced hypoxic ventilatory response with preserved blood oxygenation in yoga trainees and himalayan Buddhist monks at altitude: evidence of a different adaptive strategy? *European Journal of Applied Physiology*, *99*, 511-518.
- Davidson, R. (2010). Empirical explorations of mindfulness: Conceptual and Methodological conundrums. *Emotion*, *10* (8), 8-11.
- Donaldson, G. (1992). The chaotic behavior of resting human respiration. *Respiratory physiology*, *88*, 313-321.
- Livermore, N., Butler, J., Sharpe, L., McBain, R., Gandevia, S., & McKenzie, D. (2008). Panic attacks and perception of inspiratory resistive loads in chronic obstructive pulmonary disease. *American journal of respiratory and critical care medicine*, *178*, 7-12.
- O'Donnell, D., Banzett, R., Carrieri-Kohlman, V., Casaburi, R., Davenport, P., Gandevia, S., et al. (2007). Pathophysiology of dyspnea in chronic obstructive pulmonary disease. *Proceeds of the American Thoracic Society*, *4*, 145-168.
- Orsillo, S., Roemer, L., & Holowka, D. (2005). Acceptance-based behavioral therapies for anxiety: using acceptance and mindfulness to enhance traditional cognitive-behavioral approaches. In *Acceptance and mindfulness based approaches to anxiety* (pp. 3-35). New York, N.Y., U.S.A.: Springer science and business media.
- Pei-Ying, S., & Davenport, P. (2010). The role of nicotine on respiratory sensory gating measured by respiratory related evoked potentials. *Journal of applied physiology*, *108*, 662-669.
- Peng, C., Mietus, J., Liu, Y., Lee, C., Hausdorff, J., Stanley, H., et al. (2002). Quantifying fractional dynamics on human respiration; age and gender effects. *Annals of Biomedical Engineering*, *30* (15), 683.
- Rafferty, G. F., & Gardner, W. N. (1996). Control of the respiratory cycle in conscious humans. *Journal of Applied Physiology*, *81* (4), 1744.

- Ries, A., Bauldoff, G., Carlin, B., Casaburi, R., Emery, C., Mahler, D., et al. (2007). Pulmonary rehabilitation. *Chest*, 131 (5), 4S-42S.
- Spicuzza, L., Gabutti, A., Porta, C., Montano, N., & Bernardi, L. (2000). Yoga and chemoreflex response to hypoxia and hypercapnea. *Lancet*, 356, 1495.
- Unkown. (1999). Dyspnea. mechanisms, assessment, and management: A consensus statement: American Thoracic Society. *American journal of respiratory and critical care*, 159 (1), 321.
- Villien, F., Yu, M., Barthelemy, P., & Jammes, Y. (2005). Training to yoga respiration selectively increases respiratory sensation in healthy man. *Respiratory physiology and neurobiology*, 146, 85-96.
- Wallace, R., Benson, H., & Wilson, A. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology*, 221 (3), 795.
- Wienthes, C., Grossman, P., & Gaillard, A. (1998b). Influence of drive and timing mechanisms on breathing pattern and ventilation during mental task performance. *Biological Psychology*, 49, 53-70.
- Wolkove, N., Kreisman, H., Darragh, D., Cohen, C., & Frank, H. (1984). Effect of transcendental meditation on breathing and respiratory control. *Journal of applied physiology: respiratory, environmental and exercise physiology*, 56 (3), 607.
- ZuWallack, R. (2007). How are you doing? What are you Doing? Differing perspectives in the assessment of individuals with COPD. *Journal of chronic obstructive pulmonary disease*, 4, 293-297.

Chapter II

Meditation interventions for Chronic Disease populations: MBSR and beyond: A structure review

The western health care system has embraced meditation as an intervention having potential preventative and restorative health benefits for people with chronic disease. Approximately 133 million Americans have been diagnosed with at least one chronic disease as of 2005 resulting in premature loss of life and sky rocketing health care costs (National Center for Chronic Disease Prevention and Health Promotion, 2005). Adding to this burden we find that persons with chronic disease are often diagnosed with anxiety and depression that worsens morbidity and impedes rehabilitation efforts (Giardino, et al., 2010). There is strong evidence that meditation programs decrease both anxiety and depression in health populations (Vollestad, Nielsen, & Neilsen, 2012). Researchers have also found that meditation improves cognitive function, emotional maturity and positive feelings and decreases acute medical symptoms (Kim, Kim, Park, Lee, & Lee, 2002; Cheung, Han, & Chan, 2008; Lutz, Greischar, Ricard, & Davidson, 2004; Arias, Steinberg, Banga, & Trestman, 2006). All of

these benefits may enable full and sustained participation in rehabilitation activities for persons with chronic disease.

Meditation is a complex intervention with multiple skill sets each with different levels of complexity and focus (Lutz, Brefczynski, Johnstone, & Davidson, 2008), taught by a single mediation teacher to develop the overall trait of mindfulness which is necessary to establish optimal mental, physical and spiritual health. Meditation is composed of three skills, exclusive attentional skills, inclusive attentional skills and body/mind awareness through movement. The two attentional meditation skills are a self-regulation of attention to an exclusive foci and self-regulation of inclusionary attention to the shifting background of one's internal or external environment (Delmonte, 1989; Bishop, 2008; Shapiro, Carlson, Astin, & Freedman, 2006). Both of these attentional skills are accomplished through the use of a self-guided state of relaxed logic or suspension of belief (Bond, et al., 2009). These two attentional skills are traditionally combined with the skill of mindful movement. The skill of mindful movement combines the attentional skills with body movement to promote interceptive awareness, flexibility, increased circulation and proprioception (e.g. Tai Chi, Qi Gong and yoga).

Systematic reviews have been published about the effects of meditation on chronic illness. Two included only Mindfulness-Based Stress Reduction (MBSR) (Grossman, Niemann, & Walach, 2004; Merkes, 2010). The third review included studies involving multiple meditation styles (Arias, Steinberg, Banga, & Trestman,

2006). In a meta-analysis of randomized controlled studies of MBSR, Grossman and colleagues found a reduction in physical symptoms ($P < 0.00$) with an effect size of $d = 0.53$ (2004). In a more recent review of MBSR, Merkes included all studies regardless of research design and concluded that participation in a MBSR program was associated with improved coping with chronic disease, higher quality of life and enhanced health outcomes (Merkes, 2010). Arias and colleagues included randomized controlled trials of many types of meditation interventions; mindfulness, relaxation response, yoga, and specific forms of meditation such as Sahaja and Transcendental meditation. The authors identified the specific meditation technique for each intervention, the authenticity of the technique and whether the relaxation response as defined by Herbert Benson (Benson, 1975) could be identified as a mechanism of action. Without comparing the different meditation techniques, this review concluded that meditation in general was safe and significantly reduced symptoms for persons with medical disease (Arias, Steinberg, Banga, & Trestman, 2006).

There is evidence to suggest that each meditation skill has a distinct and identifiable neurological mechanism (Dunn, Hartigan, & Mikulas, 1999). Mantra meditation (exclusive attention to a specific object) activates and develops the anterior cingulate cortex allowing beginning practitioners to develop a greater ability to maintain focus and attention through the development of “top-down” neurological processing (Hotzel, Lazar, Gard, Schuman-Olivier, Vago, & Ott, 2011; Hotzel, et al., 2007; Jhal, Krompinger, & Baime, 2007; Slater, et al., 2007; van Leeuwen, Singer, & Mellon, 2012). Development of increased exclusive attention

is necessary in order to advance to other meditation skills such as unfocused concentrative meditation (Hotzel, Lazar, Gard, Schuman-Olivier, Vago, & Ott, 2011; Maupin, 1965). However, it is often used singularly as in Benson's relaxation response (Benson, 1975), mantra-based meditation interventions (Rajesh, Jayachandran, Mohandas, & Radhakreishnan, 2006; Curiati, et al., 2005; Rajesh, Jayachandran, Mohandas, & Radhakreishnan, 2006) and compassionate or loving-kindness meditations (Fredrickson, Coffey, Pek, Cohn, & Finkel, 2009; Salzberg S. , 2002).

The second skill of meditation, inclusive attention is most often described as a shift in neurological function that occurs when attention is no longer brought back to a single focal point but is allowed to shift from one focal point to another in turn (Delevoye-Turrell & Bobineau, 2012; Telles, Raghavendra, Naveen, Namjunath, Kumar, & Subramanya, 2012). Practicing inclusive attention develops the skill of non-habitual division of attentional awareness among all sources of stimulation (Dunn, Hartigan, & Mikulas, 1999). The therapeutic goal of practicing inclusive attention is to increase awareness of feelings, sensations and surroundings including negative sensations (Baer, 2003). Research on inclusive meditation demonstrated increased neurological density in the medulla (Vestergaard-Poulsen, et al., 2009), reduced reactivity to external signals (Van den Hurk, Janssen, Giommi, Barendregt, & Gielen, 2010) and internal signals (Perlman, Salomons, Davidson, & Lutz, 2010) resulting in improved processing of physical sensations or whole body awareness.

Originally, mindful movement was not seen as a necessary part of developing a practice of meditation. Kabat-Zinn included gentle yoga in MBSR in order to gently return function to muscles and joints previously unused due to pain (Kabat-Zinn, 1982). However, researchers now understand that physical movement combined with mindful awareness improves flexibility and increases body awareness. Using movement in this manner is truer to the original purpose of body-centered practice in meditation teaching and introduces the eastern concept of the mind in the body (Kerr, 2002). This led some researchers to reframe how they use yoga and to embrace QiGong and Tai Chi as a new form of exercise identified as “meditative movement” (Larkey, Jahnke, Etneir, & Gonzalez, 2009). Current research demonstrates that mindful movement increased somatic awareness and improved proprioception (Wolf, Barnhart, Kutner, McNeely, Coogler, & Xu, 2003). It is thought that the addition of mindful movement, leading to increased body awareness, allows persons with chronic disease to identify more positively with their body leading to increased activity and quality of life (Wang, Collet, & Lau, 2004).

Meditation has been shown to decrease anxiety and depression in healthy persons and persons with clinically significant anxiety and depression (Young, Cappola, & Blaine, 2009). It was also seen to impact the autonomic nervous system and the immune system positively impacting the physiological trajectory of disease (Kabat-Zinn, 1982). For this review we focused on the outcomes of anxiety, depression and chronic disease symptoms. Meditation is a new intervention for persons with chronic disease and a well-established intervention

for use in health care settings has not clearly been identified. Along with the few studies that strictly applied the MBSR protocol, there are other studies that modified MBSR or used a unique meditation intervention. Appropriate to a new area of research, many of the studies involving unique interventions did not use randomized controlled research protocols. Because meditation for persons with chronic disease includes a variety of different meditation interventions with few studies using randomized controlled research designs, we reviewed experimental, quasi-experimental research with all types of meditation interventions for persons with chronic disease.

Methods

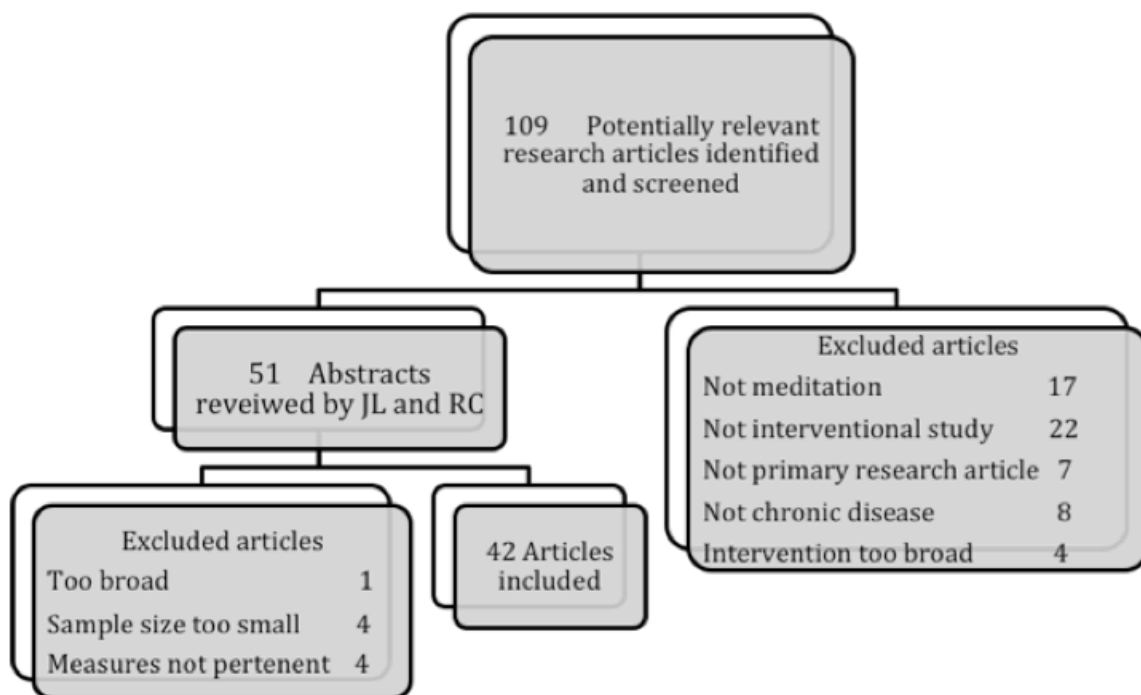
Search strategy

A systematic search was conducted of research published between 1960 and 2012 in three databases: CINAHL, PsycINFO and MEDLINE/PubMed. We used the following search terms; “meditation”, “mindfulness”, “compassion”, “loving-kindness”, “internal QiGong”, and “relaxation response”. We combined each interventional term with terms related to chronic disease; “CHF”, chronic heart failure”, “COPD”, “chronic obstructive pulmonary disease”, “chronic disease”, “chronic pain”, “back pain”, “multiple sclerosis”, “Crohn’s disease”, “arthritis”, “HIV”, “chronic fatigue syndrome”, and “fibromyalgia”. We excluded studies focusing on cancer.

We included studies if meditation was identified as the single or primary component of a multi-component mind/body intervention. All studies were

written in English, published in a peer-reviewed journal and reported one or more of the following outcome measures, anxiety, depression, or chronic disease symptoms. We included both experimental and quasi-experimental research designs. We excluded studies if the sample size was fewer than 15 or if other significant components were added to the intervention such as nutritional changes or active therapy like massage or acupuncture. The search produced 183 abstracts that included 3 meta-analysis articles, 11 review articles and 109 research articles. A review of the abstracts identified 42 original research articles that met the inclusion criteria (see figure 2.1).

Figure 2.1: Article review



Intervention Design and content

We categorized interventions based on the meditation skills they included. Interventions that used MBSR as the meditation intervention included all three meditation skills. Some studies modified the MBSR intervention by adding educational information or activities to address specific chronic disease group needs. Some meditation interventions included all three meditation skills but did not reference MBSR and based their intervention on different specific meditation styles. For this reason there are three meditation intervention categories that include all three meditation skills: MBSR, Modified MBSR and Exclusive/Inclusive/Movement. The remaining four categories are self-explanatory and identified by the specific meditation skill that is included in the meditation intervention. Categories were as follows: 1) MBSR, 2) Modified MBSR, 3) Exclusive meditation/inclusive meditation/movement, 4) Exclusive meditation/movement 5) Exclusive meditation/Inclusive meditation 6) Exclusive meditation and 7) Inclusive meditation.

Interventional consistency

We assessed interventional consistency and competency of the teachers for each research study. Quality meditation interventions have clear learning objectives based on theory and science, a method to promote consistent teaching between groups and trained teachers with a history of personal meditation experience. The Mindfulness Based Stress Reduction intervention developed by Kabat-Zinn at the University of Massachusetts addressed these problems through

a structured course outline, structured classroom materials and specific teacher training that includes a documented and supported personal meditation practice. As noted, the use of mediation as an intervention for persons with chronic disease has led to the individualization of meditation interventions, making it necessary to document the intervention standardization and the meditation instructor’s understanding, experience and training for each intervention employed (Salzberg S. , 1995). In order to assess the quality of the meditation intervention a checklist of six necessary characteristics was developed. The first two questions assess the theoretical basis of the meditation intervention and the last four address the reliability of the intervention (see Table 2.1).

Table 2.1: Intervention rating form

Necessary characteristics	✓ if present
Documented adherence to system or stated clear rationale for changes made to system	
Manual	
Meditation teacher training	
Meditation teacher experience	
Fidelity checks between teachers or classes	
Total	

Research quality

Research quality ratings were based on the Johns Hopkins University evidence rating scales. There are two components to this quality measure. The first component is based on research design and has three ratings (Levels I - III).

The first level contains randomized controlled trials, the second level contains all quasi-experimental trials with manipulation of an independent variable however lacks randomization or control group. The third level contains non-experimental studies and qualitative research.

The second component is research trial quality, which has three levels, (Level A, Level B and Level C). Level A research demonstrates sufficient sample size, adequate control and definitive conclusions along with a thoughtful literature review with reference to scientific evidence. Level B research demonstrates sufficient sample size and definitive conclusion with some control and a fairly comprehensive literature review. Level C represents research of low quality that demonstrates insufficient sample size, no control, and inconsistent results or little evidence. Thus, each study rated receives a I, II or III and a letter grade of A, B or C (Newhouse, Dearholt, Pugh, & White, 2005).

Results

Most studies (24/42) were based on MBSR. Seventeen did not vary from the MBSR framework. Seven were based on the MBSR framework and included all three meditation skills but added components to the intervention such as disease specific education. Some of the modified MBSR interventions added specific mindful movement skills to accommodate changes due to chronic disease. Five meditation interventions were identified that contained all three skills without mention of MBSR that were included in the category of “Exclusive meditation/Inclusive meditation/movement”. The remaining categories are self-

explanatory and reflect the meditation skills that were included in the meditation intervention (see Table 2.2).

Table 2.2: Meditation interventions by categories

Meditation interventions	Count
MBSR	17
Modified MBSR	7
Exclusive meditation/Inclusive meditation/movement	5
Exclusive meditation/movement	2
Exclusive meditation/Inclusive meditation	2
Exclusive meditation	4
Inclusive mediation	5

Intervention consistency

Overall, the interventions were primarily based on known meditation interventions, such as MBSR, Transcendental meditation or compassionate meditation traditions (38 out of 42) with more than half documenting adherence to the system identified and/or clear rationale for deviation from the system identified (25 out of 42). Two-thirds of the studies documented teacher training and experience, very few (10 out of 42) documented the use of a teaching manual and four included documented use of a system of fidelity checks between teachers or classes (see Table 2.3).

Meditation interventions	Research Quality Ratings (0 =lowest - 6 = highest)							
	0	1	2	3	4	5	6	
MBSR		1	2	3	7	3	1	
Modified MBSR			1	1	4		1	
Exclusive/Inclusive/Movement	1	1	2		1			
Exclusive/Movement					1	1		
Exclusive/Inclusive	1		1					
Exclusive		1		1	1		1	
Inclusive		2	1	1	1			

Research quality

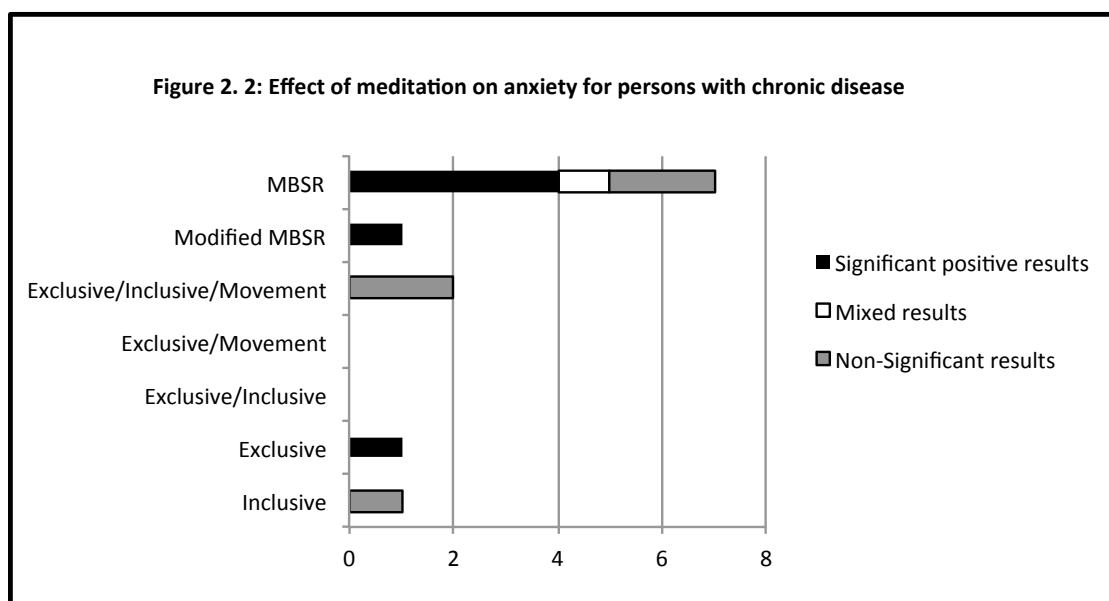
Half of the studies used a randomized controlled design (21/42) resulting in a level I rating. Of the 21 studies that used a randomized controlled design almost half used an active control group as opposed to a wait list or treatment as usual design (9/21). Randomized controlled trials were conducted in each category of meditation intervention except the category of Exclusive/Movement (see Table 2.4).

Meditation interventions	Research Quality Ratings (IA = highest - IIC = lowest)					
	IA	IB	IC	IIA	IIB	IIC
MBSR	5	1	1		9	1
Modified MBSR	4	1			2	
Exclusive/Inclusive/Movement	1				4	
Exclusive/Movement					2	
Exclusive/Inclusive	2					
Exclusive	1	2		1		
Inclusive	1	1	1	1	1	

Anxiety

The measure of anxiety used most frequently was the State Trait Anxiety Index (STAI) and the Symptom Check List-90 (SCL-90). Others included the Brief Symptom Inventory (BSI), the Mental Health Index (MHI), the Depression, Anxiety and Positive Outlook Scale (DAPOS) and the Hospital Anxiety and Depression Scale (HADS). In the 12 studies that targeted anxiety, six demonstrated significant improvement in anxiety, five reported no significant changes in anxiety and one reported mixed results (see Table 2.2). The meditation intervention that used only inclusive meditation was not effective in reducing anxiety (Sadlier, Stephens, & Kennedy, 2008) while programs that included exclusive meditation showed significant improvements in anxiety (Carson, et al., 2005; Gross, et al., 2010; Grossman, et al., 2010). A review of studies by chronic disease revealed that meditation significantly reduced anxiety for people after organ transplant (Gross, et al., 2010), for those with multiple sclerosis (Gross, et al., 2010). It also reduced anxiety in a study involving subjects with various chronic diseases (Simpson & Mapel, 2011). Results were mixed for persons with chronic pain. A single study reported both positive and non-significant results for anxiety in persons with chronic pain. Rosenzweig and colleagues found anxiety lowered in those with a variety of chronic pain issues except for those with Fibromyalgia (Rosenzweig, Greeson, Reibel, Green, Jasser, & Beasley, 2010). Other studies that did not show a significant reduction in anxiety involved subjects with HIV/AIDs (Brazier, Mulkins, & Verhoef, 2006) and tinnitus (Sadlier, Stephens, & Kennedy, 2008).

Comparisons of the studies that did and did not significantly reduce anxiety reveal similar research quality ratings. However we found that studies demonstrating significant reduction in anxiety had higher interventional consistency ratings (3 to 6) as opposed to studies that did not show an improvement in anxiety (1 to 4). Of the studies that measured the effect of meditation on anxiety all but two used an eight-week long meditation intervention. One study involved a 15-day in-patient program followed by 12 weekly outpatient meditation classes (Brazier, Mulkins, & Verhoef, 2006) and one involved a four-week program (Sadlier, Stephens, & Kennedy, 2008).



Depression

The ability of a meditation intervention to affect depression in the chronic disease population was measured in 26 studies. A great variety of depression scales were employed with close to half of the studies using either the Center or Epidemiologic Studies for Depression Scale (CES-D; 6/26) or the Beck Depression

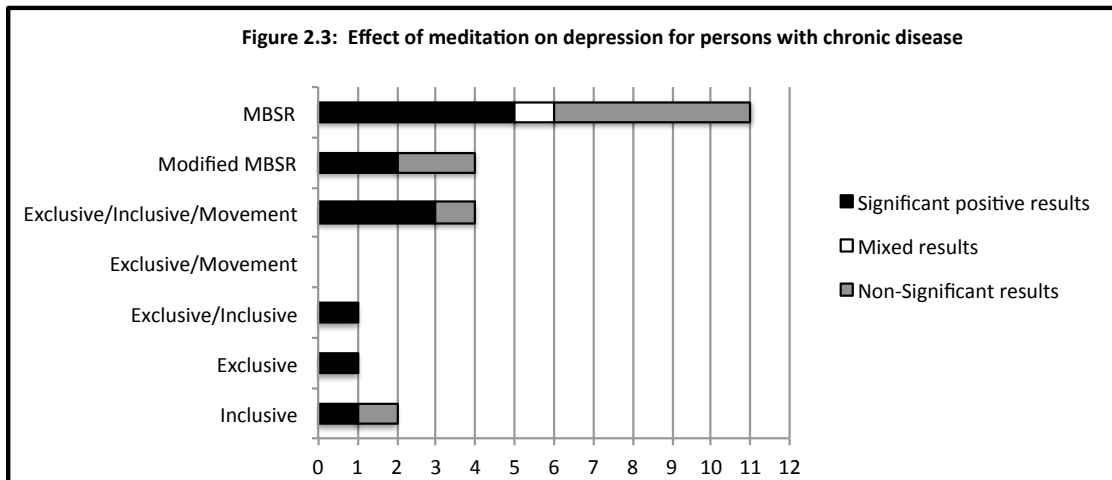
Inventory (BDI; 6/26). The next most common measure for depression was the Symptom Check-List 90 (SCL-90). Other individual studies used the Hospital Anxiety and Depression scale (HADS), Brief Symptom Inventory (BSI), Depression Anxiety and Stress Scale (DASS), Mental Health Inventory (MHI), Q Depression Scale (Q9) and the Inventory of Depressive Symptoms.

Thirteen out of 23 studies found a significant decline in depressive symptoms. Nine found no benefit and one showed mixed results (see Table 2.3). An examination of the studies by disease category indicated a significant reduction in depression in a broad range of diagnosis including epilepsy (Rajesh, Jayachandran, Mohandas, & Radhakrishnan, 2006), diabetes (Rungreangkulkij, Wongtakee, & Thongyot, 2011), multiple sclerosis (Grossman, et al., 2010), chronic heart disease (Jayadevappa, et al., 2007) and various chronic pain conditions (Cusens, Duggan, Thorne, & Burch, 2010).

There were conflicting results for subjects with chronic pain. Five studies did not demonstrate significant reduction in depression in subjects with a variety of chronic pain conditions (Fox, Flynn, & Allen, 2011; Lush, Salmon, Floyd, Studts, Weissbecker, & Sephton, 2009; Pradhan, et al., 2007; Wong, et al., 2011; Schmidt, Grossman, Schwarzer, Jena, Naumann, & Walach, 2010). As with anxiety, Rosenzweig and colleagues demonstrated significant improvement in some groups but not with others. Meditation significantly reduced depression in persons with back/neck pain, arthritis and co-morbid pain but not in subjects with headache/migraine pain or fibromyalgia (Rosenzweig, Greeson, Reibel,

Green, Jasser, & Beasley, 2010). In two studies, depression was not significantly decreased in subjects with HIV/AIDs (Duncan, Moskowitz, Neilands, Dilworth, Hecht, & Johnson, 2012; Brazier, Mulkins, & Verhoef, 2006) nor was it significantly reduced in subjects with tinnitus (Sadler, Stephens, & Kennedy, 2008) or after organ transplant (Gross, et al., 2010).

There were no differences in research design quality or meditation intervention quality between those studies that were successful in reducing depression and those that were not successful. Eighteen out of the 26 studies that targeted depression used an eight-week long weekly meditation class intervention. Variations from the eight-week program did not appear to impact success in reducing depression. In terms of meditation intervention style, we found a variety of meditation programs significantly improved depression.



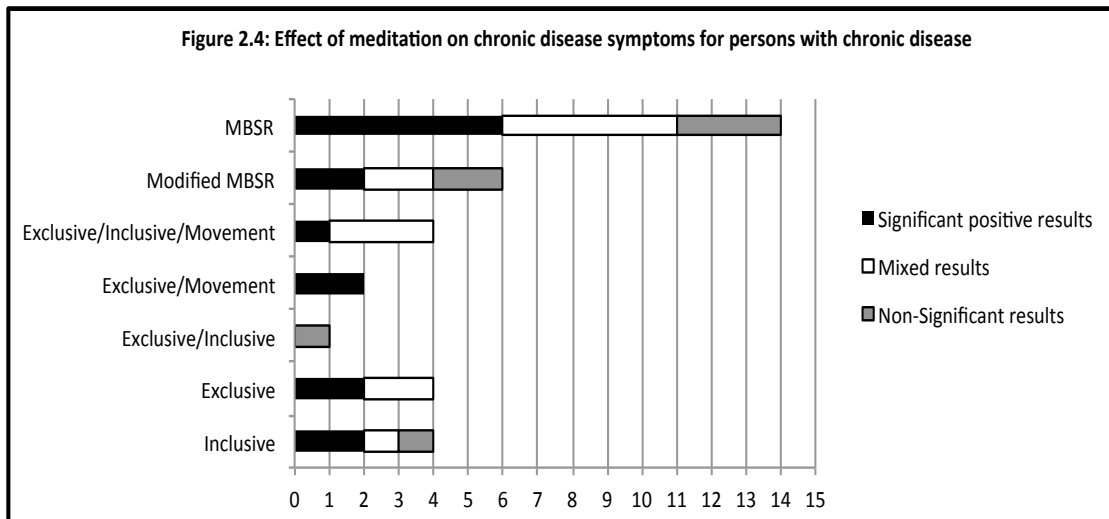
Physical symptoms

Most studies targeted chronic disease symptoms (35 out of 42). Fifteen observed significant improvement in chronic disease symptom measures and 7

indicated no improvement. Most researchers measured more than one chronic disease symptom thus 13 studies reported both significant and non-significant results (see Table 2.4). Meditation reduced chronic disease symptoms for subjects with epilepsy (Rajesh, Jayachandran, Mohandas, & Radhakreishnan, 2006), multiple sclerosis and peripheral neuropathy (Tavee, Rensel, Planchon, Butler, & Stone, 2011) and tinnitus (Sadlier, Stephens, & Kennedy, 2008). For all other chronic disease categories we found both positive and negative results. In some studies that report mixed results, improvement was seen in perception or acceptance of a specific chronic disease symptom while the symptom itself did not decrease (Cusens, Duggan, Thorne, & Burch, 2010; Gross, et al., 2010; Rosenzweig, Greeson, Reibel, Green, Jasser, & Beasley, 2010; Morone, Rollman, Moore, Li, & Weiner, 2009). Yet in other studies that report mixed results, there was improvement in one chronic disease symptom and not for another chronic disease symptom (Rosenzweig, et al., 2007; Robinson, Mathews, & Witek-Janusek, 20003; Creamer, Singh, Hochberg, & Berman, 2000; Chang, Zhao, LoCastro, & Slawsky, 2005; Jayadevappa, et al., 2007; Curiati, et al., 2005).

A review of meditation intervention ratings indicated slightly higher quality ratings for those studies with positive results as opposed to those with mixed or negative results. Research quality, on the other hand did not appear to correlate with results. All but three studies measuring the impact of meditation on chronic disease symptoms used meditation interventions that were eight weeks or longer. Only three studies used shorter meditation interventions, one reporting significant improvements (Sadlier, Stephens, & Kennedy, 2008) one

reporting mixed results (Jayadevappa, et al., 2007), and one reporting negative results (Teixeira, 2010). It is important to note that one study reporting mixed results found that only those subjects identified as having recurrent depression showed improvements in chronic disease symptoms as opposed to those subjects who did not demonstrate recurrent depression (Zautra, et al., 2008)



Discussion

This review of meditation interventions for persons with chronic disease revealed that 33 studies (33/42) found significant improvement in anxiety, depression or chronic illness symptoms, whereas nine (9/42) studies did not demonstrate significant improvement in any of these areas. Improvement in

physical symptoms did not necessarily occur simultaneously with an improvement in either anxiety or depression. However, in those studies that analyzed both anxiety and depression we found that in most of these studies, anxiety and depression either simultaneously improved or simultaneously failed to improve. The bulk of the evidence suggests that meditation interventions can significantly improve depression, anxiety and/or chronic illness symptoms in persons with chronic disease.

Although meditation promoted significant improvement in anxiety, depression and chronic disease symptoms in persons with chronic disease the results were not consistent within specific chronic disease categories. It may be then that the affects of meditation on persons with chronic disease have more to do with other variables such as, personality traits of the individual subject, the skill level of the meditation teacher or the dose level of the intervention. Persons with chronic disease often have a large burden of self-care in order to maintain an acceptable level of quality of life. An intervention that does not fit within their activities of daily living and align with their values and belief system will not be maintained over time.

Individual personality traits such as anxiety, problems with interpersonal skills and an inability to feel comfortable with new ideas interfere with a person's ability to meditate. People with high anxiety often attempt meditation but are frequently not a successful (Delmonte, 1984). Anxiety can also limit the meditation experience. Persons with anxiety who are able to meditate tend to

experience only the relaxation response as opposed to others who achieve a significant level of internalized attention generated by mindfulness practices (Murata, et al., 2004). Further, persons who have difficult interpersonal relationships in terms of healthy attachment will also have difficulty practicing mindfulness (Shaver, Lavy, Saron, & Mikulincer, 2007). In a large cross-sectional survey, people more likely to participate in a 10-day meditation retreat for treatment of chronic disease symptoms were college educated, female, with high pain and symptoms of disease and retired or not working (Goyal, et al., 2010). Perhaps as suggested by Shaver and traditional spiritual meditation experts, one must advance slowly toward the skill of mindfulness through the development of single concentration meditation and the concept of compassion for self and others (Shaver, Lavy, Saron, & Mikulincer, 2007; Lama, 2001; Salzberg S. , 2002).

Differences between meditation teachers will impact the efficacy of a meditation intervention and may explain those studies with mixed results. Pradham and colleagues had statistically significant improvement in depressive symptoms and psychological distress in one cohort and not in another that was taught by a different teacher (Pradhan, et al., 2007). Kabat-Zinn found differences in the improvement in three individual cohorts although he does not specify whether the teachers were different (Kabit-Zinn, 1982). In both of these studies, the full MBSR program was used and teachers were trained similarly. However, in the Pradhan study, the cohort with sustained significant results over 6 months was led by the most experienced teacher/practitioner (Pradhan, et al.,

2007). In addition one must consider the characteristic of the setting where the group meets and the interaction effect between teacher and group.

Traditionally, meditation students are allowed to learn meditation skills in a time frame that is individualized to each individual student. This allows them to progress from simple to complex meditation skills, as they are ready. Limiting a meditation intervention to the same time frame for all participants may not provide an effective dose of the intervention some while providing unnecessary time for others. This may affect the observed outcomes. Most of the papers examined the effects of eight-week long meditation interventions regardless of the meditation intervention skill content (29/42). The remaining meditation interventions varied a great deal with two studies investigating single sessions interventions (Coleman, 2011; Teixeira, 2010) and one studying a 15-day in-patient intervention that was followed by four months of weekly meetings (Brazier, Mulkins, & Verhoef, 2006). Several studies also had some form of follow-up to encourage study participants to continue home practice (Brazier, Mulkins, & Verhoef, 2006; Teixeira, 2010; Pradhan, et al., 2007). Kabat-Zinn and colleagues developed a follow-up meditation class for those interested in continuing with the classes after the original 10-week course (Kabat-Zinn, 1982). The follow-up classes were free flowing allowing participants to discuss their meditation experience without teaching additional meditation skills and demonstrated continued improvement for those attending these sessions (Kabat-Zinn, Lipworth, & Burney, 1985).

Interestingly, there were five studies that demonstrated non-significant results immediately post intervention and demonstrated statistically significant outcomes at later follow-up, perhaps signaling the need for longer interventions or longer periods of support necessary to develop the skill of meditation and then translate that skill into measurable results (Creamer, Singh, Hochberg, & Berman, 2000; Coleman, 2011; Pradhan, et al., 2007; Rosenzweig, et al., 2007; Rosenzweig, et al., 2007; Sephton, et al., 2007).

Future research

Meditations inherent complexity will always be both a stumbling block and source of creativity. Acknowledging the distinct physiological mechanisms and outcomes that exclusive meditation, inclusive meditation and mindful movement bring to the meditation intervention will allow health care providers to develop interventions that will meet chronic disease patient group's needs. Perhaps we can learn from the original teachers of meditation and apply meditation interventions for the persons with chronic disease while focusing on individual needs by selecting the correct skill and timing of teaching that skill based on best practice evidence. Researchers also have to address this complexity issue by providing clear descriptions of meditation interventions used, teacher training and experience, manuals and fidelity checks and employ rigorous research design.

Bibliography

- Abrams, K., Dorflinger, L., Zvolensky, M., Galatix, A., Blank, M., & Eissenberg, T. (2008). Fear reactivity to bodily sensations among heavy smokers and non smokers. *Experimental and clinical psychopharmacology*, 16 (3), 230-239.
- Allison, J. (1970). Respiratory changes during transcendental meditaiton. *Lancet*, 1, 833.
- Arias, A., Steinberg, K., Banga, A., & Trestman, R. (2006). Systematic review of the efficacy of meditatin techniques as treatments for medical illness. *The journal of alternative and comlementary medicine*, 12 (8), 817-832.
- Astin, J., Berman, B., Bausell, B., Lee, W., Hochberg, M., & Forys, K. (2003). The efficacy of mindfulness meditation plus Qigong movement therapy in the treatment of fibromyalgia: a ramdom contorlled trial. *The journal of rheumatology*, 30 (10), 2257-2262.
- Baer, R. (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clinical psychology Science and Practice*, 10 (2), 125-143.
- Benson, H. (1975). *The Relaxation Response*. New York, New York: Morrow.
- Bernardi, L., Passino, C., Spaducini, G., Bonfichi, M., Arcaini, L., Malcovati, L., et al. (2007). Reduced hypoxic ventilatory response with preserved blook oxygenation in yoga trainees and himalayan Buddhist monks at altitude: evidence of a different adaptive strategy? *European Journal of Applied Physiology*, 99, 511-518.
- Bishop, S. (2008). Neuroal mechanisms underlying selective attention to threat. *Annals of the New york Academy of Sciences*, 1129, 141-152.
- Bond, K., Ospina, M., Hooton, N., Bialy, L., Dryden, D., Buscemi, N., et al. (2009). Defining a complex intervention: The development of demarcatin criteria for "Meditation". *Psychology of Religion and Spirituality*, 1 (2), 129-137.
- Brazier, A., Mulkins, A., & Verhoef, M. (2006). Evaluating a yogic breathing and meditation intervention for individuals living with HIV/AIDS. *American journal of health promotion*, 20 (3), 192-195.
- Carson, J., Keefe, F., Lynch, T., Carson, K., Goli, V., Fras, A., et al. (2005). Loving-Kindness meditaiton for chronic low back pain: results from a pilot trial. *Journal of Holistic nursing*, 23, 287.
- Caspi, O., & Burleson, K. (2005). Methodological challenges in meditation research. *Advances in mind-body medicine*, 21 (1), 4-11.

- Chang, A., Zhao, Y., LoCastro, J., & Slawsky, M. (2005). A relaxation response randomized trial on patients with chronic heart failure. *Journal of Cardiopulmonary Rehabilitation* , 25 (3), 149-57.
- Cheung, M., Han, Y., & Chan, A. (2008). Electroencephalographic (EEG) measurements of mindfulness-based triarchic body-pathway relaxation technique: A pilot study. *Applied Psychophysiology and Biofeedback* , 33 (1), 39.
- Chiesa, A., & Serretti, A. (2010). A systematic review of neurobiological and clinical features of mindfulness meditations. *Psychological Medicine* , 40 (8), 1239.
- Cho, S., Heiby, E., McCracken, L., Lee, S., & Moon, D. (2010). Pain-related anxiety as a mediator of the effects of mindfulness on physical and psychosocial functioning in chronic pain patients in Korea. *The Journal of Pain* , 11 (8), 789-797.
- Coleman, J. (2011). Spring forest QiGong and chronic pain: Making a difference. *Journal of Holistic Nursing* , 29, 118-127.
- Creamer, P., Singh, B., Hochberg, M., & Berman, B. (2000). Sustained improvement produced by nonpharmacologic intervention in fibromyalgia: Results of a pilot study. *Arthritis care and research* , 13 (4), 198-204.
- Curiati, J., Bocchi, E., Freire, J., Arantes, A., Braga, M., Barcia, Y., et al. (2005). Meditation reduces sympathetic activation and improves the quality of life in elderly patients with optimally treated heart failure: A prospective randomized study. *The journal of alternative and complementary medicine* , 11 (3), 465-472.
- Cusens, B., Duggan, G., Thorne, K., & Burch, V. (2010). Evaluation of the Breathworks mindfulness-based pain management programme: Effects on well-being and multiple measures of mindfulness. *Clinical psychology and psychotherapy* , 17, 63-78.
- Davidson, R. (2010). Empirical explorations of mindfulness: Conceptual and Methodological conundrums. *Emotion* , 10 (8), 8-11.
- Delevoye-Turrell, Y., & Bobineau, C. (2012). Motor consciousness during intertino-based and stimulus based actions: Modulating attention resources through mindfulness meditation. *Frontiers in Psychology* , 3, 290.
- Delmonte, M. (1984). Factors influencing the regularity of meditation practice in a clinical population. *British journal of medical psychology* , 57, 275-278.
- Delmonte, M. (1989). Meditation, the unconscious and psychosomatic disorders. *International journal of psychosomatics* , 36 (1-4), 45-56.
- Dobkin, P., & Zhao, Q. (2011). Increase mindfulness-The active component of the mindfulness-based stress reduction program? *Complementay therapies in clinical practice* , 17, 22-27.

- Donaldson, G. (1992). The chaotic behavior of resting human respiration. *Respiratory physiology*, 88, 313-321.
- Downey, L., Engelberg, R., Standish, L., Kozak, L., & Lafferty, W. (2009). Three lessons from a randomized trial of massage and meditation at end of life: Patient benefit outcome measure selection and design of trials for terminally ill patients. *American journal of hospice and palliative medicine*, 26, 246-253.
- Duncan, L., Moskowitz, J., Neilands, T., Dilworth, S., Hecht, F., & Johnson, M. (2012). Mindfulness-Based stress reduction for HIV treatment side effects: A randomized, wait-list controlled trial. *Journal of Pain management*, 43 (2), 161.
- Dunn, R., Hartigan, J., & Mikulas, W. (1999). Concentration and mindfulness meditation: Unique forms of consciousness. *Applied psychophysiology and biofeedback*, 24 (3), 147.
- Foley, E., Baillie, A., Huxter, M., Price, M., & Sinclair, E. (2010). Mindfulness-based cognitive therapy for individuals whose lives have been affected by cancer: A randomized controlled trial. *Journal of consulting and clinical psychology*, 78 (1), 72-79.
- Fox, S., Flynn, E., & Allen, R. (2011). Mindfulness meditation for women with chronic pelvic pain A pilot study. *the journal of reproductive medicine*, 56 (3-4), 158-62.
- Fulambarker, A., Farooki, B., Kheir, F., Copur, A., Srinivasan, L., & Schultz, S. (2010). Effect of yoga in chronic obstructive pulmonary disease. *American journal of therapeutics*, 1-5.
- Giardino, N., Curtis, J., Abelson, J., King, A., Pamp, B., Liberzon, I., et al. (2010). The impact of panic disorder on interoception and dyspnea reports in chronic obstructive pulmonary disease. *Biological psychology*, 84, 142-146.
- Goldenberg, D., Kaplan, K., Nadeau, M., Brodeur, C., Smith, S., & Shid, C. (1994). A controlled study of a stress-reduction, cognitive-behavioural treatment program in fibromyalgia. *Journal of musculoskeletal pain*, 2 (2), 53.
- Goyal, M., Haythornthwaite, J., Levine, D., Becker, D., Valdy, D., Hills-Briggs, F., et al. (2010). Intensive meditation for refractory pain and symptoms. *The Journal of Alternative and complimentary medicine*, 16 (6), 627-631.
- Gross, C., Kreitzer, M., Thomas, W., Reilly-Spong, M., Cramer-Bornemann, M., Nyman, J., et al. (2010). Mindfulness-based stress reduction for solid organ transplant recipients: A randomized controlled trial. *Alternative therapies in health and medicine*, 16 (5), 30-38.
- Grossman, P. (2008). On measuring mindfulness in psychosomatic and psychological research. *Journal of psychosomatic research*, 64 (4), 405.

Grossman, P., Niemann, L., & Walach, H. (2004). Meta-analysis of mindfulness-based stress reduction. *Focus on alternative and complementary therapies*, 9 (4), 308-309.

Grossman, P., Tiefenthaler-Gilmer, U., Raysz, A., & Kesper, U. (2007). Mindfulness training as an intervention for fibromyalgia: Evidence of postintervention and 3-year follow-up benefits in well-being. *Psychotherapy and psychosomatics*, 76, 226-233.

Grossman, P., Kappos, L., Gensicke, H., D'Souza, M., Mohr, D., Penner, I., et al. (2010). MS quality of life, depression, and fatigue improve after mindfulness training. *Neurology*, 75, 1141-1149.

Hotzel, B., Lazar, S., Gard, T., Schuman-Olivier, Z., Vago, D., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on psychological science*, 6, 537.

Hotzel, B., Ott, U., Hempel, H., Hackl, A., Wolf, K., Stark, R., et al. (2007). Differential engagement of anterior cingulate and adjacent medial frontal cortex in adept meditators and non-meditators. *neuroscience letters*, 421, 16-21.

Jayadevappa, R., Johnson, J., Bloom, B., Nidich, S., Desai, S., Chhatre, S., et al. (2007). Effectiveness of transcendental meditation on functional capacity and quality of life of African Americans with congestive heart failure: A randomized control study. *Ethnicity and disease*, 17, 72-77.

Jhal, A., Krompinger, J., & Baime, M. (2007). Mindfulness training modifies subsystems of attention. *Cognitive affective behavioral neuroscience*, 7 (2), 109.

Kabat-Zinn, J., Lipworth, K., & Burney, R. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of behavioral medicine*, 8 (2), 163-189.

Kabat-Zinn, J. (1982). An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation. *General hospital psychiatry*, 4, 33-47.

Kerr, C. (2002). Translating "mind-in-body" two models of patient experience underlying a randomized controlled trial of qigong. *Culture medicine and psychiatry*, 26, 419-447.

Kim, Y., Kim, S., Park, S., Lee, S., & Lee, K. (2002). Changes in EEG of children during brain respiration-training. *The American Journal of Chinese Medicine*, 30 (2 and 3), 465.

Lama, T. D. (2001). *Stages of meditation*. (G. Jordhen, L. Ganchenpa, & J. Russell, Trans.) Boulder, Colorado, U.S.A.: Snow Lion Publications.

- Larkey, L., Jahnke, R., Etneir, J., & Gonzalez, J. (2009). Meditative movement as a category of exercise: Implications for research. *Journal of physical activity and health*, 6, 230-238.
- Livermore, N., Butler, J., Sharpe, L., McBain, R., Gandevia, S., & McKenzie, D. (2008). Panic attacks and perception of inspiratory resistive loads in chronic obstructive pulmonary disease. *American journal of respiratory and critical care medicine*, 178, 7-12.
- Lush, E., Salmon, P., Floyd, A., Studts, J., Weissbecker, I., & Sephton, S. (2009). Mindfulness meditation for symptom reduction in fibromyalgia: psychophysical correlates. *Journal of clinical psychological medical settings*, 16, 200-207.
- Lutz, A., Brefczynski, J., Johnstone, T., & Davidson, R. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PlosOne*, 3 (3), e1897.
- Lutz, A., Greischar, L., Ricard, M., & Davidson, R. (2004). Long-term meditators self-induced high-amplitude gamma synchrony during mental practice. *Proceedings of the National Academy of Sciences of the United States of America*, 101 (46), 16369.
- Majumdar, M., Grossman, P., Dietz-Waschkowski, B., Kersig, S., & Walach, H. (2002). Does mindfulness meditation contribute to health? Outcome evaluation of a German sample. *The journal of alternative and complementary medicine*, 8 (6), 719-730.
- Maupin, E. (1965). Individual difference in response to a zen meditation exercise. *Journal of consulting psychology*, 29 (2), 139-145.
- McCracken, L., & Keogh, E. (2009). Acceptance, mindfulness, and values-based action may counteract fear and avoidance of emotions in chronic pain: An analysis of anxiety sensitivity. *The journal of Pain*, 10 (4), 408-415.
- Merkes, M. (2010). Mindfulness-based stress reduction for people with chronic disease. *Australian journal of primary health*, 16, 200-210.
- Morone, N., Rollman, B., Moore, C., Li, Q., & Weiner, D. (2009). A mind-body program for older adults with chronic low back pain: results of a pilot study. *Pain Medicine*, 10 (8), 1395-1407.
- Mularski, R., Munjas, B., Lorenz, K., Sun, S., Robertson, S., Schmelzer, W., et al. (2009). Randomized controlled trial of mindfulness-based therapy for dyspnea in chronic obstructive lung disease. *The journal of alternative and complementary medicine*, 15 (6), 1083-1090.
- Murata, T., Takahashi, T., Hamada, M., Omon, M., Kosaka, H., Yoshida, H., et al. (2004). Individual trait anxiety levels characterizing the properties of Zen meditation. *Pharmacoelectroencephalography*, 50, 189-194.

- National Center for Chronic Disease Prevention and Health Promotion. (2005). *The power of prevention*. Retrieved 2012 йил 8-November from Centers for Disease Control: www.cdc.gov/chronicdisease/resources/publicationsindex.htm
- Newhouse, R., Dearholt, S., Pugh, L., & White, K. (2005). *The Johns Hopkins Nursing Evidence-based Practice Rating Scale*. Johns Hopkins University School of Nursing, Nursing. Baltimore: John Hopkins University.
- O'Donnell, D., Banzett, R., Carrieri-Kohlman, V., Casaburi, R., Davenport, P., Gandevia, S., et al. (2007). Pathophysiology of dyspnea in chronic obstructive pulmonary disease. *Proceeds of the American Thoracic Society*, 4, 145-168.
- Orsillo, S., Roemer, L., & Holowka, D. (2005). Acceptance-based behavioral therapies for anxiety: using acceptance and mindfulness to enhance traditional cognitive-behavioral approaches. In *Acceptance and mindfulness based approaches to anxiety* (pp. 3-35). New York, N.Y., U.S.A.: Springer science and business media.
- Ospina, M., Bond, K., Karkhaneh, M., Buscemi, N., Bryden, D., Barnes, V., et al. (2008). Clinical trials of meditation practices in health care: Characteristics and quality. *The journal of alternative and complementary medicine*, 14 (10), 1199-1213.
- Pei-Ying, S., & Davenport, P. (2010). The role of nicotine on respiratory sensory gating measured by respiratory related evoked potentials. *Journal of applied physiology*, 108, 662-669.
- Peng, C., Mietus, J., Liu, Y., Lee, C., Hausdorff, J., Stanley, H., et al. (2002). Quantifying fractional dynamics on human respiration; age and gender effects. *Annals of Biomedical Engineering*, 30 (15), 683.
- Perlman, D., Salomons, T., Davidson, R., & Lutz, A. (2010). Differential effects of pain intensity and unpleasantness of two meditation practices. *Emotion*, 10 (1), 65-71.
- Pradhan, E., Baumgarten, M., Langenberg, P., Handwerker, B., Gilpin, A., Magyari, T., et al. (2007). Effect of mindfulness-based stress reduction in rheumatoid arthritis patients. *Arthritis and rheumatism*, 57 (7), 1134-1142.
- Rafferty, G. F., & Gardner, W. N. (1996). Control of the respiratory cycle in conscious humans. *Journal of Applied Physiology*, 81 (4), 1744.
- Rajesh, B., Jayachandran, D., Mohandas, G., & Radhakrishnan, K. (2006). A pilot study of a yoga meditation protocol for patients with medically refractory epilepsy. *The journal of alternative and complementary medicine*, 12 (4), 367-371.
- Rapgay, L., & Bystricky, A. (2009). Classical Mindfulness: An introduction to its theory and practice for clinical application. *Longevity, regeneration and optimal health*, 1172, 148-162.

- Ries, A., Bauldoff, G., Carlin, B., Casaburi, R., Emery, C., Mahler, D., et al. (2007). Pulmonary rehabilitation. *Chest*, 131 (5), 4S-42S.
- Robinson, F., Mathews, H., & Witek-Janusek, L. (2003). Psycho-endocrine-immune response to mindfulness-based stress reduction in individuals infected with the human immunodeficiency virus: A quasiexperimental study. *The journal of alternative and complementary medicine*, 9 (5), 683-694.
- Rosenzweig, S., Greeson, J., Reibel, D., Green, J., Jasser, S., & Beasley, D. (2010). Mindfulness-based stress reduction for chronic pain conditions: Variation in treatment outcomes and role of home meditation practice. *Journal of psychosomatic research*, 68, 29-36.
- Rosenzweig, S., Reibel, D., Greeson, J., Edman, J., Jasser, S., McMearty, K., et al. (2007). Mindfulness-based stress reduction is associated with improved glycemic control in type 2 diabetes mellitus: A pilot study. *Alternative therapies in health and medicine*, 13 (5), 36-38.
- Rungreangkulkij, S., Wongtakee, W., & Thongyot, S. (2011). Buddhist group therapy for diabetes patients with depressive symptoms. *Archives of psychiatric nursing*, 25 (3), 195-205.
- Sadlier, M., Stephens, S., & Kennedy, V. (2008). Tinnitus rehabilitation: a mindfulness meditation cognitive behavioural therapy approach. *The journal of laryngology and otology*, 122, 31-37.
- Sagula, D., & Rice, K. (2004). The effectiveness of mindfulness training on the grieving process and emotional well-being of chronic pain patients. *Journal of clinical psychology in medical settings*, 11 (4), 333-341.
- Salzberg, S. (2002). *Lovingkindness: The revolutionary art of happiness*. Boston, MA, U.S.A.: Shambala Press.
- Salzberg, S. (1995). *The Revolutionary art of Happiness*. Boston, MA: Shambala press.
- Schmidt, S., Grossman, P., Schwarzer, B., Jena, S., Naumann, J., & Walach, H. (2010). Treating fibromyalgia with mindfulness-based stress reduction: Results from a 3-armed randomized trial. *Pain*, in press, 1-10.
- Sephton, S., Salmon, P., 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 and Rheumatism*, 57 (1), 77-85.
- Shapiro, S., Carlson, L., Astin, J., & Freedman, B. (2006). Mechanisms of mindfulness. *Journal of clinical psychology*, 62 (3), 373-386.

- Shaver, P., Lavy, S., Saron, C., & Mikulincer, M. (2007). Social foundations of the capacity for mindfulness: an attachment perspective. *Psychological Inquiry: An international journal for advancement of psychological theory*, 18 (4), 264-271.
- Simpson, J., & Mapel, T. (2011). An investigation into the health benefits of mindfulness-based stress reduction (MBSR) for people living with a range of chronic physical illnesses in New Zealand. *The New Zealand medical journal*, 124 (1338), 68-74.
- Singh, B., Berman, B., Hadhazy, V., & Creamer, P. (1998). A pilot study of cognitive behavioural therapy in fibromyalgia. *Alternative therapies*, 4 (2), 67-70.
- Slater, H., Lutz, A., Greischar, L., Francis, A., Nieuwenhuis, S., Davis, J., et al. (2007). Mental training affects distribution of limited brain resources. *PLoS Biology*, 5 (6), e138.
- Spicuzza, L., Gabutti, A., Porta, C., Montano, N., & Bernardi, L. (2000). Yoga and chemoreflex response to hypoxia and hypercapnea. *Lancet*, 356, 1495.
- Sullivan, M., Wood, L., Terry, J., Brantley, J., Charles, A., McGee, V., et al. (157 йил 84-90-1). The support, education, and research in chronic heart failure study (SEARCH): A mindfulness-based psychoeducational intervention improves depression and clinical symptoms in patients with chronic heart failure. *American heart Journal*.
- Tavee, J., Rensel, M., Planchon, S., Butler, R., & Stone, L. (2011). Effects of meditation on pain and quality of life in multiple sclerosis and peripheral neuropathy. *International journal of MS care*, 13, 163-168.
- Teixeira, E. (2010 йил September/October). The effect of mindfulness meditation of painful diabetic peripheral neuropathy in adults older than 50 years. *Holistic nursing practice*, 277-283.
- Telles, S., Raghavendra, B., Naveen, K., Namjunath, N., Kumar, S., & Subramanya, P. (2012). Changes in autonomic variables following two meditative states described in yoga texts. *Journal of Alternative and complementary medicine*, E Pub ahead of print.
- Unkown. (1999). Dyspnea. mechanisms, assessment, and management: A consensus statement: American Thoracic Society. *American journal of respiratory and critical care*, 159 (1), 321.
- Van den Hurk, P., Janssen, B., Gionmi, F., Barendregt, H., & Gielen, S. (2010). Mindfulness meditation associated with alterations in bottom-up processing: Psychophysiological evidence for reduced reactivity. *International Journal of Psychophysiology*, 1-7.

- van Leeuwen, S., Singer, W., & Mellon, L. (2012). Meditation increases depth of information processing and improves the allocation of attention in space. *Frontiers in human neuroscience*, 6, 133.
- Vestergaard-Poulsen, P., van Beek, M., Skewes, J., Bjarkam, C., Stubberup, M., Bertelsen, J., et al. (2009). Long-term meditation is associated with increased gray matter density in the brain stem. *NeuroReport*, 20 (2), 1.
- Villien, F., Yu, M., Barthelemy, P., & Jammes, Y. (2005). Training to yoga respiration selectively increases respiratory sensation in healthy man. *Respiratory physiology and neurobiology*, 146, 85-96.
- Vollestad, N., Nielsen, M., & Neilsen, G. (2012). Mindfulness and acceptance based interventions for anxiety disorders: A systematic review. *The British journal of clinical psychology*, 51 (3), 239.
- Wallace, R., Benson, H., & Wilson, A. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology*, 221 (3), 795.
- Wang, C., Collet, J., & Lau, J. (2004). The effect of Tai Chi on health outcomes in patients with chronic conditions. *Archives Internal Medicine*, 164, 493-501.
- Wienthes, C., Grossman, P., & Gaillard, A. (1998b). Influence of drive and timing mechanisms on breathing pattern and ventilation during mental task performance. *Biological Psychology*, 49, 53-70.
- Wolf, S., Barnhart, H., Kutner, N., McNeely, E., Coogler, C., & Xu, T. (2003). Reducing frailty and falls in older persons: an investigation of Tai Chi and computerized balance training. *Journal of American Geriatrics Society*, 51, 1794-1803.
- Wolkove, N., Kreisman, H., Darragh, D., Cohen, C., & Frank, H. (1984). Effect of transcendental meditation on breathing and respiratory control. *Journal of applied physiology: respiratory, environmental and exercise physiology*, 56 (3), 607.
- Wong, S., Chan, F., Wong, R., Chu, M., Lam, Y., Mercer, S., et al. (2011). Comparing the effectiveness of mindfulness-based stress reduction and multidisciplinary intervention programs for chronic pain: A randomized comparative trial. *Clinical journal of pain*, 27 (8), 724-734.
- Young, L., Cappola, A., & Blaime, M. (2009). Mindfulness based stress reduction: effect on emotional distress in diabetes. *Practice Diabetes International*, 16 (6), 222-224.
- Zautra, A., Davis, M., Reich, J., Tennen, H., Nicassio, P., Finan, H., et al. (2008). Comparison of cognitive behavioral and mindfulness meditation interventions on adaptation to Rheumatoid Arthritis for patients with and without a history of

recurrent depression. *Journal of consulting and clinical psychology* , 76 (3), 408-421.

ZuWallack, R. (2007). How are you doing? What are you Doing? Differing perspectives in the assessment of individuals with COPD. *Journal of chronic obstructive pulmonary disease* , 4, 293-297.

Chapter III

Stability of breathing timing parameters in the COPD population

Meditation is intimately intertwined with the experience of breathing. A focus on breathing may be the starting point for meditation or the entirety of one's meditation practice. Breathing rate and variability, a normally stable variable in healthy individuals (Schaefer, 1958), has been shown to change in response to meditation and may be changed over time as a result of developing a personal meditation practice (Robert-McComb, Tacon, Randolph, & Caldera, 2004; Villen, Yu, Berthelemy, & Jammes, 2005; Allison, 1970). Research indicates that persons with COPD can perhaps accommodate necessary changes in breathing patterns during meditation for short periods of time (Pomidori, Campigotto, Amarya, Bernardi, & Cogo, 2009; Estve, Blanc-Gras, Gallego, & Benchetrit, 1996). However, we do not know if persons with COPD can sustain these breathing pattern changes as demonstrated in persons without pulmonary disease. It is first important to identify if breathing timing parameters are stable in persons with COPD before using them to identify changes resulting from developing a practice of meditation.

Breathing is the only organ function that is controlled by both voluntary and involuntary neuro-circuits. There is a complicated network of signals that change timing and volume of each breath facilitated or limited by the functioning level of the muscles of respiration and lung parenchyma (Milic-Emili, Whitelaw, & Grassino, 1981). The timing of the respiratory cycle is measured as inspiratory time, inspiratory pause, expiratory time and expiratory pause and respiratory rate and follows the trend of minimal work output under conditions of rest and exercise in a fairly stable manner (Schaefer, 1958). The volume of each breath is the tidal volume, or the volume of air inhaled or exhaled in a single breath. Identified pathways for voluntary and involuntary control of breathing are not totally independent of one another (Homma & Masaoka, 1999). The timing and volume is controlled by a combination of voluntary higher cortical processes and involuntary chemo and mechanical processes. Volume is more a function of chemo-regulation and timing more a function of higher cortical affective processes and speech. Subjects are able to voluntarily vary both inspiratory time (T_i) and expiratory time (T_e) without discomfort for long periods of time to accommodate for variation due to speech and normal emotions (Rafferty & Gardner, 1996).

Breathing timing patterns vary between individuals but are highly consistent within individuals (Shea, Pham, & Hamilton, 1993; Shea, Walter, Pelley, & Guz, 1987). This individual pattern of breathing is influenced by the emotional state of the individual, perhaps based on their affect. Specifically there appears to be a link between anxiety and respiratory variability (Wilhem,

Trabert, & Roth, 2001). Persons with anxiety demonstrate an increase in respiratory rate and a decrease in expiratory time that has been linked to increased activation of the amygdala (Masaoka & Homa, 1999; Masaoka & Homma, 1997; Masaoka & Homma, 2000; Masaoka, Hirasawa, Yamane, & Homma, 2004; Homma & Masaoka, 2008). Although studies have demonstrated that persons with anxiety have a more unstable respiratory rate in studies done in a clinical setting (Wilhem, Trabert, & Roth, 2001) it has since been found that when evaluated over time in their own homes, persons with anxiety do not demonstrate different respiratory patterns than those without anxiety (Pfaltz, Michael, Grossman, Blechert & Wilhelm, 2009). It is perhaps the case that the association between emotions and breathing patterns are complex and require multidimensional models that take circadian rhythm and stress hormone function into consideration (Abelson, Khan, Liberzon & Young, 2007).

Persons with COPD experience pathological changes in lung function that may alter their breathing timing parameters as they strive to maintain effective gas exchange without increasing their work of breathing. Chronic obstructive pulmonary disease results in the loss of elastic recoil of the lung parenchyma resulting in air trapping causing hyperinflation of chest and foreshortening of the diaphragm. This impairs diaphragm function and increases the work of breathing for the individual. In response to this increase in work of breathing, persons with COPD increase their respiratory rate and decrease their tidal volume. Tobin and colleagues used inductive plethysmography to measure breathing patterns in subjects with asthma, COPD, restrictive lung disease, pulmonary hypertension

and asymptomatic smokers and compared them to breathing patterns of healthy subjects (Tobin, Jenouri, Lind, Watson, Schneider, & Sackner, 1983). As compared to normal subjects, those with COPD demonstrated increased respiratory frequency, a decreased inspiratory time of one second or less and heightened respiratory drive as measures by increased V_t/T_i (Tidal volume divided by inspiration time). The subjects with COPD also demonstrated major fluctuations of expiratory timing, periodic fluctuations of end-expiratory levels and asynchrony between rib cage and abdominal movements with predominantly chest breathing (Tobin, Jenouri, Lind, Watson, Schneider, & Sackner, 1983).

Research demonstrates that changes in expiratory time, respiratory rate, and respiratory variability can correspond to changes in emotional function and that meditation can produce long lasting changes in these respiratory timing parameters. To date this research has been conducted in persons with healthy lungs. Persons with COPD have a high rate of co-morbid anxiety and would perhaps benefit from a program of meditation that could improve emotional function through a decrease in anxiety. This study will assess whether breathing timing parameters in persons with COPD can be used to assess potential changes resulting from a meditation intervention. Specifically we will be looking at the test-retest reliability of breathing timing parameters and the relationship between breathing timing parameters and age, years with COPD and COPD disease severity. We will also examine the relationship between breathing timing parameters and anxiety sensitivity, COPD symptom burden, and level of mindfulness.

Methods

This study is part of a larger study investigating the efficacy of a meditation intervention in persons with COPD. Persons with COPD were recruited from pulmonary rehabilitation programs from four midwestern health care systems. All persons with a diagnosis of COPD, who could read and write English and who could attend eight weekly classes in meditation were eligible to participate. Those with lung disease other than COPD or mental status changes that made attending to class material difficult were excluded. Forty-seven subjects were enrolled. Measures of respiratory timing parameters, COPD symptoms including level of dyspnea, mindfulness, anxiety sensitivity were taken for each subject.

Inductive plethysmography has been shown to accurately measure breathing parameters while eliminating interference from intrusive mouthpieces CITATION Tob831 \l 1033 (Tobin, Jenouri, Lind, Watson, Schneider, & Sackner, 1983) . The inductive plethysmography dual stretch band system from Clev-Med (Clev-Med Bio-radio system) was selected for this study. This system consists of a BioRadio user unit that attaches to the dual stretch band system and is clipped on the belt of the subject to allow freedom of movement. The user unit amplifies, samples and digitizes the physiological signals and wirelessly transmits them to the USB receiver. The second component is a USB receiver that transmits the signal to a computer equipped with BioCapture software. The BioCapture software displays and stores the data. Data reduction of the breathing patterns

was conducted by downloading the captured physiologic data to a software package developed by Vivonoetics.

VivoSence™ (Vivonoetics) software summed the abdominal and thoracic/rib cage respiratory wave forms to calculate a single volumetric waveform. The Qualitative Diagnostic Calibration (QDC) routine was used to provide unequal weightings for each respiratory compartment (Sackner, et al., 1989). The use of QDC calibration has been shown to be accurate and sufficient for measuring breathing timing parameters (Grossman, Wilhelm, & Brutsche, 2010). Inspiration time and expiration time were calculated from the tidal volume wave form. All measures were referenced to the beginning of inhalation. I used following measures:

- 1) *Respiratory rate* is derived from total breath time (Tt), which is the total time in seconds from the beginning of one breath to the beginning of the next breath. Instantaneous respiratory rate is this time converted to breaths/minute ($60/Tt$).
- 2) *Respiratory variability* is calculated using the root mean square of successive respiratory rates over a specific time period. The difference in respiration rate between each breath and the following breath is computed, these differences are then squared and summed. The square root of the sum is then computed and divided by the number of breath differences used in the sum.

- 3) *Expiratory time* is the time from the end of inhalation (peak) to the beginning of the following inhalation (trough). It is referenced to the beginning of the inhalation prior to the peak so that it belongs to the same breath. Te is reported in seconds.
- 4) *Phase angle* is the measurement of the degree of coordination between thoracic and abdominal movement during breathing. Calculation of the phase angle is conducted by assuming both RC and AB wave forms are pure sinusoids of amplitude k and m respectively with AB lagging by θ degrees, thus $RC = k \sin \theta$ and $AB = m \sin (\theta + \emptyset)$. The phase angle between the RC and the AB is θ and is determined from measured RC and AB traces. The mid-point of RC is located (point $i; j$) which is the point where $\theta = 0$ and $\theta = 180$. The corresponding points on AB will be at θ and $180 + \theta$. The more the waveforms deviate from pure sinusoids, the more error that will be incurred in the calculation. The absolute phase angle is simply the modulus of this calculation (Hammer & Newth, 2009).

Survey tools

Two survey tools were used, one to capture COPD specific symptom burden and another to capture the level of anxiety sensitivity.

The Chronic Respiratory Disease Questionnaire (CRQ) measures symptom burden for persons with chronic lung disease. The questionnaire contains four

separate and distinct scales that measure dyspnea during common daily activities along with subscales for emotion, fatigue and mastery (Guyatt, Berman, & Pugsley, 1987). The CRQ dyspnea scale has 5 items. At the initial measurement subjects identify the five activities that are most important to them, make them short of breath and they perform on a regular basis. At subsequent measurements subjects rate the intensity of dyspnea experienced during the same five activities (Covey, Larson, Wirtz, Berry, & Alex, 2001; Larson, Covey, Berry, Alex, & Langvein, 1999). The subscale for emotions contains seven questions, five of which target feelings of anxiety and two target feelings of depression. The emotional subscale has significantly correlated with the hospital anxiety and depression score, most specifically with the anxiety component of that measure (Duiverman, Wenpe, Bladden, & Kerstjens, 2008; Puhos, Frey, Buchi, & Schunemann, 2008). The fatigue subscale contains four questions that specifically and clearly ask subjects about their level of energy vs. their level of feeling sluggish or tired. The mastery scale contains four questions that assess how confident and in control subjects are during times they experience shortness of breath as opposed to how scared or how much panic they feel during these times.

CRQ items are constructed with a 7 point Likert-type scale, ordered with higher scores indicating fewer symptoms. Scores for each scale are calculated by summing responses to individual items, yielding a potential range of 5-35 for Dyspnea. The minimal clinically significant change in the CRQ score is associated with a change of .5 per item and a moderate change is associated with a change of

1 per item (Cox, Goodwin, & McWilliams, 2004). Available data support the reliability and validity of the CRQ (Guyatt, Berman, & Pugsley, 1987; Guyatt, Townsend, Berman, & Pugsley, 1987). Stability reliability was demonstrated by a coefficient of variation of 6% for CRQ Dyspnea when the instrument was administered six times over a two week period of time. Validity of the CRQ was supported by correlations which were consistent with expected relationships between the CRQ and measures of similar or related concepts including a walk test, global rating of dyspnea. Cronbach's alpha coefficients for the CRQ Dyspnea were .76 and .88. This instrument is widely used and we have used it successfully for >10 years and published evidence of its reliability and validity (Guyatt, Townsend, Berman, & Pugsley, 1987).

The Anxiety Sensitivity Index-revised, (ASI-3) measures one's sensitivity to the sensation of anxiety with an 18 question refined version of the original anxiety sensitivity Index (Taylor, et al., 2007). The original Anxiety sensitivity index is a widely used measure of anxiety sensitivity shown to possess a high level of construct validity, internal consistency and test-re-test reliability (Peterson & Reiss, 1992). The ASI-3 uses a five point likert scale to measure the degree to which a person is fearful of common symptoms associated with anxiety such as; "When I notice my heart skipping a beat, I worry that there is something seriously wrong with me". In persons with COPD, the anxiety sensitivity index was predictive of the degree of dyspnea perception during testing with resistive loads (Giardino et al., 2010) and predicted greater dyspnea avoidance (Simon et al., 2006). Anxiety sensitivity index correlated moderately with trait anxiety

measures which indicate some endurance over time (Reiss, 1991). However, anxiety sensitivity as measured with the ASI-3 has been shown to respond to cognitive behavioral therapy and interceptive experience therapy (Deacon, Lickel, Possis, Abramowitz, Mahaffey, & Wolitsky-Taylor, 2012). In testing of non-clinical populations the 18 item ASI-3 demonstrated a consistent 3 factor solution that was stable and provided the best fit of the data in both men and women. Further testing of the ASI-3 indicated that it has good internal consistency, and strongly discriminated between two latent classes (Bernstein, Zvolensky, Taylor, Abramowitz, & Stewart, 2010). Further studies conclude that the ASI-3 is a better predictor of anxious response than the original ASI (Carter, Sbrocco, & Ayati, 2009).

Data analysis

Reduced data from Vivosense™ was downloaded to SPSS for data analysis. Descriptive statistics were run on all respiratory timing measures. Pearson correlations were run between respiratory timing measures and subjects level of anxiety sensitivity, mindfulness, level of general life coping skills and COPD symptom burden. Data is presented as Pearson correlations and means (standard deviations).

Procedure

All subjects were screened at their usual pulmonary rehabilitation site. A quiet room near to the exercise space was selected. The setting of the room was

casual and non-clinical in nature. A comfortable chair was provided for the subject. The procedure was explained and the subject was made comfortable in the chair with both abdominal and chest bands applied and asked to refrain from talking during the monitoring. Since the subject remained seated for the duration of the test, the bio-radio device was placed on the table at a comfortable distance from the subject but not attached to the subject. The data collector remained in the room and was blind to treatment group assignment. The subject was monitored for between ten and fifteen minutes depending on the quality of signal being obtained. Breathing output was visually inspected for artifact and a 50 breath or longer segment for each subject was identified. These sections were then downloaded into Vivosence™ and conducted data reduction. The reduced data was then analyzed with SPSS.

It is important to note that all data was calibrated prior to reduction by the Vivosence™ software by means of QDC calibration as described in the methods section. However, the Vivosence™ software system is relatively new and the initial version of the software was unable to conduct volume calibration from a single breath. Since data was collected in a community setting, there was no access to equipment that could measure respiratory volume over multiple breaths. A subsequent software update now allows for volume calibration based on volume information from a single breath. This update came after we had begun data collection, so we were unable to gather volume data.

Results

In an initial review of baseline measures an outlier was identified. This outlier had a high respiratory rate, respiratory rate variability and high anxiety sensitivity score. No clinical difference could be identified in this outlier (subject was not in currently experiencing a COPD exacerbation, subject could walk independently and was able to talk to data collector without shortness of breath). It should be noted that including this outlier altered correlations found between respiratory timing parameters and measures of anxiety sensitivity. When excluded, the correlation between any of the respiratory timing parameters and the ASI-3 lost significance. Because there was no solid rationale for excluding this outlier, they were retained in the database. Baseline measures of breathing pattern parameters are identified in Table 3.1 and further depicted in Figures 3.1 through 3.4.

	Respiratory rate	Resp rate St. Deviation	Te	Absolute phase angle
N	46	46	46	46
Mean	17,82	6.11	2.25	37.13
St Dev	6.04	3.20	0.93	28.61
Min	7.44	2.07	0.68	6.62
Max	43.12	16.28	5.14	168.16

Figure 3.1

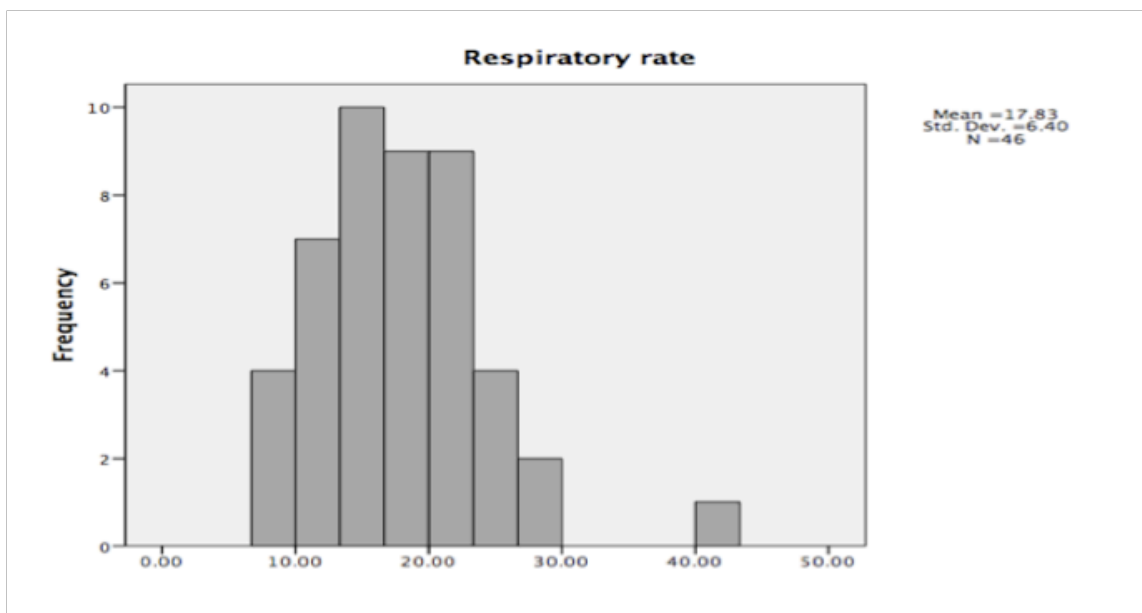


Figure 3.2

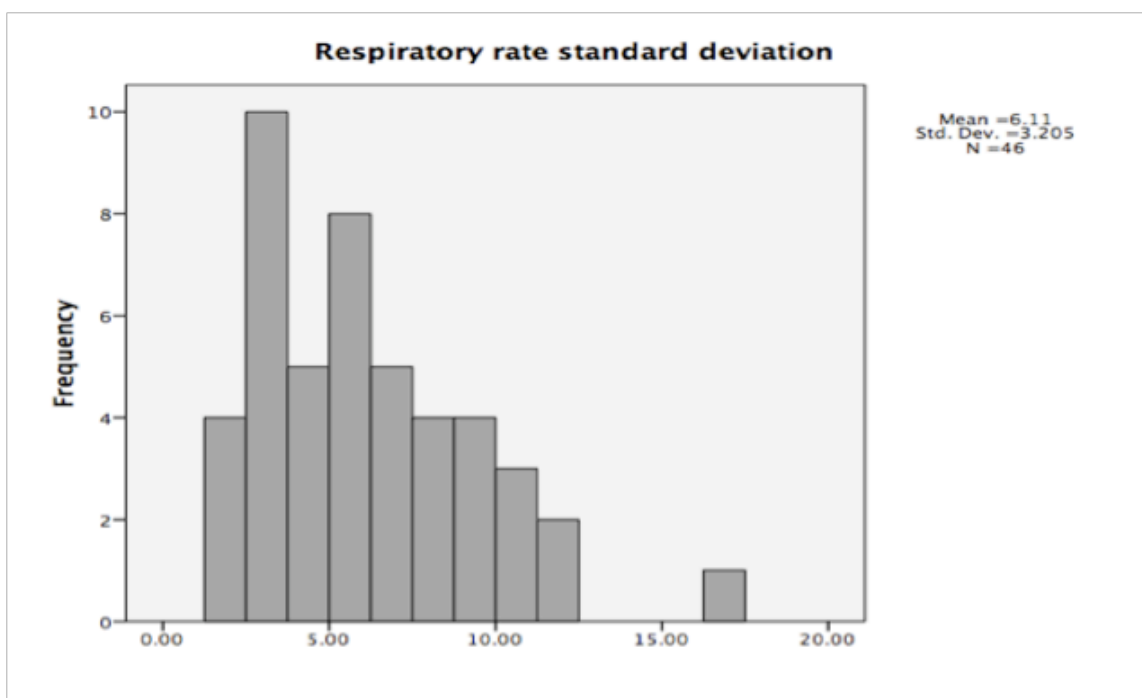


Figure 3.3

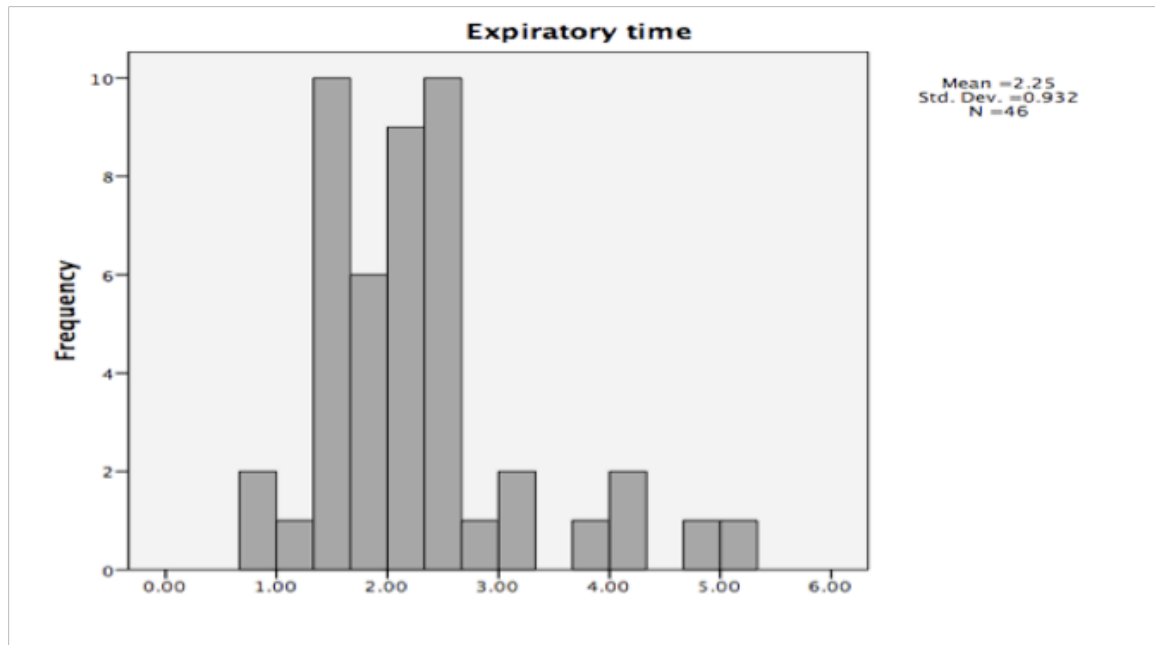
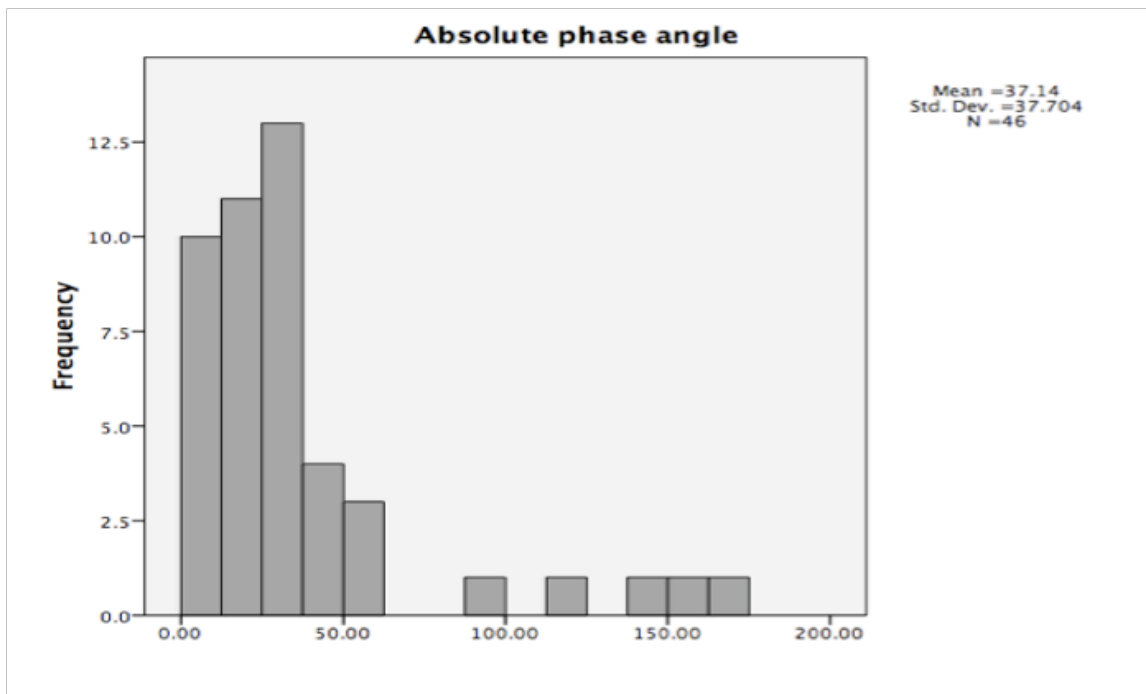


Figure 3.4



Test-retest of breathing timing parameters was assessed using Wilcoxin matched pairs to assess for differences between results at week one and at week ten for those subjects in the wait list group. No significant differences for any of the four respiratory timing parameters were demonstrated (see Table 3.2).

Table 3.2 Comparisons of timing variables over time (wait list group) Wilcoxin matched pairs test				
Variable	Time frame	Median	Z	P
Respiratory rate	Week 1	16.28	-1.045	0.30
	Week 10	17.41		
Respiratory rate St Dev	Week 1	5.59	-1.894	0.06
	Week 10	7.05		
Expiratory time	Week 1	2.28	-1.415	0.16
	Week 10	2.04		
Absolute phase angle	Week 1	27.82	-1.111	0.27
	Week 10	30.68		

Respiratory rate and variability, expiration time and absolute phase angle did not correlate with a majority of the baseline measures including FEV1, mindfulness, sense of coherence, or the mastery and emotional scales of the CRQ. Respiratory rate correlated with years with COPD ($r = -.317, N = 45, P = 0.04$) and ASI-3 ($r = 0.232, N = 43, P = 0.03$). Respiratory rate variability correlated with the CRQ fatigue ($r = -.373, N = 42, P = 0.01$) and ASI-3 ($r = 0.391, N = 43, P = 0.01$). Expiratory time correlated with years with COPD ($r = 0.309, N = 45, P = 0.04$). Absolute phase angle correlated with ASI-3 ($r = 0.308, N = 42, P = 0.05$) see Table 3.3.

Table 3.3 Significant correlations with respiratory timing variables All subjects				
Variables		N	Pearson r	P value
Respiratory rate	Years with COPD	45	-0.317	0.03
Respiratory rate	ASI-3	43	0.323	0.03
Respiratory rate St Dev	Fatigue	42	-0.373	0.02
Respiratory rate St Dev	ASI-3	43	0.391	0.01
Expiratory time	Years with COPD	45	0.309	0.04
Absolute phase angle	ASI-3	42	0.308	0.05

Discussion

The main goal for this study was to assess the stability and predictability of breathing timing parameters for persons with COPD. Overall it was found that respiratory timing parameters were stable over time, and that breathing timing parameters behaved as would be expected based on previous research. Respiratory timing parameters demonstrated a stable breathing pattern in the wait list group over the 10-week period. Further, the breathing timing parameters did not correlate with levels of the CRQ dyspnea scale or with disease severity as measured by FEV1 % predicted. This is consistent with research that indicating that breathing timing parameters do not differ based on severity of COPD (Loveridge, Kryger, & Anthonisen, 1986). Results from this study also indicate a bi-modal curve for absolute phase angle indicating a large group of subjects with normal or near normal abdominal and chest wall synchrony. This is also similar to earlier research results that indicated a small group of outliers demonstrating a large degree of abdominal and chest wall asynchrony that

predicted future need for assisted ventilation (Tobin, Jenouri, Lind, Watson, Schneider, & Sackner, 1983).

Some slight differences were found between subjects in this study as compared to results from other studies of persons with COPD. Respiratory rate in this study is slightly lower than previous research with a mean of 17.26 as opposed to a mean between 20 and 23 breaths per minute (Tobin, Jenouri, Lind, Watson, Schneider, & Sackner, 1983). It was also found that the respiratory rate and expiration time significantly correlated with years with COPD with respiratory rate declining and expiratory time increasing as years with COPD increases. Since COPD is a progressive disease and years with COPD demonstrated a significant negative correlation with FEV1% predicted in this study, it may be that our particular group of subjects is different from the norm due to their high percentage of attendance in pulmonary rehabilitation. Ninety-four percent of the subjects in this study are currently active in some form of pulmonary rehabilitation and may have learned to adapt breathing timing parameters to accommodate lung function changes over time.

Respiratory rate, respiratory rate variability and absolute phase angle all had significant positive correlations with anxiety sensitivity. Although this correlation was upheld by the inclusion of a single outlier, these results are consistent with research regarding respiratory rate variability, anxiety and chronic lung disease. Higher rates of ASI-3 are predictive of a diagnosis of anxiety and/or panic (Bernstein, Zvolensky, Taylor, Abramowitz, & Stewart, 2010).

Persons with COPD and panic do not demonstrate differences in pulmonary function as measured by FEV1% predicted and FVC than those persons with COPD without panic, however those with panic tend to demonstrate an increased rate of respiratory variability (Abelson, Weg, Nesse, & Curtis, 2001) . It is therefore not surprising that ASI-3 and respiratory variability as measured in respiratory rate variability and abdominal chest asynchrony would be significantly moderately correlated in this study.

In conclusion, this study found that respiratory breathing parameters were stable over time and were not correlated with measures of disease severity. It was also found that respiratory variability correlated with anxiety sensitivity and perhaps could be used as non-invasive physiological measure of anxiety and meditation uptake in the COPD population.

Limitations

A major limitation of this study was my failure to gather respiratory volume information due to inability to calibrate outside the laboratory setting. Volume information would have identified the presence of sighs and their impact on respiratory pattern variability. Respiratory variability is a complex measure of physiological homeostasis that includes both random and non-random variability. This dynamic yet balanced state of variability provides for maximum flexibility and adaptation to the demands of life (Vlemincx, Van Deist, & Van den Bergh, 2012) . In persons without lung disease, total variability increases during times of stress and anxiety and a sigh may serve as a mechanism to return

respiratory variability back to healthy levels (Vlemincx, Van Diest, Lehrer, Aubert, & Van den Bergh, 2010). Thus it would be useful to know how sighs impacted the respiratory variability and if sighs acted to re-establish healthy respiratory variability persons with COPD.

Future Research

Anxiety sensitivity is a particular measure similar but distinct from trait anxiety. It reflects the degree to which a person can be identified as having one of many anxiety disorders such as generalized anxiety or panic (Bernstein, Zvolensky, Taylor, Abramowitz, & Stewart, 2010). It is particularly important to persons with chronic disease especially COPD which demonstrates high levels of co-morbid anxiety and panic. In particular high anxiety sensitivity is highly correlated with a negative affect and a lower ability to be aware and accepting of current physical and life circumstances (McKee, Zvolensky, Solomon, Bernstein, & Leen-Feldner, 2007; Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001). This can create a roadblock to appropriate self-care (Zvolensky, Feldner, Leen-Feldner, & Yartz, 2005). Identifying the potential to use breathing timing parameters in the COPD population to assess level of anxiety may provide a non-invasive measure of meditation uptake. Breathing timing parameters may also help describe a mechanism of action for meditation by analyzing information on respiratory variability, sighs and the respiratory pauses that occur during meditation.

BIBLIOGRAPHY

Abelson, J., Khan, S., Liberzon, I., & Young, E. (2007). HPA axis activity in patients with panic disorder review and synthesis of four studies. *Depression and anxiety*, 24 (66-76).

Abelson, J., Weg, J., Nesse, R., & Curtis, G. (2001). Persistent respiratory irregularity in patients with panic disorder. *Society of biological psychiatry*, 49, 588-595.

Abrams, K., Dorflinger, L., Zvolensky, M., Galatix, A., Blank, M., & Eissenberg, T. (2008). Fear reactivity to bodily sensations among heavy smokers and non smokers. *Experimental and clinical psychopharmacology*, 16 (3), 230-239.

Aftanas, L., & Golocheikine, S. (2001). Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high resolution EE investigation of meditation. *Neuroscience letters*, 310 (1), 57.

Allison, J. (1970). Respiratory changes during transcendental meditaiton. *Lancet*, 1, 833.

Antonovsky, A. (1980). *Health, stress and coping*. San Francisco, CA, U.S.A.: Jossey-Bass Publishers.

Arambula, P., Peper, E., Kawakami, M., & Gibney, K. (2001). The physiological correlates of Kundalini yoga meditation: a study of a yoga master. *Applied Psychophysiological biofeedback*, 26 (2), 147-53.

Arias, A., Steinberg, K., Banga, A., & Trestman, R. (2006). Systematic review of the efficacy of meditatin techniques as treatments for medical illness. *The journal of alternative and comlementary medicine*, 12 (8), 817-832.

Ashutosh, K., Gilbert, R., & Peppi, D. (1975). Asynchronous breathing movements in patietns with crhonic obstructive pulmonary disease . *Chest*, 67, 553-557.

Astin, J., Berman, B., Bausell, B., Lee, W., Hochberg, M., & Forys, K. (2003). The efficacy of mindfulness meditation plus Qigong movement therapy in the treatment of fibromyalgia: a ramdom contorlled trial. *The journal of rheumatology*, 30 (10), 2257-2262.

Badawi, K., Wallace, R., Orme-Johnson, D., & Rouzere, A. (1984). Eletrophysiologic characteristics of respiratory suspension periods occurring during the practice of the transcendental meditaiton program. *Psychosomatic Medicine*, 46 (3), 267.

Baer, R. (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clinical psychology Science and Practice*, 10 (2), 125-143.

- Benson, H. (1975). *The Relaxation Response*. New York, New York: Morrow.
- Bernardi, L., Passino, C., Spaducini, G., Bonfichi, M., Arcaini, L., Malcovati, L., et al. (2007). Reduced hypoxic ventilatory response with preserved blood oxygenation in yoga trainees and himalayan Buddhist monks at altitude: evidence of a different adaptive strategy? *European Journal of Applied Physiology*, *99*, 511-518.
- Bernstein, A., Zvolensky, M., Taylor, S., Abramowitz, J., & Stewart, S. (2010). Dimensional, categorical, or Dimensional-categories: testing the latent structure of anxiety sensitivity among adults using factor-mixture modeling. *Behavior Therapy*, *41*, 515-529.
- Bishop, S. (2008). Neuroal mechanisms underlying selective attention to threat. *Annals of the New York Academy of Sciences*, *1129*, 141-152.
- Bond, K., Ospina, M., Hooton, N., Bialy, L., Dryden, D., Buscemi, N., et al. (2009). Defining a complex intervention: The development of demarcatin criteria for "Meditation". *Psychology of Religion and Spirituality*, *1* (2), 129-137.
- Brazier, A., Mulkins, A., & Verhoef, M. (2006). Evaluating a yogic breathing and meditation intervention for individuals living with HIV/AIDS. *American journal of health promotion*, *20* (3), 192-195.
- Brown, R., Kahler, C., Zvolensky, M., Lejuez, C., & Ramsey, S. (2001). Anxiety sensitivity relationship to negative affect smoking and smoking cessation in smokers with past major depressive disorder. *Addictive behaviors*, *26*, 887-899.
- Buchheld, N., Grossman, P., & Walach, H. (2002). Measuring mindfulness in Insight Meditation (Vipassana) and Meditation-Based Psychotherapy: The development of the Freiburg Mindfulness Inventory (FMI). *Zeitschrift fur Klinische Psychologie: Psychiatrie und Pschotherapie*, *50* (2).
- Carson, J., Keefe, F., Lynch, T., Carson, K., Goli, V., Fras, A., et al. (2005). Loving-Kindness meditaiton for chronic low back pain: results from a pilot trial. *Journal of Holistic nursing*, *23*, 287.
- Carter, M., Sbrocco, T., & Ayati, F. (2009). Predicting anxious response to a social challenge and hyperventilation: comparison of the ASI and ASI-3. *Journal of behavior therapy and experimental psychiatry*, *40*, 434-442.
- Caspi, O., & Burluson, K. (2005). Methodological challenges in meditation research. *Advances in mind-body medicine*, *21* (1), 4-11.
- Chang, A., Zhao, Y., LoCastro, J., & Slawsky, M. (2005). A relaxation response randomized trial on patients with chronic heart failure. *Journal of Cardiopulmonary Rehabilitation*, *25* (3), 149-57.

- Cheung, M., Han, Y., & Chan, A. (2008). Electroencephalographic (EEG) measurements of mindfulness-based triarchic body-pathway relaxation technique: A pilot study. *Applied Psychophysiology and Biofeedback*, 33 (1), 39.
- Chiesa, A., & Serretti, A. (2010). A systematic review of neurobiological and clinical features of mindfulness meditations. *Psychological Medicine*, 40 (8), 1239.
- Cho, S., Heiby, E., McCracken, L., Lee, S., & Moon, D. (2010). Pain-related anxiety as a mediator of the effects of mindfulness on physical and psychosocial functioning in chronic pain patients in Korea. *The Journal of Pain*, 11 (8), 789-797.
- Clark, D. (1986). A cognitive approach to panic. *Behavioral research and therapy*, 24 (4), 461-470.
- Coleman, J. (2011). Spring forest QiGong and chronic pain: Making a difference. *Journal of Holistic Nursing*, 29, 118-127.
- Collard, P., Avny, N., & Bonwell, I. (2008). Teaching Mindfulness-Based Cognitive Therapy (MBCT) to students: The effects of MBCT on the levels of mindfulness and subjective well-being. *Counseling Psychology Quarterly*, 21 (4), 65.
- Correll, C., Rosendranz, A., & Grace, A. (2005). Chronic cold stress alters prefrontal cortical modulation of amygdala neuronal activity in rats. *Biological psychiatry*, 58, 382-391.
- Covey, M., Larson, J., Wirtz, S., Berry, J., & Alex, C. (2001). High intensity inspiratory muscle training in patients with chronic obstructive pulmonary disease and severely reduced function. *Journal of Cardiopulmonary Rehabilitation*, 21, 231-240.
- Cox, B., Goodwin, R., & McWilliams, L. (2004). Depression and anxiety associated with three pain conditions" Results from a nationally representative sample. *Pain*, 111 (12), 77.
- Creamer, P., Singh, B., Hochberg, M., & Berman, B. (2000). Sustained improvement produced by nonpharmacologic intervention in fibromyalgia: Results of a pilot study. *Arthritis care and research*, 13 (4), 198-204.
- Curiati, J., Bocchi, E., Freire, J., Arantes, A., Braga, M., Barcia, Y., et al. (2005). Meditation reduces sympathetic activation and improves the quality of life in elderly patients with optimally treated heart failure: A prospective randomized study. *The journal of alternative and complementary medicine*, 11 (3), 465-472.
- Cusens, B., Duggan, G., Thorne, K., & Burch, V. (2010). Evaluation of the Breathworks mindfulness-based pain management programme: Effects on well-being and multiple measures of mindfulness. *Clinical psychology and psychotherapy*, 17, 63-78.

- Davidson, R. (2002). Anxiety and affective style: Role of prefrontal cortex and amygdala. *Society of biological psychiatry*, *51*, 68-80.
- Davidson, R. (2010). Empirical explorations of mindfulness: Conceptual and Methodological conundrums. *Emotion*, *10* (8), 8-11.
- Deacon, B., Lickel, J., Possis, E., Abramowitz, J., Mahaffey, B., & Wolitsky-Taylor, K. (2012). Do cognitive reappraisal and diaphragmatic breathing augment interoceptive exposure fo anxiety sensitivity. *Journal of cognitive psychotherapy*, *26* (3), 257-269.
- Delevoye-Turrell, Y., & Bobineau, C. (2012). Motor consciousness during intertino-based and stimulus based actions: Modulating attention resources through mindfulness meditation. *Frontiers in Psychology*, *3*, 290.
- Dellweg, D., Haidl, P., Siemon, K., Appelhans, P., & Kohler, D. (2008). Impact of breathing pattern on work of breathing in healthy subjects and patients with COPD. *Respiratory physiology and Neurobiology*, *161*, 197-200.
- Delmonte, M. (1984). Factors influencing the regularity of meditation practice in a clinical population. *British journal of medical psychology*, *57*, 275-278.
- Delmonte, M. (1989). Meditation, the unconscious and psychosomatic disorders. *International journal of psychosomatics*, *36* (1-4), 45-56.
- Dobkin, P., & Zhao, Q. (2011). Increase mindfulness-The active component of the mindfulness-based stress reduction program? *Complementay therapies in clinical practice*, *17*, 22-27.
- Donaldson, G. (1992). The chaotic behavior of resting human respiration. *Respiratino physiology*, *88*, 313-321.
- Downey, L., Engelberg, R., Standish, L., Kozak, L., & Lafferty, W. (2009). Three lessons from a randomized trial of massage and meditation at end of life: Patient benifit outcome measure selection and design of trials for terminally ill patients. *American journal of hospice and palliative medicine*, *26*, 246-253.
- Dudley, D., & Pitts-Poarch, A. (1980). Psychophysiologic aspects of respiratory control. *Clinics in chest medicine*, *1* (1), 131-142.
- Duiverman, M., Wenpe, J., Bladden, G., & Kerstjens, H. (2008). Health related quality of life in COPD patients with chronic respiratory failure. *European respiratory journal*, *32*, 379-386.
- Duncan, L., Moskowitz, J., Neilands, T., Dilworth, S., Hecht, F., & Johnson, M. (2012). Mindfulness-Based stress reduction for HIV treatment side effects: A randomized, wait-list controlled trial. *Journal of Pain mangement*, *43* (2), 161.

- Dunn, R., Hartigan, J., & Mikulas, W. (1999). Concentration and mindfulness meditation: Unique forms of consciousness. *Applied psychophysiology and biofeedback*, 24 (3), 147.
- Eisendrath, S., Delucchi, k., Bitner, R., Renimore, P., Smit, M., & McLane, M. (2008). Mindfulness-based cognitive therapy to treatment-resistant depression: A pilot study. *Psychotherapy and psychosomatics*, 77 (5), 120.
- Eriksson, M., & Lindstrom, B. (2005). Validity of Antonovski's sense of coherence scale: A systematic review. *Journal of epidemiology and community health*, 59, 460-6.
- Estve, Blanc-Gras, Gallego, & Benchetrit. (1996). The effects of breathing pattern training on ventilatory function in patients with COPD. *Biofeedback and Self-Regulation*, 21 (4), 311.
- Foley, E., Baillie, A., Huxter, M., Price, M., & Sinclair, E. (2010). Mindfulness-based cognitive therapy for individuals whose lives have been affected by cancer: A randomized controlled trial. *Journal of consulting and clinical psychology*, 78 (1), 72-79.
- Fox, S., Flynn, E., & Allen, R. (2011). Mindfulness meditation for women with chronic pelvic pain A pilot study. *the journal of reproductive medicine*, 56 (3-4), 158-62.
- Fulambarker, A., Farooki, B., Kheir, F., Copur, A., Srinivasan, L., & Schultz, S. (2010). Effect of yoga in chronic obstructive pulmonary disease. *American journal of therapeutics*, 1-5.
- Fulambarker, A., Farooki, B., Kheir, F., Copur, A., Srinivasan, L., & Schultz, S. (2012). Effect of yoga in chronic obstructive pulmonary disease. *American journal of therapeutics*, 19, 96-100.
- Giardino, N., Curtis, J., Abelson, J., King, A., Pamp, B., Liberzon, I., et al. (2010). The impact of panic disorder on interoception and dyspnea reports in chronic obstructive pulmonary disease. *Biological psychology*, 84, 142-146.
- Goldenberg, D., Kaplan, K., Nadeau, M., Brodeur, C., Smith, S., & Shid, C. (1994). A controlled study of a stress-reduction, cognitive-behavioural treatment program in fibromyalgia. *Journal of musculoskeletal pain*, 2 (2), 53.
- Goyal, M., Haythornthwaite, J., Levine, D., Becker, D., Valdy, D., Hills-Briggs, F., et al. (2010). Intensive meditation for refractory pain and symptoms. *The Journal of Alternative and complimentary medicine*, 16 (6), 627-631.
- Gross, C., Kreitzer, M., Thomas, W., Reilly-Spong, M., Cramer-Bornemann, M., Nyman, J., et al. (2010). Mindfulness-based stress reduction for solid organ transplant recipients: A randomized controlled trial. *Alternative therapies in health and medicine*, 16 (5), 30-38.

- Grossman, P. (2008). On measuring mindfulness in psychosomatic and psychological research. *Journal of psychosomatic research* , 64 (4), 405.
- Grossman, P., Niemann, L., & Walach, H. (2004). Meta-analysis of mindfulness-based stress reduction. *Focus on alternative and complementary therapies* , 9 (4), 308-309.
- Grossman, P., Tiefenthaler-Gilmer, U., Raysz, A., & Kesper, U. (2007). Mindfulness training as an intervention for fibromyalgia: Evidence of postintervention and 3-year follow-up benefits in well-being. *Psychotherapy and psychosomatics* , 76, 226-233.
- Grossman, P., Wilhelm, F., & Brutsche, M. (2010). Accuracy of ventilatory measurement employing ambulatory inductive plethysmography during tasks of everyday life. *Biological Psychology* , 84, 121-128.
- Grossman, P., Kappos, L., Gensicke, H., D'Souza, M., Mohr, D., Penner, I., et al. (2010). MS quality of life, depression, and fatigue improve after mindfulness training. *Neurology* , 75, 1141-1149.
- Guyatt, G., Berman, L., & Pugsley, S. (1987). A measure of quality of life for clinical trials in chronic lung disease. *Thorax* , 42, 773-778.
- Guyatt, G., Townsend, M., Berman, L., & Pugsley, S. (1987). Quality of life in patients with Chronic airflow limitatoin. *British Journal of Disease of the Chest* , 81, 45-54.
- Hammer, J., & Newth, C. (2009). Assessment of thoraco-abdominal asynchrony. *Paediatric respiratory reviews* , 10 (2), 75-80.
- Homma, I., & Masaoka, Y. (2008). Breathing rhythms and emotions. *Experimental Physiology* , 93 (9), 1011-1021.
- Hotzel, B., Lazar, S., Gard, T., Schuman-Olivier, Z., Vago, D., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Persepctives on psychological science* , 6, 537.
- Hotzel, B., Ott, U., Hempel, H., Hackl, A., Wolf, K., Stark, R., et al. (2007). Differential engagement of anterior cingulate and adjacent medial frontal cortex in adept meditators and non-meditators. *neuroscience letters* , 421, 16-21.
- Jayadevappa, R., Johnson, J., Bloom, B., Nidich, S., Desai, S., Chhatre, S., et al. (2007). Effectivness of transcendental meditatio on functional capacity and quality of life of African Americans with congestive heart failure: A randomized control study. *Ethnicity and disease* , 17, 72-77.
- Jhal, A., Krompinger, J., & Baime, M. (2007). Mindfulness training modifies subsystems of attention. *Cognitive affective behavioral neuroscience* , 7 (2), 109.

- Kabat-Zinn, J., Lipworth, K., & Burney, R. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of behavioral medicine*, 8 (2), 163-189.
- Kabat-Zinn, J. (1982). An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation. *General hospital psychiatry*, 4, 33-47.
- Kerr, C. (2002). Translating "mind-in-body" two models of patient experience underlying a randomized controlled trial of qigong. *Culture medicine and psychiatry*, 26, 419-447.
- Kim, Y., Kim, S., Park, S., Lee, S., & Lee, K. (2002). Changes in EEG of children during brain respiration-training. *The American Journal of Chinese Medicine*, 30 (2 and 3), 465.
- Lama, T. D. (2001). *Stages of meditation*. (G. Jordhen, L. Ganchenpa, & J. Russell, Trans.) Boulder, Colorado, U.S.A.: Snow Lion Publications.
- Larkey, L., Jahnke, R., Etneir, J., & Gonzalez, J. (2009). Meditative movement as a category of exercise: Implications for research. *Journal of physical activity and health*, 6, 230-238.
- Larson, J., Covey, M., Berry, J., Alex, C., & Langvein, W. (1999). Cycle ergometer and inspiratory muscle training in chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine*, 160, 500-507.
- Livermore, N., Butler, J., Sharpe, L., McBain, R., Gandevia, S., & McKenzie, D. (2008). Panic attacks and perception of inspiratory resistive loads in chronic obstructive pulmonary disease. *American journal of respiratory and critical care medicine*, 178, 7-12.
- Livermore, N., Sharpe, L., & McKenzie, D. (2007). Selective attention to threatening information in anxious patients with chronic obstructive pulmonary disease. *Cognitive therapy research*, 31, 885-895.
- Loveridge, B., Kryger, M., & Anthonisen, N. (1986). Alteration in breathing pattern with progression of chronic obstructive pulmonary disease. *American review of respiratory disease*, 134 (5), 930-4.
- Lush, E., Salmon, P., Floyd, A., Studts, J., Weissbecker, I., & Sephton, S. (2009). Mindfulness meditation for symptom reduction in fibromyalgia psychophysical correlates. *Journal of clinical psychological medical settings*, 16, 200-207.
- Lutz, A., Brefczynski, J., Johnstone, T., & Davidson, R. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PlosOne*, 3 (3), e1897.

- Lutz, A., Greischar, L., Ricard, M., & Davidson, R. (2004). Long-term meditators self-induced high-amplitude gamma synchrony during mental practice. *Proceedings of the National Academy of Sciences of the United States of America*, *101* (46), 16369.
- Majumdar, M., Grossman, P., Dietz-Waschkowski, B., Kersig, S., & Walach, H. (2002). Does mindfulness meditation contribute to health? Outcome evaluation of a German sample. *The journal of alternative and complementary medicine*, *8* (6), 719-730.
- Masaoka, Y., & Homa, I. (1999). Expiratory time determined by individual anxiety levels in humans. *Journal of applied physiology*, *86*, 1329-1336.
- Masaoka, Y., & Homma, I. (1997). Anxiety and respiratory patterns: their relationship during mental stress and physical load. *International Journal of Psychophysiology*, *27*, 153-159.
- Masaoka, Y., & Homma, I. (2000). The source generator of respiratory-related anxiety potential in the human brain. *Neuroscience letters*, *283*, 21-24.
- Masaoka, Y., Hirasawa, K., Yamane, F., & Homma, I. (2004). Effects of left amygdala lesions on respiration, skin conductance, heart rate, anxiety, and activity of the right Amygdala during anticipation of negative stimulus. *Behavioral Modification*, *27* (5), 607-619.
- Masaoka, Y., Jack, S., Warburton, C., & Homma, I. (2004). Breathing patterns associated with trait anxiety and breathlessness in humans. *Japanese journal of physiology*, *54*, 465-470.
- Maupin, E. (1965). Individual difference in response to a zen meditation exercise. *Journal of consulting psychology*, *29* (2), 139-145.
- McCracken, L., & Keogh, E. (2009). Acceptance, mindfulness, and values-based action may counteract fear and avoidance of emotions in chronic pain: An analysis of anxiety sensitivity. *The journal of Pain*, *10* (4), 408-415.
- McKee, L., Zvolensky, M., Solomon, S., Bernstein, A., & Leen-Feldner, E. (2007). Emotional-vulnerability and mindfulness: A preliminary test of associations among negative affectivity, anxiety sensitivity and mindfulness skills. *Cognitive behavioral therapy*, *36* (2), 91-101.
- Merkes, M. (2010). Mindfulness-based stress reduction for people with chronic disease. *Australian journal of primary health*, *16*, 200-210.
- Moon, P., & Norekual, T. (2006). Is sense of coherence a pathway for improving the quality of life of patients who grow up with chronic disease? *European journal of cardiovascular disease*, *5* (1), 16.

Morone, N., Rollman, B., Moore, C., Li, Q., & Weiner, D. (2009). A mind-body program for older adults with chronic low back pain: results of a pilot study. *Pain Medicine*, 10 (8), 1395-1407.

Mularski, R., Munjas, B., Lorenz, K., Sun, S., Robertson, S., Schmelzer, W., et al. (2009). Randomized controlled trial of mindfulness-based therapy for dyspnea in chronic obstructive lung disease. *The journal of alternative and complementary medicine*, 15 (6), 1083-1090.

Murata, T., Takahashi, T., Hamada, M., Omon, M., Kosaka, H., Yoshida, H., et al. (2004). Individual trait anxiety levels characterizing the properties of Zen mediation. *Pharmacoelectroencephalography*, 50, 189-194.

National Center for Chronic Disease Prevention and Health Promotion. (2005). *The power of prevention*. Retrieved 2012 йил 8-November from Centers for Disease Control: www.cdc.gov/chronicdisease/resources/publicationsindex.htm

Newhouse, R., Dearholt, S., Pugh, L., & White, K. (2005). *The Johns Hopkins Nursing Evidence-based Practice Rating Scale*. Johns Hopkins University School of Nursing, Nursing. Baltimore: John Hopkins University.

O'Donnell, D., Banzett, R., Carrieri-Kohlman, V., Casaburi, R., Davenport, P., Gandevia, S., et al. (2007). Pathophysiology of dyspnea in chronic obstructive pulmonary disease. *Proceeds of the American Thoracic Society*, 4, 145-168.

Orsillo, S., Roemer, L., & Holowka, D. (2005). Acceptance-based behavioral therapies for anxiety: using acceptance and mindfulness to enhance traditional cognitive-behavioral approaches. In *Acceptance and mindfulness based approaches to anxiety* (pp. 3-35). New York, N.Y., U.S.A.: Springer science and business media.

Ospina, M., Bond, K., Karkhaneh, M., Buscemi, N., Bryden, D., Barnes, V., et al. (2008). Clinical trials of meditation practices in health care: Characteristics and quality. *The journal of alternative and complementary medicine*, 14 (10), 1199-1213.

Pagoni, G., Miose, C., & Ying, G. (2008). Thinking about not thinking: Neural correlates of conceptual Zen meditation. *PloS one*, 3 (9), e3083.

Pallent, J., & Lae, L. (2002). Sense of coherence, wellbeing, coping and personality factors: Further evaluation of the sense of coherence scale. *Individual differences*, 33, 39-48.

Pei-Ying, S., & Davenport, P. (2010). The role of nicotine on respiratory sensory gating measured by respiratory related evoked potentials. *Journal of applied physiology*, 108, 662-669.

Peng, C., Mietus, J., Liu, Y., Lee, C., Hausdorff, J., Stanley, H., et al. (2002). Quantifying fractional dynamics on human respiration; age and gender effects. *Annals of Biomedical Engineering*, 30 (15), 683.

- Perlman, D., Salomons, T., Davidson, R., & Lutz, A. (2010). Differential effects of pain intensity and unpleasantness of two meditation practices. *Emotion*, *10* (1), 65-71.
- Pfaltz, M., Michael, T., Grossman, P., Blechert, J., & Wilhelm, F. (2009). Respiratory pathophysiology of panic disorder: An ambulatory monitoring study. *Psychosomatic Medicine*, *71*, 869-87.
- Pomidori, L., Campigotto, F., Amarya, T., Bernardi, L., & Cogo, A. (2009). Efficacy and tolerability of yoga breathing in patients with chronic obstructive pulmonary disease: A pilot study. *Journal of cardiopulmonary rehabilitation and prevention*, *29* (2), 133.
- Porzelius, J., Vest, M., & Nochomovitz, M. (1992). Respiratory function, cognitions and panic in chronic obstructive pulmonary patients. *Behavioral research and therapy*, *30* (1), 75-77.
- Pradhan, E., Baumgarten, M., Langenberg, P., Handwerker, B., Gilpin, A., Magyari, t., et al. (2007). Effect of mindfulness-based stress reduction in rheumatoid arthritis patients. *Arthritis and rheumatism*, *57* (7), 1134-1142.
- Puhas, M., Frey, M., Buchi, S., & Schunemann, J. (2008). The minimal important difference of the hospital anxiety and depression scale in patients with Chronic Obstructive Pulmonary Disease. *Health and Quality of life*, *6*, 46.
- Rafferty, G. F., & Gardner, W. N. (1996). Control of the respiratory cycle in conscious humans. *Journal of Applied Physiology*, *81* (4), 1744.
- Rajesh, B., Jayachandran, D., Mohandas, G., & Radhakrishnan, K. (2006). A pilot study of a yoga meditation protocol for patients with medically refractory epilepsy. *The journal of alternative and complementary medicine*, *12* (4), 367-371.
- Rapgay, L., & Bystricky, A. (2009). Classical Mindfulness: An introduction to its theory and practice for clinical application. *Longevity, regeneration and optimal health*, *1172*, 148-162.
- Reiss, S. (1991). Expectancy model of fear, anxiety and panic. *Clinical psychology review*, *11*, 141-153.
- Ries, A., Bauldoff, G., Carlin, B., Casaburi, R., Emery, C., Mahler, D., et al. (2007). Pulmonary rehabilitation. *Chest*, *131* (5), 4S-42S.
- Robert-McComb, J., Tacon, A., Randolph, P., & Caldera, Y. (2004). A pilot study to examine the effects of a mindfulness-based stress reduction and relaxation program on levels of stress hormones, physical functioning and submaximal exercise responses. *The journal of alternative and complementary medicine*, *10* (5), 819-827.

- Robinson, F., Mathews, H., & Witek-Janusek, L. (2003). Psycho-endocrine-immune response to mindfulness-based stress reduction in individuals infected with the human immunodeficiency virus: A quasiexperimental study. *The journal of alternative and complementary medicine*, 9 (5), 683-694.
- Rosenzweig, S., Greeson, J., Reibel, D., Green, J., Jasser, S., & Beasley, D. (2010). Mindfulness-based stress reduction for chronic pain conditions: Variation in treatment outcomes and role of home meditation practice. *Journal of psychosomatic research*, 68, 29-36.
- Rosenzweig, S., Reibel, D., Greeson, J., Edman, J., Jasser, S., McMearty, K., et al. (2007). Mindfulness-based stress reduction is associated with improved glycemic control in type 2 diabetes mellitus: A pilot study. *Alternative therapies in health and medicine*, 13 (5), 36-38.
- Rungreangkulkij, S., Wongtakee, W., & Thongyot, S. (2011). Buddhist group therapy for diabetes patients with depressive symptoms. *Archives of psychiatric nursing*, 25 (3), 195-205.
- Sackner, M., Watson, H., Selsito, A., Feinerman, D., Soares, M., Gonzolez, G., et al. (1989). Calibration of respiratory inductive plethysmograph during natural breathing. *Journal of applied physiology*, 66 (1), 410-420.
- Sadler, M., Stephens, S., & Kennedy, V. (2008). Tinnitus rehabilitation: a mindfulness meditation cognitive behavioural therapy approach. *The journal of laryngology and otology*, 122, 31-37.
- Sagula, D., & Rice, K. (2004). The effectiveness of mindfulness training on the grieving process and emotional well-being of chronic pain patients. *Journal of clinical psychology in medical settings*, 11 (4), 333-341.
- Salzberg, S. (2002). *Lovingkindness: The revolutionary art of happiness*. Boston, MA, U.S.A.: Shambala Press.
- Salzberg, S. (1995). *The Revolutionary art of Happiness*. Boston, MA: Shambala press.
- Schaefer, K. (1958). Respiratory pattern and respiratory response to CO₂. *Journal of Applied Physiology*, 13 (1), 1.
- Schmidt, S., Grossman, P., Schwarzer, B., Jena, S., Naumann, J., & Walach, H. (2010). Treating fibromyalgia with mindfulness-based stress reduction: Results from a 3-armed randomized trial. *Pain*, in press, 1-10.
- Sephton, S., Salmon, P., 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 and Rheumatism*, 57 (1), 77-85.

- Shapiro, S., Carlson, L., Astin, J., & Freedman, B. (2006). Mechanisms of mindfulness. *Journal of clinical psychology*, 62 (3), 373-386.
- Shaver, P., Lavy, S., Saron, C., & Mikulincer, M. (2007). Social foundations of the capacity for mindfulness: an attachment perspective. *Psychological Inquiry: An international journal for advancement of psychological theory*, 18 (4), 264-271.
- Shea, S., Pham, D., & Hamilton, R. (1993). Behavioral patterns of monozygous twins during behavioral tasks. *Acta Geneticae Medicae et Gemellologia*, 42 (2), 359.
- Shea, S., Walter, J., Pelley, K., & Guz, A. (1987). The effect of visual and auditory stimuli upon resting ventilation in man. *Respiration Physiology*, 68, 345-357.
- Simpson, J., & Mapel, T. (2011). An investigation into the health benefits of mindfulness-based stress reduction (MBSR) for people living with a range of chronic physical illnesses in New Zealand. *The New Zealand medical journal*, 124 (1338), 68-74.
- Singh, B., Berman, B., Hadhazy, V., & Creamer, P. (1998). A pilot study of cognitive behavioral therapy in fibromyalgia. *Alternative therapies*, 4 (2), 67-70.
- Slater, H., Lutz, A., Greischar, L., Francis, A., Nieuwenhuis, S., Davis, J., et al. (2007). Mental training affects distribution of limited brain resources. *PLoS Biology*, 5 (6), e138.
- Spicuzza, L., Gabutti, A., Porta, C., Montano, N., & Bernardi, L. (2000). Yoga and chemoreflex response to hypoxia and hypercapnea. *Lancet*, 356, 1495.
- Sullivan, M., Wood, L., Terry, J., Brantley, J., Charles, A., McGee, V., et al. (157 жыл 84-90-1). The support, education, and research in chronic heart failure study (SEARCH): A mindfulness-based psychoeducational intervention improves depression and clinical symptoms in patients with chronic heart failure. *American heart Journal*.
- Tavee, J., Rensel, M., Planchon, S., Butler, R., & Stone, L. (2011). Effects of meditation on pain and quality of life in multiple sclerosis and peripheral neuropathy. *International journal of MS care*, 13, 163-168.
- Taylor, S., Cox, B., Heimberg, R., Ledley, D., Holaway, R., Steward, S., et al. (2007). Robust dimensions of anxiety sensitivity: development and initial validation of the anxiety sensitivity index-3. *Psychological assessment*, 19 (2), 176-188.
- Teixeira, E. (2010 жыл September/October). The effect of mindfulness meditation of painful diabetic peripheral neuropathy in adults older than 50 years. *Holistic nursing practice*, 277-283.
- Telles, S., Raghavendra, B., Naveen, K., Namjunath, N., Kumar, S., & Subramanya, P. (2012). Changes in autonomic variables following two meditative states

described in yoga texts. *Journal of Alternative and complementary medicine*, E Pub ahead of print.

Tobin, M., Jenouri, G., Lind, B., Watson, H., Schneider, A., & Sackner, M. (1983). Validation of respiratory inductive plethysmography in patients with pulmonary disease. *Chest*, *83*, 615-620.

Travis, F., Haaga, D., Tanner, M., Nidich, S., Gaylord-King, C., Grosswald, S., et al. (2009). Effects of Transcendental Meditation practice on brain functioning and stress reactivity in college students. *International Journal of Psychophysiology*, *71*, 170-176.

Unkown. (1999). Dyspnea. mechanisms, assessment, and management: A consensus statement: American Thoracic Society. *American journal of respiratory and critical care*, *159* (1), 321.

Van den Hurk, P., Janssen, B., Giommi, F., Barendregt, H., & Gielen, S. (2010). Mindfulness meditation associated with alterations in bottom-up processing: Psychophysiological evidence for reduced reactivity. *International Journal of Psychophysiology*, 1-7.

van Leeuwen, S., Singer, W., & Mellon, L. (2012). Meditation increases depth of information processing and improves the allocation of attention in space. *Frontiers in human neuroscience*, *6*, 133.

Vestergaard-Poulsen, P., van Beek, M., Skewes, J., Bjarkam, C., Stubberup, M., Bertelsen, J., et al. (2009). Long-term meditation is associated with increased gray matter density in the brain stem. *NeuroReport*, *20* (2), 1.

Villen, F., Yu, M., Berthelemy, P., & Jammes, Y. (2005). Training to yoga respiration selectively increases respiratory sensations in healthy man. *Respiratory physiology and neurobiology*, *146* (1), 85-96.

Villien, F., Yu, M., Barthelemy, P., & Jammes, Y. (2005). Training to yoga respiration selectively increases respiratory sensation in healthy man. *Respiratory physiology and neurobiology*, *146*, 85-96.

Vlemincx, E., Van Deist, I., & Van den Bergh, O. (2012). A sigh following sustained attention and mental stress: Effects on respiratory variability. *Physiology and behavior*, *107*, 1-6.

Vlemincx, E., Van Diest, I., Lehrer, P., Aubert, A., & Van den Bergh, O. (2010). Respiratory variability preceding and following sighs: A resetter hypothesis. *Biological psychology*, *84*, 82-87.

Vollestad, N., Nielsen, M., & Nielsen, G. (2012). Mindfulness and acceptance based interventions for anxiety disorders: A systematic review. *The British journal of clinical psychology*, *51* (3), 239.

Wallace, R., Benson, H., & Wilson, A. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology* , 221 (3), 795.

Wang, C., Collet, J., & Lau, J. (2004). The effect of Tai Chi on health outcomes in patients with chronic conditions. *Archives Internal Medicine* , 164, 493-501.

Wienthes, C., Grossman, P., & Gaillard, A. (1998b). Influence of drive and timing mechanisms on breathing pattern and ventilation during mental task performance. *Biological Psychology* , 49, 53-70.

Wientjes, C., & Grossman, P. (1998a). Respiratory psychophysiology as a discipline: introduction to the special issue. *Biological Psychology* , 49, 1-8.

Wilhem, F., Trabert, W., & Roth, W. (2001). Physiologic instability in panic disorder and generalized anxiety disorder. *Society of Biological psychiatry* , 49, 596-605.

Wolf, S., Barnhart, H., Kutner, N., McNeely, E., Coogler, C., & Xu, T. (2003). Reducing frailty and falls in older persons: an investigation of Tai Chi and computerized balance training . *Journal of American Geriatrics Society* , 51, 1794-1803.

Wolkove, N., Kreisman, H., Darragh, D., Cohen, C., & Frank, H. (1984). Effect of transcendental meditation on breathing and respiratory control. *Journal of applied physiology: respiratory, environmental and exercise physiology* , 56 (3), 607.

Wong, S., Chan, F., Wong, R., Chu, M., Lam, Y., Mercer, S., et al. (2011). Comparing the effectiveness of mindfulness-based stress reduction and multidisciplinary intervention programs for chronic pain A randomized comparative trial. *Clinical journal of pain* , 27 (8), 724-734.

Young, L., Cappola, A., & Blaime, M. (2009). Mindfulness based stress reduction: effect on emotional distress in diabetes. *Practice Diabetes International* , 16 (6), 222-224.

Zautra, A., Davis, M., Reich, J., Tennen, H., Nicassio, P., Finan, H., et al. (2008). Comparison of cognitive behavioral and mindfulness meditation interventions on adaptation to Rheumatoid Arthritis for patients with and without a history of recurrent depression. *Journal of consulting and clinical psychology* , 76 (3), 408-421.

ZuWallack, R. (2007). How are you doing? What are you Doing? Differing perspectives in the assessment of individuals with COPD. *Journal of chronic obstructive pulmonary disease* , 4, 293-297.

Zvolensky, M., Feldner, M., Leen-Feldner, E., & Yartz, A. (2005). Exploring basic processes underlying acceptance and mindfulness. In S. Orsillo, & L. Roemer,

Acceptance and mindfulness-based approaches to anxiety: conceptualization and treatment (pp. 325-359). New York, New York: Springer.

CHAPTER IV

Modified mindfulness-based stress reduction intervention in COPD

People with Chronic Obstructive Pulmonary Disease (COPD) experience dyspnea with exertion (Sin, Stafinski, Ng, Bell, & Jacobs, 2002) and they avoid physical and emotional stress to minimize symptoms, sometimes early in the disease (Watz, Waschki, & Magnussen, 2008). Pulmonary rehabilitation has been shown to make significant improvements in COPD symptoms, but gains are lost within a relatively short period of time (Foglio, Bianchi, Porta, Vitacca, & Balbi, 2007). Additionally, persons with COPD and co-morbid anxiety have an impaired ability to judge respiratory sensations causing them to overestimate danger, further interfering with their ability to participate in rehabilitation activities (Orsillo, Roemer, & Holowka, 2005). Thus it is important to investigate strategies that will allow people to accurately assess symptoms and successfully participate in self-management activities over a longer period of time.

Mindfulness meditation is a simple self-management skill that has the potential to change breathing patterns, decrease sensitivity to anxiety and thereby reduce the unpleasantness of dyspnea, but the effects have not been fully examined in people with COPD.

Functionally, persons with moderate to severe COPD experience expiratory flow limitation and static hyperinflation of the lungs, resulting in functional inability to meet respiratory needs (Koulouris, Valta, Lavoie, Corbeil, Chasse', & Braidy, 1995). During times of physical or emotional demands, persons with expiratory flow limitation experience increased end expiratory lung volume described as dynamic or acute hyperinflation of the lungs (O'Donnell & Laveneziana, 2007). This contributes to the symptom of dyspnea.

When asked to describe feelings of dyspnea, persons are able to distinctively and consistently choose word identifiers that have been correlated with lung pathology and fMRI images of participating neuro-networks (Banzett, Mulnier, Murphy, Rosen, Wise, & Adams, 2000; Elliott, Adams, Cockroft, MacRae, & Guz, 1991; Mahler, Harver, Lentine, Scott, Beck, & Schwartzstein, 1996; Peiffer, 2008; Von Leupoldt, 2008). Persons with COPD consistently describe their dyspnea as increased work of breathing and air hunger, identifying air-hunger as the factor limiting their ability to actively engage in life (Carrieri-Kohlman, 1996; Firth, Petkov, Olds, Cafarella, & Williams, 2008). For persons with COPD, anxiety can trigger hyperventilation. Once triggered, hyper-ventilation leads to a sensation of air-hunger which is anxiety provoking. This then establishes a potential endless feedback loop of anxiety and dyspnea (Stein, 2009; Culpepper, 2009; Brenes, 2002; Freire, et al., 2008; Jones, Harding, Chung, & Campbell, 2008). The presence of anxiety disorders in persons with pulmonary disease is associated with more severe self-reported shortness of breath, less participation in rehabilitative programs (Giardino, et al., 2010; Moore & Zebb, 1999; Eisner, et

al., 2009) and to more often appraise experiences in a negative manner (Von Leupoldt, Taube, Henjhus, Dahme, & Magnusen, 2009; Vogele & von Leupoldt, 2008).

The dyspnea of air-hunger is specific to persons with COPD as well as persons with anxiety disorders such as generalized anxiety disorder, post traumatic stress disorder, post traumatic stress disorder and panic disorder (Skarbek, 1970; Zvolensky, Gibson, Vujanovic, & Feldner, 2008). Anxiety sensitivity is a personality feature that occurs to a greater or lesser degree in people with anxiety (Reiss, 1991). It defines how fearful one is to the sensations of anxiety (Eifert, Zvolensky, Sorrell, & Hopko, 1999; Reiss, 1991). Persons with high anxiety sensitivity believe that the sensation of anxiety signals impending death which drives their response to anxiety provoking situations (Clark, 1986; Reiss, 1991). Some research indicates that persons with high anxiety sensitivity display attentional focus toward anxiety provoking sensations while others avoid anxiety provoking sensations with threat avoiders more often found to be women and those that reported a history of panic attacks (Noel, Taylor, Quinlan, & Stewart, 2012). Both threat avoidance and threat vigilance represent dysfunctional cognitive thinking and maladaptive emotional processing (McKee, Zvolensky, Solomon, Bernstein, & Leen-Feldner, 2007) that will negatively impact chronic disease management styles. Anxiety sensitivity has been shown to be an enduring characteristic, and it has been lessened with cognitive behavioral therapy involving interoceptive exposure (planned experiences with the

symptoms) (Deacon, Lickel, Possis, Abramowitz, Mahaffey, & Wolitsky-Taylor, 2012; Smits, Berry, Tart, & Powers, 2008).

Current research infers that an active practice of meditation improves sensory gating thus improving perception of interoceptive information including accuracy of respiratory load perhaps by lowering chemo-sensitivity to CO₂ and providing faster recovery after sensory processing has occurred (Slagter, Lutz, Greischar, Niewenhuis, & Davidson, 2008; Spicuzza, Gabutti, Porta, Montano, & Bernardi, 2000; Wolkove, Kreisman, Darragh, Cohen, & Frank, 1984; Wallace, Mills, Orme-Johnson, Dillbeck, & Jacobe, 1983; Pagoni, Miose, & Ying, 2008). Research has also demonstrated that meditation has a positive impact on a person's ability to sustain attention (van Leeuwen, Muller, & Melloni, 2009; Pagnoni & Milosi, 2007; Davidson, Goleman, & Schwartz, 1976). The combination of both improved gating and attention results in an increased resistance to stressful stimuli without the need to block awareness (Bowen, Witkiewitz, Dillworth, & Marlatt, 2007; van den Hurk, Janssen, Giommi, Barendregt, & Gielen, 2010; Takaharchi, et al., 2005). Specifically for persons with COPD and anxiety, meditation may improve respiratory sensation gating resulting in decreased sensitivity to CO₂ and more accurate interoception of respiratory load (Vestergaard-Poulsen, et al., 2009; Lutz, Brefczynski, Johnstone, & Davidson, 2008). Along with improved ability to detect and monitor respiratory load and immediate ventilatory needs, improved mental acuity and increased emotional maturity may facilitate participation in self-care management and activities (Kim,

Kim, Park, Lee, & Lee, 2002; Cheung, Han, & Chan, 2008; Lutz, Greischar, Ricard, & Davidson, 2004).

Overall, the use of meditation as an intervention for persons with COPD has shown mixed results. Mulinski and colleagues did not demonstrate significant improvement in the levels of dyspnea, function and COPD related quality of life after a randomized trial of a modified mindfulness-based stress reduction program using group therapy as an active control (Mularski, et al., 2009). However, Fulambacker and colleagues studied a yoga meditation program consisting of various pranayammas, assanas and meditation with a pre-post research design and demonstrated significant improvements in measures of dyspnea, COPD related quality of life, and pulmonary function as measured by PiMax, PeMax and FVC (Fulambarker, Farooki, Kheir, Copur, Srinivasan, & Schultz, 2012). Neither of these research studies attempted to measure breathing parameters that may shed light on the physiological affect of meditation in persons with COPD.

The purpose of this research was to pilot test a modified mindfulness based stress-reduction meditation program designed for persons with COPD. This intervention de-emphasized breathing as a focus of meditation, assists subjects to identify personal and perhaps spiritual mantras and provided positive breathing experiences. Measures were taken to determine if this modified MBSR intervention would be acceptable to persons with COPD and to examine effects on

breathing parameters, anxiety sensitivity, level of mindfulness, COPD symptom burden and view life as more comprehensible, manageable and meaningful.

Methods

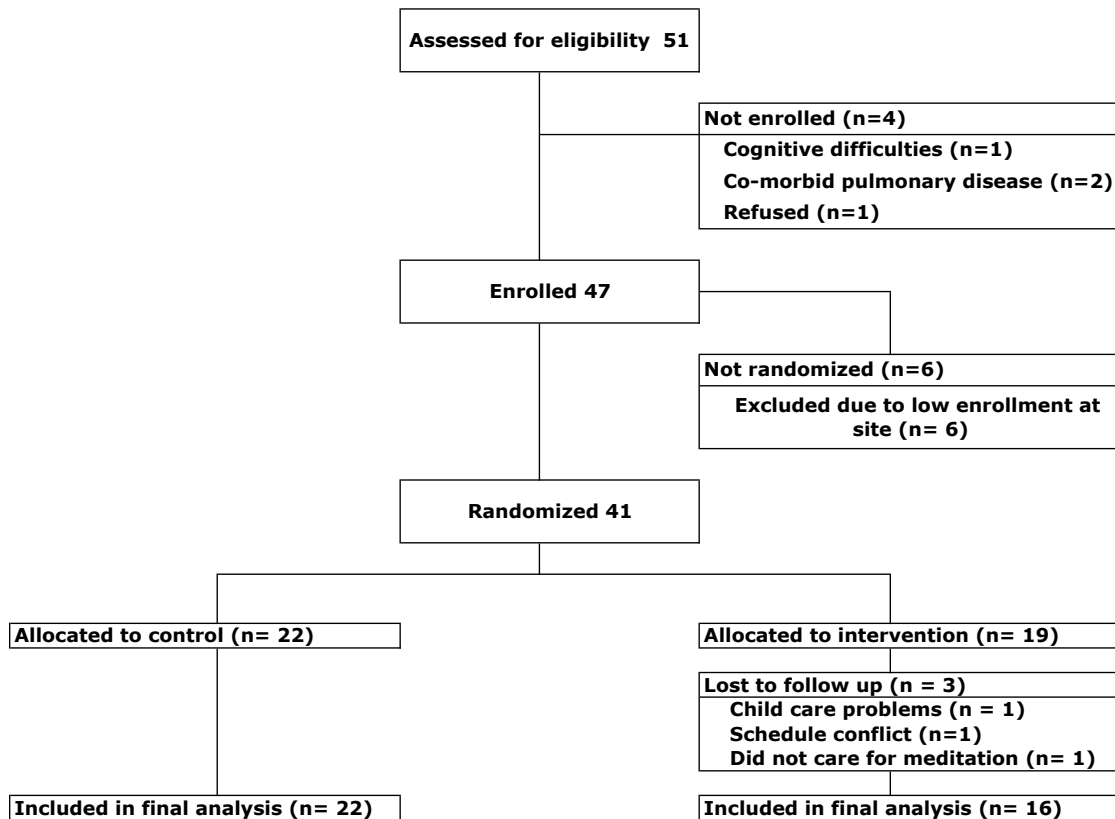
Research Design

Study design. This study used a randomized controlled design with subjects assigned to a meditation intervention group or wait-list group. Data collector and subjects were aware of group assignment. Measures were taken one week prior to attending the first class and one week following completion of the last class. The intervention was comprised of eight sixty-minute classes of modified mindfulness-based stress reduction meditation classes held weekly. Class size was set at a minimum of 5 and a maximum of 15 to promote group interaction and learning. Those randomized to wait-list were offered the classes after all measures were completed. A randomized block design was employed blocking on FEV1% predicted ($< 40\%$ FEV1 and $\geq 40\%$ FEV1). Inclusion criteria were as follows: physician diagnosis of COPD, able to read and write English and having reliable transportation. Exclusion criteria included co-morbid lung diseases, and cognitive difficulties that would impact ability to attend during class. Recruitment was conducted at four pulmonary rehabilitation centers in southeastern Michigan.

Subjects. Fifty one subjects voiced interest initially. Three subjects did not meet criteria one for mental status changes and two had co-morbid pulmonary disease. One subject declined to participate. Forty seven subjects

were enrolled at four sites. Six subjects were excluded because we enrolled less than ten subjects at the fourth site that would have resulted in a meditation class of less than five after randomization. Forty-one subjects were randomized. Three subjects dropped out and were lost to follow-up, all from the treatment group. One discontinued classes prior to the start of the program citing problems getting child care for his grandchildren, one discontinued after the second class because he stated he did not feel his COPD was problematic enough to relate to the other class members and one discontinued after four classes stating that it was simply not for him. A fourth stopped attending classes after week four stating difficulty with the emotional aspects of the class, not wanting to experience “old hurts” during mindfulness training. He reported that he was continuing to use the body scan and mantra meditation with his selected mantra, returned for follow-up measures and was included in the final analysis (See Figure 4.1).

Figure 4.1 consort diagram



Measures

Breathing parameters were measured using Inductive plethysmography with a portable dual elastic band system (Clev-Med bio radio system). Breathing parameter data were reduced with Vivonoetic’s vivosense™ software. Respiratory timing measures included; respiratory rate, respiratory rate variability, expiration time (Te) and synchronization of chest/abdomen movement (absolute phase angle).

The Anxiety Sensitivity Index-revised, (ASI-3) measures ones sensitivity to the sensation of anxiety with an 18 question refined version of the original anxiety sensitivity Index (Taylor, et al., 2007). The original Anxiety Sensitivity Index (ASI) is a widely used measure of anxiety sensitivity, shown to possess a high level of construct validity, internal consistency and test-re-test reliability (Peterson & Reiss, 1992). In persons with COPD, the ASI was predictive of the degree of dyspnea perception during testing with resistive loads (Giardino et al., 2010) and predicted greater dyspnea avoidance (Simon et al., 2006). The ASI correlated moderately with trait anxiety measures, indicating some endurance over time (Reiss, 1991). However, anxiety sensitivity as measured with the ASI-3 has been shown to respond to cognitive behavioral therapy and interceptive experience therapy (Deacon, Lickel, Possis, Abramowitz, Mahaffey, & Wolitsky-Taylor, 2012). In testing of non-clinical populations the 18 item ASI-3 demonstrated a consistent 3 factor solution that was stable and provided the best fit of the data in both men and women. Further testing of the ASI-3 indicated that it has good internal consistency, and strongly discriminated between two latent classes (Bernstein, Zvolensky, Taylor, Abramowitz, & Stewart, 2010). Further studies conclude that the ASI-3 is a better predictor of anxious response than the original ASI (Carter, Sbrocco, & Ayati, 2009).

The Orientation to Life Questionnaire or Sense of coherence (SOC) is a global measure of ones overall ability to cope with life. More specifically it identifies a persons ability to have a dynamic and pervasive sense of confidence that allows them to see life as manageable, meaningful and comprehensible. Persons with a

high sense of coherence can identify and use internal and external resources to meet the demands of life allowing them to acknowledge both the joyfull and the difficult aspects of life. They view the difficult times in life as worthy of investment and engagement (Antonovsky, 1980). It is assessed using the life orientation questionnaire. For this study we used the 13-item Life Orientation questionnaire which been shown to be valid and reliable over time and culture and has been used in 32 countries and translated into 33 languages (Eriksson & Lindstrom, 2005). Higher scores are associated with better physical health, fewer physical symptoms of stress, lower levels of perceived stress, less negative affect, greater positivie affect and greater life satisfaction (Pallent & Lae, 2002).

The Chronic Respiratory Disease Questionnaire (CRQ) measures symptom burden for persons with chronic lung disease. The questionnaire contains four separate and distinct scales that measure dyspnea during common daily activities along with subscales for emotion, fatigue and mastery (Guyatt, Berman, & Pugsley, 1987). The CRQ dyspnea scale has 5 items. At the initial measurement subjects identify the five activities that are most important to them, make them short of breath and they perform on a regular basis. At subsequent measurements subjects rate the intensity of dyspnea experienced during the same five activities (Guyatt, Berman, & Pugsley, 1987; Guyatt, Townsend, Berman, & Pugsley, 1987). The subscale for emotions contains seven questions, five of which target feelings of anxiety and two target feelings of depression. The emotional subscale has significantly correlated with the Hospital Anxiety and

Depression Score, most specifically with the anxiety component of that measure (Duiverman, Wenpe, Bladden, & Kerstjens, 2008; Puhos, Frey, Buchi, & Schunemann, 2008). The fatigue subscale contains four questions that specifically and clearly ask subjects about their level of energy and their level of feeling sluggish or tired. The mastery scale contains four questions that assess how confident and in control subjects are during times of shortness of breath.

CRQ items are constructed with a 7 point Likert-type scale, ordered with higher scores indicating fewer symptoms. Scores for each scale are calculated by summing responses to individual items, yielding a potential range of 5-35 for Dyspnea. The minimal clinically significant change in the CRQ score is associated with a change of .5 per item and a moderate change is associated with a change of 1 per item (Cox, Goodwin, & McWilliams, 2004). Available data support the reliability and validity of the CRQ (Guyatt, Berman, & Pugsley, 1987; Guyatt, Townsend, Berman, & Pugsley, 1987). Stability reliability was demonstrated by a coefficient of variation of 6% for CRQ Dyspnea when the instrument was administered six times over a two-week period of time. Validity of the CRQ was supported by correlations that were consistent with expected relationships between the CRQ and measures of similar or related concepts including a walk test and global rating of dyspnea. Cronbach's alpha coefficients for the CRQ Dyspnea were .76 and .88. This instrument is widely used and we have used it successfully for >10 years and published evidence of its reliability and validity (Guyatt, Townsend, Berman, & Pugsley, 1987).

The Friedberg Mindfulness Inventory (FMI) is a 14-item questionnaire that appears to measure a single holistic concept of mindfulness that is comprised of three or four distinct facets that vary with experience. The questionnaire is based on the teachings from the original Buddhist Pali tradition and assesses the subjects level of mindfulness and ability to tolerate negative sensations and experiences (Buchheld, Grossman, & Walach, 2002). In a study involving experienced meditation practitioners attending a meditation retreat a review of the results of the pre and post questionnaires indicate an increase in mean scores a full standard deviation higher from pre to post ($M_{t1} = 77.12$; $SD_{t1} = 12.45$ and $M_{t2} = 89.4$; $SD_{t2} = 11.33$; $P < 0.001$) indicating that in experienced meditation practitioners the FMI had incremental validity (Buchheld, Grossman, & Walach, 2002). The FMI demonstrated good reliability with an alpha of .93 and .94 respectively, and inter-item correlations of 0.32 and 0.33 respectively. Two independent studies looked at the impact of mindfulness based cognitive therapy and its impact on mindfulness used single group pre-post design. Both studies found that mindfulness as measured by the FMI was significantly negatively correlated with negative affect (Eisendrath, Delucchi, Bitner, Renimore, Smit, & McLane, 2008; Collard, Avny, & Bonwell, 2008).

Statistical analysis. Power analysis using PASS software (Hintze, 2008; Roisin, Rabe, Anzueto, Bourbeau, Calverley, & Casas, 2008) was conducted to determine the number of subjects needed per condition to have 80% power to detect what Cohen (Cohen, 1988) defined as a medium-large effect ($d=.65$, where d =the difference in the means divided by the standard deviation). This analysis

used covariance algebra to determine an adjustment to the standard deviation in ANCOVA due to a pretest-posttest correlation of 0.5. The sample size needed is 29 per group. However, since this was considered a pilot test the research proceeded with 19 subjects in the treatment group and 22 in the control group for a total of 41 subjects.

Data were analyzed using SPSS software. Baseline measures were evaluated using student T-test for differences between groups. Effect of meditation (group X time) was analyzed using general linear modeling for repeated measures. The Mann-Whitney U test was used for comparison between attenders and non-attenders due to low number of non-attenders. Data are presented as mean (standard deviation).

Intervention

The intervention consisted of eight sixty-minute classes of modified mindfulness-based stress reduction meditation classes held weekly. A registered nurse (RC) conducted the classes. She is an advanced board certified holistic nurse trained in MBSR who maintains a personal mindfulness meditation practice. Class sessions were not recorded, however, the nurse leader made extensive notes immediately after each session that were then transcribed and used to establish consistency between sites. A teaching manual was developed based on the Mindfulness Based Stress Reduction University of Massachusetts program along with additional material address issues of living with COPD.

Weekly handouts and a CD of all meditations and exercises were provided to each participant. Modifications to the MBSR program were as follows:

- Reduced focus on breath until week four
- Introduced concept of spiritual mantra
- Substituted QiGong for yoga
- Taught Ujjayi breathing
- Used labyrinth for walking meditation

Focus on the breath: Our first modification of the MBSR program was an attempt to find alternative focuses for the body scan and concentrative meditation practice other than the breath. In other meditation research it was found that a concentration on areas of the body that directly related to current illness was anxiety provoking and could interfere with ability to fully engage in meditation (Foley, Baillie, Huxter, Price, & Sinclair, 2010). For this reason the body scan was taught with an optional focus on the heartbeat or sensations of color and/or vibration.

Spiritual mantra: Herbert Benson's relaxation response was originally developed as a secular mantra meditation skill with a focus on the breath or the word "one" (Benson H. , 1975). After years of meditation research, Dr. Benson adapted the relaxation response to include spiritual mantras. In a subsequent book he implied that persons who maintain a spiritual intention in their meditation practice meditate over a longer period of time and pursue more complex meditation skills (Benson H. , 1996). There is substantial support for the

efficacy of using spiritually based mantras. Wachholtz and colleagues compared meditation interventions using a spiritually based mantra to those using a secular self-based mantra and a third group practicing progressive muscle relaxation (Wachholtz & Pargement, 2005). In their first study Wachholtz and Pargement found that subjects in the spiritual mantra group demonstrated a significant decrease in anxiety ($P < 0.00$) a significant increase in positive mood ($P < 0.01$) and were able to tolerate a 50% increase in time spent in cold pressor test ($P < 0.05$) in comparison with those in the secular mantra group (2005). They then repeated this study design with a group of migraine headache sufferers. The results indicated that the migraine sufferers who participated in the spiritual mantra meditation group had a significant decline in the number of headaches ($P < 0.01$), a significant increase in pain tolerance ($P < 0.05$) and migraine headache management self-efficacy ($P < 0.00$) as opposed to those in the secular mantra group (Wachholtz & Pargement, 2008). Borman and colleagues also studied the use of spiritual meditation through the use of spiritually based mantras in HIV positive subjects and found increases in long term positive reappraisal coping that was predicted by a more immediate reduction in anger (Borman & Carrico, 2009; Borman, et al., 2006). The spiritually based mantra is a simple way to establish a spiritual intention and we used the Mantran Handbook as a guide to assisting subjects to identify their own spiritually based mantra (Easwaran, 1977).

QiGong: Traditionally, all schools of meditation included teachings that developed the student's ability to connect the experience of their physical body to

the larger experience of the universe. These teachings were facilitated by extending the experience of mindfulness to the body through movements and postures that are part of the practice of yoga, Tai Chi and QiGong (Chaoul & Cohen, 2010). This increase in body awareness is important for persons with chronic disease (Wang, Collet, & Lau, 2004) who tend to over focus on primary symptoms of their disease. Persons with COPD focus on their shortness of breath and lose ability to connect with other more positive body sensations. This results in an unbalanced assessment of their state of health and a consequent decreased participation in rehabilitative activities and poorer quality of life (Giardino, et al., 2010). In this study, QiGong as opposed to yoga was selected as a vehicle to promote body awareness due to the difficulty persons with COPD may have with the more static yoga stretches that require a prolonged breath. QiGong is a more fluid practice that can be done standing or seated. It also highlights the concept of having the breath lead muscle movement, meaning that movement accommodates normal calm breathing. This is in direct opposition to activities they encounter in traditional rehabilitation exercises where muscle movement is encouraged requiring an increase in breathing rate and depth. Recent research has shown QiGong to lower blood pressure, increase mental health, functional balance and immune function (Larkey, Jahnke, Etneir, & Gonzalez, 2009). It has also been shown to improve aerobic capacity and ventilatory efficiency (Lan, Chow, Chen, Lai, & Wong, 2004). Four QiGong exercises were included in this meditation intervention; Lung wake up, Lung release, QiGong walking and Lung meditation.

Ujjai breathing: Ujjai breathing is a diaphragmatic breath that first fills the lower belly, rises to the lower rib cage, and finally moves into the upper chest and throat. Inhalation and exhalation are both done through the nose. The "ocean sound" is created by slightly constricting the glottis as air passes in and out. As the throat passage is narrowed so, too, is the airway, the passage of air through which creates a "rushing" sound. The diaphragm is then used to control the length and speed of the breath, strengthening the diaphragm and bringing increased awareness and enjoyment to the process of breathing. The inhalations and exhalations are equal in duration, and are controlled in a manner that causes no distress to the practitioner.

Labyrinth: Persons with COPD often become short of breath when walking requiring them to pace their daily activities. Walking is also a major diagnostic tool that lets the person with COPD and the health care provider know if the disease is advancing or under control. Thus walking can be associated with many negative emotions. For this reason, labyrinth walking was selected to allow subjects to decrease their fearful anticipation of walking by developing a meditative focus while walking slowly. It was explained to the subjects that walking a labyrinth has been associated with the sensation of taking a breath as one walks into the middle of the labyrinth and then out again, thus allowing them to develop a positive association with walking and fully experience walking at a slow pace.

Procedures

Subjects were randomized to a meditation intervention group or a wait-list group, both of whom continued to receive normal care and continued to attend their respective pulmonary rehabilitation programs. The wait list group participated in the meditation intervention immediately after follow-up measures were obtained. All persons in the wait list group were allowed to participate to the same extent as the active group. They attended the same classes at the same location with the same meditation instructor. They also participated by completing weekly journal sheets and were given homework assignments and written handouts and the audio CD. The differences between the meditation intervention group and wait list group were that the wait list had a delayed start and follow-up measures were not repeated after they completed the eight-week meditation intervention.

During the first meeting subjects met with the intake researcher at their respective pulmonary rehabilitation site. A comfortable, non-clinical room close to the workout room was reserved for this purpose. During this initial visit, subjects were presented with informed consent. After subjects signed informed consent all pre-measures were obtained including screening PFTs, demographic information, paper surveys and breathing parameters. To collect baseline breathing parameters, subjects were seated in a comfortable chair and fitted with the elastic inductive plethysmography bands. After a five-minute period of acclimation, respiratory measures were taken for approximately ten minutes

depending on the quality of the signal captured. All subjects were instructed to refrain from speaking while measurements of their breathing were taken. After all baseline data was collected, the subjects were randomized.

The meditation intervention group then attended eight weekly classes as described above. During the first class they signed a confidentiality agreement to not discuss the content of the class with fellow pulmonary rehabilitation participants. During week ten, follow-up measures were taken from both treatment and control group members in the same fashion as the base-line measures. At week 10 the wait list group began attending the eight-week meditation intervention.

Results

Baseline results. The subjects were mostly female 33/48, with a mean age of 69.5 (7.9) and mean of 6.78 (5.84) years since diagnosis with COPD. This was a highly functional group with 20% currently attending pulmonary rehabilitation and another 70% attending self-pay maintenance programs at a pulmonary rehabilitation center. Only 6% of the subjects had never attended and/or were not now attending any type of pulmonary rehabilitation program. Of the 41 subjects randomized, 84% had no experience with any type of meditation and 23% had very little experience mostly reading about meditation or trying meditation on their own without instruction. Eleven percent had taken some type of meditation class, most often that experience was taking TM classes in the 1960's and early 1970's when TM was newly popular to the United States. One

subject in the wait list group had advanced training and was currently teaching meditation. There was no difference between the groups in terms of FEV1% predicted (P = 0.861). However, the meditation intervention group had statistically and clinically significant less dyspnea (meditation intervention group mean 4.86 (1.69), and wait list group mean 3.84 (1.31); P = 0.035) and statistically and clinically less anxiety sensitivity (Meditation intervention group mean 14.44 (10.23), and control group 25.45 (15.62); P = 0.016). (See Table 4.1)

Table 4.1 Comparisons of baseline measures between meditation intervention group and wait list group

Variable	Group	Mean	SD	Test for equality of means		
				T value	df	Sig level (two tailed)
Dyspnea	Meditation	4.86	1.69	2.19	39	0.04
	Wait list	3.84	1.31			
ASI-3	Meditation	14.44	10.23	-2.54	36	0.02
	Wait list	25.45	15.62			
SOC	Meditation	66.63	12.27	1.17	39	0.25
	Wait list	61.59	15.00			
FMI	Meditation	41.89	8.37	1.23	38	0.28
	Wait list	38.59	8.51			
FEV1% Predicted	Meditation	44.82	21.45	-0.18	37	0.86
	Wait list	45.91	15.13			

A review of the meditation intervention group demonstrated good participation in the class with twelve of the subjects attended six or more classes. The group also demonstrated high level of home practice. Fourteen of the subjects in the meditation intervention group practiced meditation three or more

times a day with thirteen of the group reporting practicing meditation between 10 and 30 minutes with each attempt at meditation (see Table 4.2).

Table 4.2 Participation in meditation intervention activities for meditation intervention group

Measures	N	Mean	Maximum	Minumum
Number of classes attended	19	5.7	8	0
Average number of days meditating per week	18	3.85	7	0
Average number of minutes meditating per meditation attempt	17	22.04	51.43	9.79

Treatment effects. Subjects in the mediation intervention group demonstrated a statistically significant time x group increase in respiratory rate at the end of the meditation intervention compared to the wait list group (15.93(2.82) to 21.30(3.05)) vs (17.18(6.44) to 18.73(4.31)), ($P = 0.05$) (see figure 4.2) and no significant time x group change in expiratory time, absolute phase angle or respiratory rate variability. The change in respiratory rate was not correlated with change in the Orientation to Life Questionnaire, the Anxiety Sensitivity index-3 or the Friedburg Mindfulness Index.

The anxiety sensitivity and sense of coherence did not demonstrate a significant interaction effect, however the Freidburg mindfulness inventory significantly decreased in the meditation intervention group in comparison to the wait list group over time (42.75 (8.10) to 40.43 (8.25)) vs (38.48 (8.70) to 40.09 (7.84)), ($P = 0.02$) (see figure 4.3). Two subscales of the CRQ showed improvement after the intervention as compared with the control group, but the changes were not statistically significant. The emotional subscale increased in the

meditation intervention group as compared to the wait list group over time (5.08 (1.26) to 5.42 (1.05)) vs (4.33 (1.13) to 4.24 (1.06)), (P = 0.06) (see figure 4.4) and the mastery subscale increased in the meditation intervention group as compared to a decrease in the wait list group over time (5.10 (1.26) to 5.47 (1.25)) vs (4.31 (1.36) to 4.09 (1.07)), (P = 0.06) (see figure 4.5).

Figure 4.2: Change in respiratory rate pre-post intervention by group

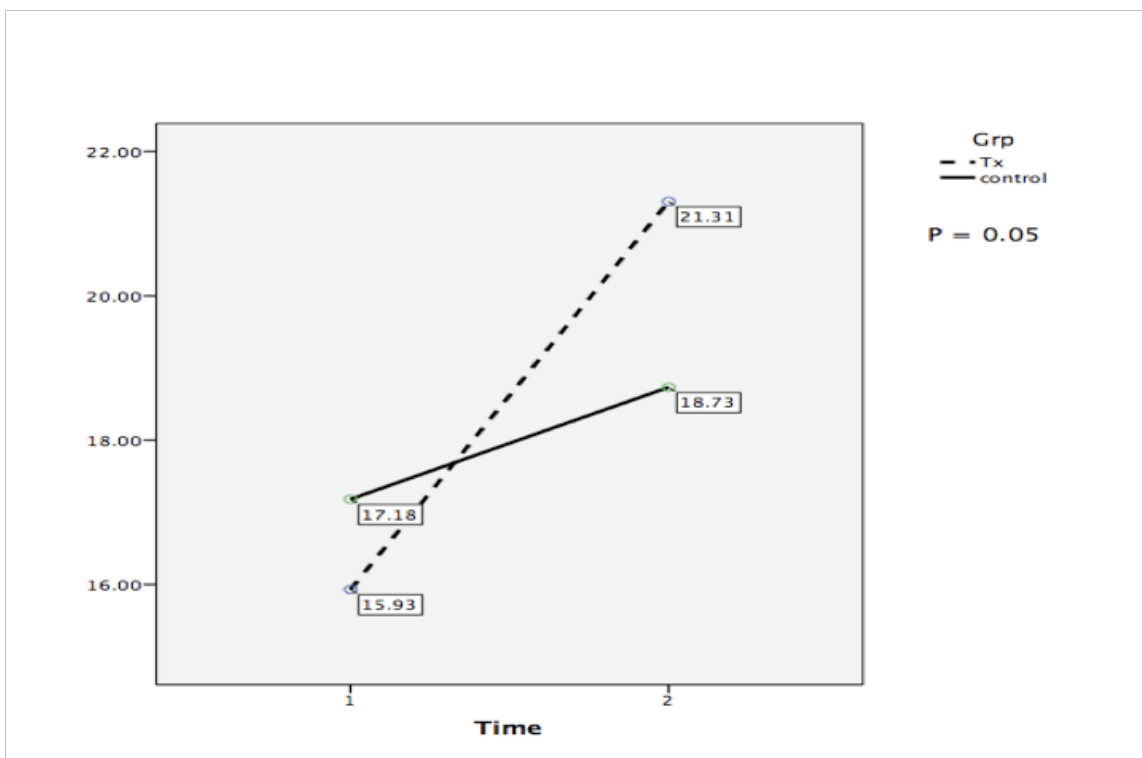


Figure 4.3: Change in FMI pre-post intervention by group

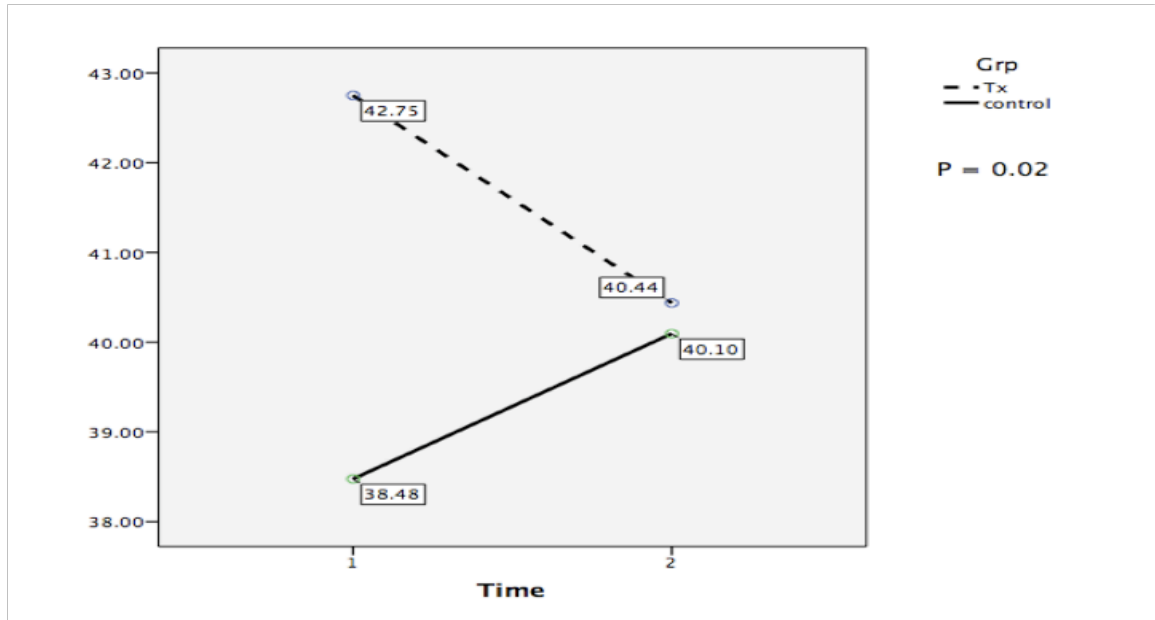


Figure 4.4: Change in CRQ emotional scale pre-post intervention by group

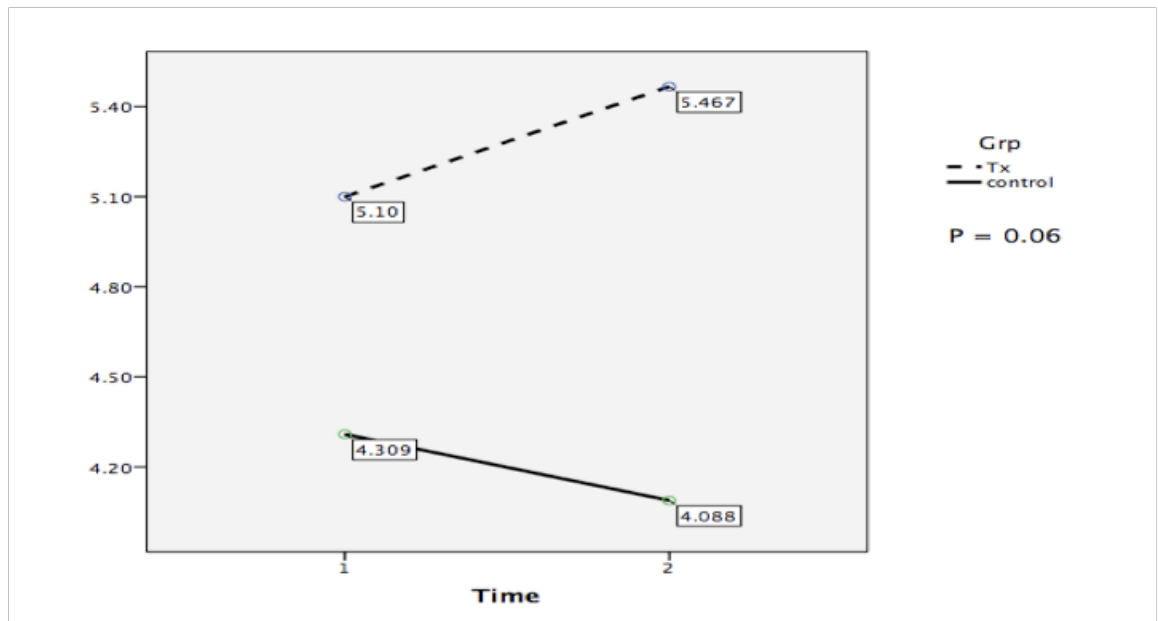
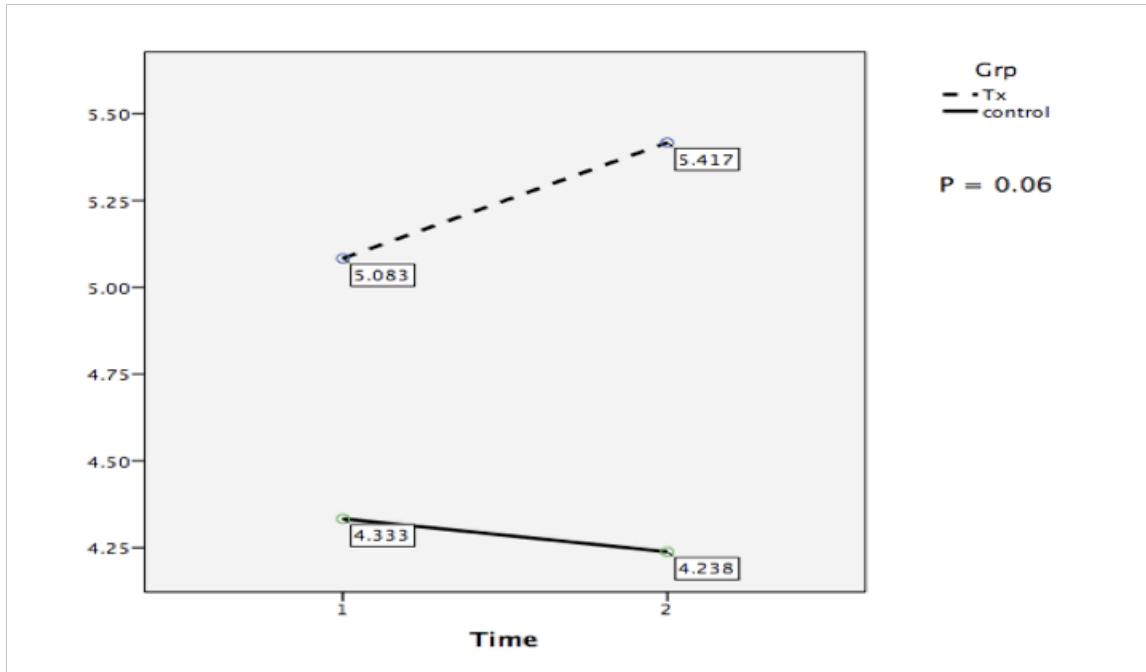


Figure 4.5: Change in CRQ mastery scale pre-post intervention by group



In an effort to understand the decrease in mindfulness in the meditation intervention group the FMI was subject to principal factor analysis with direct oblimin rotation. Three latent variables were identified; body awareness, present moment awareness and self-acceptance. When these variables were assessed separately, only the sub-scale for body awareness decreased significantly in the treatment group as opposed to the control group over time (10.25 (1.69) to 9.00 (1.63) vs. (9.22 (1.69) to 9.27 (2.00)), $P = .001$).

Barriers and support for developing a practice of meditation. A comparison of the adherence for the meditation intervention group and wait list group indicated that both groups spent a similar amount of time meditating each

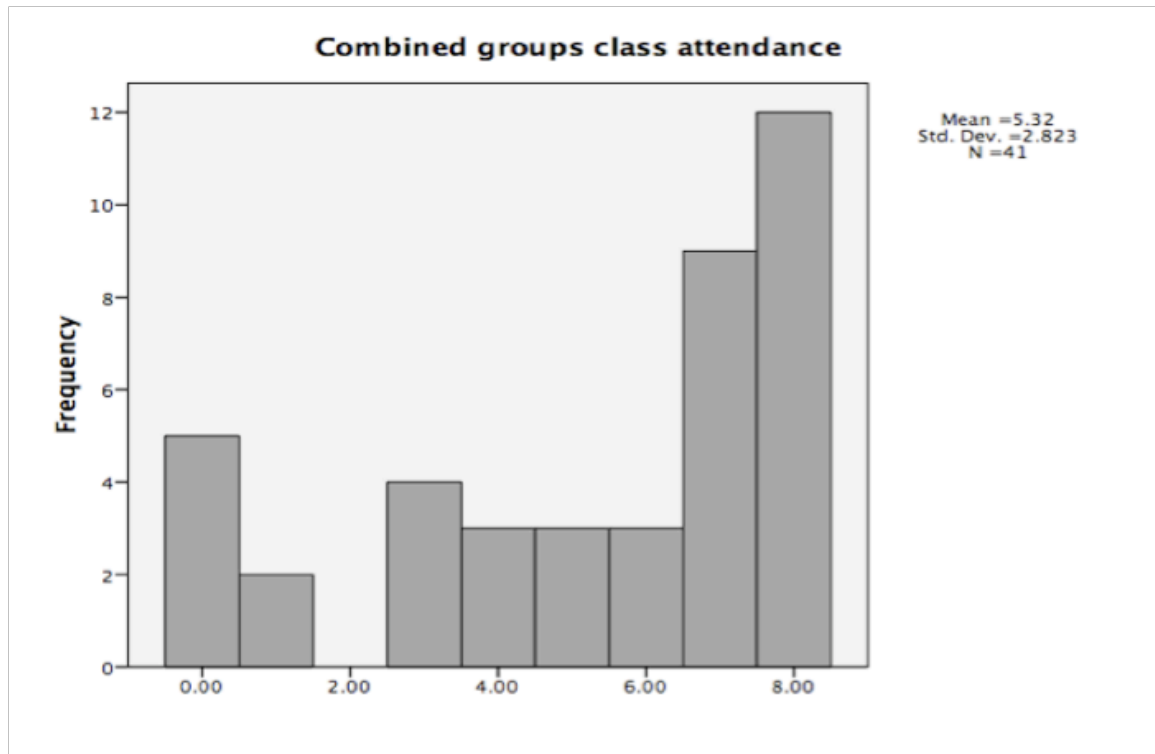
time they meditated during at home practice, spent a similar number of days meditating per week and attended a similar number of classes overall. Based on this information the meditation intervention group and wait list group were combined into a single group in order to identify barriers or support for their practice of meditation. Out of the 42 subjects consented to attend meditation classes 51% attended 7 or 8 classes with only 5 not attending any class at all. Of the 37 subjects who attended classes an average of 24 subjects returned weekly logs indicating time spent in meditation per week and number of days per week meditation was attempted were included.

For the combined groups it was found that the baseline measure of CRQ emotion significantly positively correlated with number of classes attended ($r = .35, P = 0.05$). When considering the two questions on the weekly logs, 1) How helpful has meditation been this week and 2) How much worrying thoughts have you had this week, only helpfulness of meditation significantly correlated with number of days per week that subjects reported having meditated ($r = .36, P = 0.05$). How much worrying thoughts a subject had did not correlate with time spent in meditation or class attendance.

A review of histograms for class attendance identified a similar natural break between those attending one or no classes and those attending two or more classes in both the treatment and the control group (see Figure 6). Therefore, non-attenders were defined as those subjects who attended ≤ 1

meditation classes and attenders were defined as those who attended > 1 meditation classes (7/32).

Figure 4.6



Due to low numbers in the non-attending group the scores from the baseline measures were compared using a Mann-Whitney U-test. Non-attenders significantly differed from attenders in that they demonstrated significantly less mastery, emotional function and significantly more fatigue based on the CRQ. Also, they demonstrated significantly lower sense of coherence. Using information gained from the factor analysis completed on the results for the FMI in this study, it was found that the non-attenders had significantly lower scores in the self-acceptance and present-moment-awareness subscales as opposed to the body awareness subscale. Finally, the non-attenders had significantly higher

anxiety sensitivity than attenders with a mean rating that is consistent with a diagnosis of panic. In reviewing the subscales of the ASI-3 we found that the non-attenders had significantly more anxiety sensitivity around social issues as opposed to cognitive or physical issues (See Table 4.3).

Table 4.3: Mann-Whitney U test differences between attenders and non-attenders

Comparisons between Non-attenders (≤ 1 class) and Attenders (> 1 class)		
Variable	Whitney-U	P value
CRQ fatigue	28.00	0.02
CRQ Mastery	8.00	0.01
CRQ emotion	12.50	0.00
Sense of Coherence	47.50	0.01
ASI-3	9.50	0.00
ASI-3 social subscale	57.50	0.03
ASI-3 physical subscale	73.50	0.12
ASI-3 cognitive subscale	94.50	0.40
FMI	58.00	0.04
FMI body awareness variable	95.00	0.42
FMI present moment variable	62.00	0.05
FMI self-acceptance variable	53.00	0.03

Discussion

The major findings in this study were that respiratory rate was the only breathing timing parameter to demonstrate a time x group change, increasing significantly more in the meditation intervention group than the wait list group. Mindfulness also demonstrated a time x group change, decreasing in the meditation intervention group as compared to the wait list group. Both were contrary to expectations. However, the decrease in mindfulness did not significantly correlate with the increase in respiratory rate.

The unexpected drop in mindfulness in the treatment group deserves further discussion. It is not uncommon to see non-significant results when measures are taken immediately after an eight week meditation intervention with significant improvement demonstrated only at four, six or one year follow-up measures (Creamer, Singh, Hochberg, & Berman, 2000; Pradhan, et al., 2007; Rosenzweig, et al., 2007; Sephton, et al., 2007; Kabiat-Zinn, 1982; Coleman, 2010). However, other potential causes for the decrease in mindfulness may have been the decreased class time or discomfort with focusing on their breath during meditation.

Standard MBSR classes are scheduled for ninety-minute classes for eight weeks. Our class time was shortened to eight sixty-minute classes to accommodate subjects need to be on oxygen support and because of their fatigue due to COPD. This may have not provided enough time with the instructor to adequately learn meditation techniques. Also, although the meditation class was

modified to decrease focus on the breath, some subjects reported during class that they choose to use the breath as a source of focus for the body scan and occasionally during mantra meditations and QiGong exercises. Despite statements of comfort with and their willingness to participate in meditation, it could be that the subjects became less mindful in an attempt to block uncomfortable sensations around focusing on their breath. Body awareness was the only mindfulness factor to significantly change over time providing evidence to support this notion. Despite the decrease in mindfulness, the treatment group did demonstrate a trend toward improvement in both the CRQ emotion and CRQ mastery that however did not reach significance. Perhaps these would have reached significance if the study had been fully powered.

Neither the SOC nor the ASI-3 levels changed significantly as a result of attending the meditation intervention. It is not unexpected that the levels of the SOC were unchanged by exposure to the meditation intervention. The SOC is a rather enduring characteristic with most change seen in those under thirty (Antonovsky, 1980). Further, at baseline the SOC was at very high levels indicating that the lack of change may also be due to a ceiling effect. It is important to note that the majority of persons who enrolled in this study were highly motivated individuals who were seeking out pulmonary rehabilitation beyond that prescribed by their physician. The lower levels of anxiety sensitivity found in the meditation group at baseline, thus demonstrating a floor effect, can perhaps explain the lack of effect with respect to anxiety sensitivity.

Interestingly it was found that non-attenders had significantly lower levels on the SOC and significantly higher levels on the ASI-3. The low SOC indicates an inability to identify and use resources that is consistent with their decision to not attend the program. The higher level of anxiety sensitivity demonstrated by non-attenders suggests that a diagnosis of anxiety or panic, as implied by a level of anxiety sensitivity over 25, may impede one's ability to participate in beginning meditation (Delmonte, 1984). More specifically, the social sub-scale of the ASI-3 that was significantly higher in non-attenders may be an indication that the group style of the class may have been anxiety provoking for these subjects.

Potential support to participating in meditation was perhaps captured by the CRQ emotional scale and the weekly journal question of "how helpful was meditation this week. Helpfulness was positively correlated with number of days subjects meditated per week. Also, the baseline measure of CRQ-emotion was positively correlated to a moderate degree with number of classes attended.

Limitations of the study and future research

This study was limited by a small sample size and short data collection time that potentially obstructed out ability to glean significant results. It is recommended that future research on meditation in persons with chronic disease and in particular those with COPD be of longer duration, although not necessarily longer session time. It is also recommended that measures be taken post intervention and then four and six months after the intervention class experience both with and without reminder sessions or booster meditation classes.

Bibliography

- Aftanas, L., & Golocheikine, S. (2001). Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high resolution EE investigation of meditation. *Neuroscience letters*, *310* (1), 57.
- Allison, J. (1970). Respiratory changes during transcendental meditation. *Lancet*, *1*, 833.
- Allison, J. (1970). Respiratory changes during transcendental meditation. *Lancet*, *1* (7651), 833-4.
- Antonovsky, A. (1980). *Health, stress and coping*. San Francisco, CA, U.S.A.: Jossey-Bass Publishers.
- Arambula, P., Peper, E., Kawakami, M., & Gibney, K. (2001). The physiological correlates of Kundalini yoga meditation: a study of a yoga master. *Applied Psychophysiological biofeedback*, *26* (2), 147-53.
- Arias, A., Steinberg, K., Banga, A., & Trestman, R. (2006). Systematic review of the efficacy of meditation techniques as treatments for medical illness. *The journal of alternative and complementary medicine*, *12* (8), 817-832.
- Baer, M. (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clinical Psychology: Science and Practice*, *10* (2), 125.
- Bailey, P. (2004). The dyspnea-anxiety-dyspnea cycle - COPD patients stories of breathlessness; it is scary when I can't breathe. *Qualitative health research*, *14* (6), 760.
- Banzett, R., Mulnier, H., Murphy, K., Rosen, S., Wise, R., & Adams, L. (2000). Breathlessness in humans activates insula cortex. *Neuroreport*, *11* (10), 2117.
- Benson, H. (1975). *The Relaxation Response*. New York, New York: Morrow.
- Benson, H. (1996). *Timeless healing*. New York, NY, U.S.A.: Scriber.
- Bernardi, L., Passino, C., Spaducini, G., Bonfichi, M., Arcaini, L., Malcovati, L., et al. (2007). Reduced hypoxic ventilatory response with preserved blood oxygenation in yoga trainees and himalayan Buddhist monks at altitude: evidence of a different adaptive strategy? *European Journal of Applied Physiology*, *99*, 511-518.
- Bernstein, A., Zvolensky, M., Taylor, S., Abramowitz, J., & Stewart, S. (2010). Dimensional, categorical, or Dimensional-categories: testing the latent structure of anxiety sensitivity among adults using factor-mixture modeling. *Behavior Therapy*, *41*, 515-529.

Borman, J., & Carrico, A. (2009). Increases in positive reappraisal coping during a group-based mantram intervention mediates sustained reductions in anger in HIV positive persons. *International journal of behavioral medicine* , 16, 74-80.

Borman, J., Gifford, A., Shively, M., Smith, T., Redwine, L., Kelly, A., et al. (2006). Effects of spiritual mantram repetition on HIV outcomes: a randomized controlled study. *Journal of behavioral medicine* , 29 (4), 359-375.

Bowen, S., Witkiewitz, K., Dillworth, T., & Marlatt, A. (2007). The role of thought suppression in the relationship between mindfulness meditation and alcohol use. *Addictive behavior* , 32 (10), 2324-8.

Brenes, G. A. (2002). Anxiety and chronic obstructive pulmonary disease: Prevalence, impact and treatment. *Psychosomatic Medicine* , 65 (6), 963.

Buchheld, N., Grossman, P., & Walach, H. (2002). Measuring mindfulness in Insight Meditation (Vipassana) and Meditation-Based Psychotherapy: The development of the Freiburg Mindfulness Inventory (FMI). *Zeitschrift fur Klinische Psychologie: Psychiatrie und Psychotherapie* , 50 (2).

Carrieri-Kohlman, V. (1996). Differentiation between dyspnea and its affective components. *Western Journal of Nursing Research* , 626.

Carter, M., Sbrocco, T., & Ayati, F. (2009). Predicting anxious response to a social challenge and hyperventilation: comparison of the ASI and ASI-3. *Journal of behavior therapy and experimental psychiatry* , 40, 434-442.

Chaoul, A., & Cohen, L. (2010). Rethinking yoga and the application in modern medicine . *Cross Currents* , 60 (12), 144.

Cheung, M., Han, Y., & Chan, A. (2008). Electroencephalographic (EEG) measurements of mindfulness-based triarchic body-pathway relaxation technique: A pilot study. *Applied Psychophysiology and Biofeedback* , 33 (1), 39.

Cho, S., Heiby, E., McCracken, L., Lee, S., & Moon, D. (2010). Pain-related anxiety as a mediator of the effects of mindfulness on physical and psychosocial functioning in chronic pain patients in Korea. *The Journal of Pain* , 11 (8), 789-797.

Clark, D. (1986). A cognitive approach to panic. *Behavioral research and therapy* , 24 (4), 461-470.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, N.J., U.S.A.: Erlbaum Associates.

Coleman, J. (2010). Spring Forest Qigong and chronic pain: Making a difference. *Journal of holistic nursing* , 29 (2), 118-128.

- Collard, P., Avny, N., & Bonwell, I. (2008). Teaching Mindfulness-Based Cognitive Therapy (MBCT) to students: The effects of MBCT on the levels of mindfulness and subjective well-being. *Counseling Psychology Quarterly*, 21 (4), 65.
- Correll, C., Rosendranz, A., & Grace, A. (2005). Chronic cold stress alters prefrontal cortical modulation of amygdala neuronal activity in rats. *Biological psychiatry*, 58, 382-391.
- Covey, M., Larson, J., Wirtz, S., Berry, J., & Alex, C. (2001). High intensity inspiratory muscle training in patients with chronic obstructive pulmonary disease and severely reduced function. *Journal of Cardiopulmonary Rehabilitation*, 21, 231-240.
- Cox, B., Goodwin, R., & McWilliams, L. (2004). Depression and anxiety associated with three pain conditions" Results from a nationally representative sample. *Pain*, 111 (12), 77.
- Creamer, P., Singh, B., Hochberg, M., & Berman, B. (2000). Sustained improvement produced by nonpharmacologic intervention in fibromyalgia: Results of a pilot study. *Arthritis care and research*, 13 (4), 198-204.
- Culpepper, L. (2009). Generalized anxiety disorder and medical illness. *The journal of clinical psychiatry*, 70 (suppl 2), 20.
- Cysarz, D., & Bussing, A. (2005). Cardiorespiratory synchronization during Zen meditation. *European Journal of Applied Physiology*, 95, 88-95.
- Danucalov, M. (2008). Cardiorespiratory and metabolic changes during yoga sessions: The effects of respiratory exercises and meditation practices. *Applied Psychophysiology*, 33 (2), 77.
- Davidson, R. (2002). Anxiety and affective style: Role of prefrontal cortex and amygdala. *Society of biological psychiatry*, 51, 68-80.
- Davidson, R. (2010). Empirical explorations of mindfulness: Conceptual and Methodological conundrums. *Emotion*, 10 (8), 8-11.
- Davidson, R., Goleman, D., & Schwartz, G. (1976). Attentional and affective concomitants of meditation: a cross sectional study. *Journal of abnormal psychology*, 85 (2), 235-8.
- Deacon, B., Lickel, J., Possis, E., Abramowitz, J., Mahaffey, B., & Wolitsky-Taylor, K. (2012). Do cognitive reappraisal and diaphragmatic breathing augment interoceptive exposure to anxiety sensitivity. *Journal of cognitive psychotherapy*, 26 (3), 257-269.
- Delmonte, M. (1984). Factors influencing the regularity of meditation practice in a clinical population. *British journal of medical psychology*, 57, 275-278.

Dobkin, P. (2008). Mindfulness-based stress reduction: what process are at work? *Complementary Therapies*, 14, 8-16.

Dobkin, P., & Zhao, Q. (2011). Increase mindfulness-The active component of the mindfulness-based stress reduction program? *Complementary therapies in clinical practice*, 17, 22-27.

Easwaran, E. (1977). *The Mantram Handbook*. Canada: Nilgiri Press.

Eifert, G., Zvolensky, M., Sorrell, J., & Hopko, D. (1999). Predictors of self-reported anxiety and panic symptoms: An evaluation of anxiety sensitivity, suffocation fear, heart-focused anxiety and breath-holding duration. *Journal of psychopathology and behavioral assessment*, 21 (4), 293.

Eisendrath, S., Delucchi, k., Bitner, R., Renimore, P., Smit, M., & McLane, M. (2008). Mindfulness-based cognitive therapy to treatment-resistant depression: A pilot study. *Psychotherapy and psychosomatics*, 77 (5), 120.

Eisner, M., Blanc, P., Yelin, E., Katz, P., Sanchez, G., Iribaren, C., et al. (2009). Influence of anxiety on health outcomes in COPD. *Thorax*, 65, 229-234.

Elliott, M., Adams, L., Cockroft, A., MacRae, K., & Guz, A. (1991). The language of breathlessness: use of verbal descriptors by patients with cardiopulmonary disease. *American Review Respiratory Disease*, 144 (4), 826.

Emery, C., Schein, R., Hauk, E., & MacIntyre, N. (1998). Psychological and cognitive outcomes of a randomized trial of exercise among patients with chronic obstructive pulmonary disease. *Health and Psychology*, 17, 232-40.

Eriksson, M., & Lindstrom, B. (2005). Validity of Antonovski's sense of coherence scale: A systematic review. *Journal of epidemiology and community health*, 59, 460-6.

Firth, P., Petkov, J., Olds, T., Cafarella, P., & Williams, M. (2008). The language of breathlessness differentiates between patients with COPD and age-matched adults. *Chest*, 134 (3), 489.

Foglio, K., Bianchi, L., Porta, R., Vitacca, M., & Balbi, B. (2007). Seven-year time course of lung function symptoms, health-related quality of life, and exercise tolerance in COPD patients undergoing pulmonary rehabilitation programs. *Respiratory Medicine*, 101 (9), 1961.

Foley, E., Baillie, A., Huxter, M., Price, M., & Sinclair, E. (2010). Mindfulness-based cognitive therapy for individuals whose lives have been affected by cancer: A randomized controlled trial. *Journal of consulting and clinical psychology*, 78 (1), 72-79.

Fraser, R., Pare', P., Pare', P. D., & Genereux, G. (1990). *Diagnosis of diseases of the chest*. Philadelphia, PA: Saunders.

- Freire, R., Lopes, F., Valenca, A., Nascimento, I., Veras, A., Mezzasalma, M., et al. (2008). Panic disorder respiratory subtype: A comparison between responses to hypoventilation and CO2 challenge tests. *Psychiatry research*, *157*, 307-310.
- Fried, R. (1987). Relaxation with biofeedback-assisted guided imagery: The importance of breathing rate as an index of hypoarousal. *Biofeedback and self-regulation*, *1* (4), 273.
- Fulambarker, A., Farooki, B., Kheir, F., Copur, A., Srinivasan, L., & Schultz, S. (2012). Effect of yoga in chronic obstructive pulmonary disease. *American journal of therapeutics*, *19*, 96-100.
- Giardino, N., Curtis, J., Abelson, J., King, A., Pamp, B., Liberzon, I., et al. (2010). The impact of panic disorder on interoception and dyspnea reports in chronic obstructive pulmonary disease. *Biological psychology*, *84*, 142-146.
- Giardino, N., Curtis, J., Abelson, J., King, A., Pamp, B., Liberzon, I., et al. (2010). The impact of panic disorder on interoception and dyspnea reports in chronic obstructive pulmonary disease. *Biological Psychology*, *In press*.
- Gjhal, A., Krompinger, J., Baime, M., & Jha, A. (2007). Mindfulness training modifies subsystems of attention. *Cognitive affective behavioral neuroscience*, *7* (2), 109.
- Grossman, P. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of Psychosomatic Research*, *57* (1), 35.
- Guyatt, G., Berman, L., & Pugsley, S. (1987). A measure of quality of life for clinical trials in chronic lung disease. *Thorax*, *42*, 773-778.
- Guyatt, G., Townsend, M., Berman, L., & Pugsley, S. (1987). Quality of life in patients with Chronic airflow limitatoin. *British Journal of Disease of the Chest*, *81*, 45-54.
- Han, J., Stegan, K., Caubergh, M., & van de Woestijne, K. (1997). Influence of awareness of breathing on respiratory patterns in healthy humans. *The European Respiratory Journal*, *10* (1), 161.
- Hintze, J. (2008). *PASS 2008 users' guide*. Kaysville, UT, U.S.A.: Number Cruncher.
- Hochstetter. (2005). An investigatoin into the immediate impact of breathlessness management on the breathless patients: Randomised controlled trial. *Physiotherapy*, *91* (3), 178.
- Homma, I., & Masaoka, Y. (2008). Breathing rhythms and emotions. *Experimental Physiology*, *93* (9), 1011-1021.

- Incalzi, Marra, Giordano, Calcagni, Cappa, & Basso. (2003). Cognitive impairment in chronic obstructive pulmonary disease - a neuropsychological and spect study. *Journal of Neurology*, 250 (3), 325.
- Irving, J., Dobkin, P., & Park, J. (2009). Cultivating mindfulness in health care professionals: A review of empirical studies of mindfulness-based stress reduction (MBSR). *Complementary Therapies in Clinical Practice*, 15 (2), 61.
- Jha, A., Krompinger, J., & Baime, M. (2007). Mindfulness training modifies subsystems of attention. *Cognitive affective behavioral neuroscience*, 7 (2), 109.
- Jones, R., Harding, S., Chung, C., & Campbell, J. (2008). The prevalence of post-traumatic stress disorder in patients undergoing pulmonary rehabilitation and changes in PTSD symptoms following rehabilitation. *Journal of Cardiopulmonary Rehabilitation and Prevention*, 29 (1), 49.
- Kabat-Zinn, J. (1982). An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results. *General Hospital Psychiatry*, 4 (1), 33.
- Kim, Y., Kim, S., Park, S., Lee, S., & Lee, K. (2002). Changes in EEG of children during brain respiration-training. *The American Journal of Chinese Medicine*, 30 (2 and 3), 465.
- Klauke, B., Deckert, J., Reif, A., Pauli, P., & Domschke, K. (2010). Life events in panic disorder - an update on "candidate stressors". *Depression anxiety*, 27 (8), 716-730.
- Koulouris, N., Valta, P., Lavoie, A., Corbeil, A., Chasse', M., & Braidy, J. (1995). A simple method to detect expiratory flow limitation during spontaneous breathing. *The European respiratory journal*, 8 (2), 306.
- Krisanaprakornkit, T., Piyavhatkul, N., Wimonrat, S., & Laopai boon, M. (2006). Meditation therapy for anxiety disorders. *The Cochran Database of Systematic Reviews*, 1, CD004998.
- Lan, C., Chow, S., Chen, S., Lai, J., & Wong, M. (2004). The aerobic capacity and ventilatory efficiency during exercise in Qigong and Tai Chi Chuan practitioners. *The American Journal of Chinese Medicine*, 32 (1), 141-150.
- Larkey, L., Jahnke, R., Etneir, J., & Gonzalez, J. (2009). Meditative movement as a category of exercise: Implications for research. *Journal of physical activity and health*, 6, 230-238.
- Livermore, N., Sharpe, L., & McKenzie, D. (2007). Selective attention to threatening information in anxious patients with chronic obstructive pulmonary disease. *Cognitive therapy research*, 31, 885-895.

Livermore, N., Sharpe, L., & McKenzie, D. (2007). Selective attention to threatening information in anxious patients with chronic obstructive pulmonary disease. *Cognitive therapy research* , 31, 885-895.

Lutz, A., Brefczynski, J., Johnstone, T., & Davidson, R. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PlosOne* , 3 (3), e1897.

Lutz, A., Greischar, L., Ricard, M., & Davidson, R. (2004). Long-term meditators self-induced high-amplitude gamma synchrony during mental practice. *Proceedings of the National Academy of Sciences of the United States of America* , 101 (46), 16369.

Mahler, Harver, Lentine, Scott, Beck, & Schwartzstein. (1996). Descriptors of breathlessness in cardiorespiratory disease. *American Journal of Respiratory and Critical Care Medicine* , 154 (5), 1357.

Majumdar, M., Grossman, P., Dietz-Waschkowski, B., Kersig, B., & Walach, H. (2002). Does mindfulness meditation contribute to health? Outcome evaluation of a German sample. *Journal of Alternative and Complementary Medicine* , 8 (6), 719.

Maoska, Y., & Homma, I. (2000). The source generator of respiratory -related anxiety potential in the human brain. *Neuroscience letter* , 283, 21-24.

Masaoka, Y., & Homma, I. (2000). The source generator of respiratory-related anxiety potential in the human brain. *Neuroscience letters* , 283, 21-24.

Masaoka, Y., Hirasawa, K., Yamane, F., & Homma, I. (2004). Effects of left amygdala lesions on respiration, skin conductance, heart rate, anxiety, and activity of the right Amygdala during anticipation of negative stimulus. *Behavioral Modification* , 27 (5), 607-619.

Meek, & Hu. (2005). Health related quality of life in individuals with chronic obstructive pulmonary disease. *Heart Lung* , 34 (6), 415.

Merkes, M. (2010). Mindfulness-based stress reduction for people with chronic disease. *Australian journal of primary health* , 16, 200-210.

Moon, P., & Norekual, T. (2006). Is sense of coherence a pathway for improving the quality of life of patients who grow up with chronic disease? *European journal of cardiovascular disease* , 5 (1), 16.

Moore, M., & Zebb, B. (1999). The catastrophic misinterpretation of physiological distress. *Behavioral Research and Therapy* , 37, 1105-1118.

Morone, N., Lynch, C., Greco, C., Tindle, H., & Weiner, D. (2008). "I felt like a new person." The effects of mindfulness meditation on older adults with chronic pain: Qualitative narrative analysis of diary entries. *The Journal of Pain* , 9 (9), 841.

- Mularski, R., Munjas, B., Lorenz, K., Sun, S., Robertson, S., Schmelzer, W., et al. (2009). Randomized controlled trial of mindfulness-based therapy for dyspnea in chronic obstructive lung disease. *The journal of alternative and complementary medicine*, 15 (6), 1083-1090.
- Murata, T., Takahashi, T., Hamada, M., Omon, M., Kosaka, H., Yoshida, H., et al. (2004). Individual trait anxiety levels characterizing the properties of Zen mediation. *Pharmacoelectroencephalography*, 50, 189-194.
- Noel, M., Taylor, T., Quinlan, C., & Stewart, S. (2012). The impact of attention style on directed forgetting among high anxiety sensitive individuals. *Cognitive therapy research*, 36, 375-389.
- O'Donnell, D. E., & Laveneziana, P. (2007). Dyspnea and activity limitation in COPD: Mechanical factors. *COPD*, 4 (3), 225.
- Orsillo, S., Roemer, L., & Holowka, D. (2005). Acceptance-based behavioral therapies for anxiety: using acceptance and mindfulness to enhance traditional cognitive-behavioral approaches. In *Acceptance and mindfulness based approaches to anxiety* (pp. 3-35). New York, N.Y., U.S.A.: Springer science and business media.
- Pagnoni, G., & Milosi, C. (2007). Age effects on gray matter volume and attentional performance in Zen meditation. *Neurobiology and aging*, 28 (10), 1623-7.
- Pagoni, G., Miose, C., & Ying, G. (2008). Thinking about not thinking: Neural correlates of conceptual Zen meditation. *PloS one*, 3 (9), e3083.
- Pallent, J., & Lae, L. (2002). Sense of coherence, wellbeing, coping and personality factors: Further evaluation of the sense of coherence scale. *Individual differences*, 33, 39-48.
- Peiffer, C. (2008). Relief of dyspnea involves a characteristic brain activation and a specific quality of sensation. *American Journal of Respiratory Critical Care Medicine*, 177.
- Peng, C. (2008). Heart rate dynamics during three forms of meditation. *International journal of cardiology*, 95 (1), 19.
- Pradhan, E., Baumgarten, M., Langenberg, P., Handwerker, B., Gilpin, A., Magyari, t., et al. (2007). Effect of mindfulness-based stress reduction in rheumatoid arthritis patients. *Arthritis and rheumatism*, 57 (7), 1134-1142.
- Reiss, S. (1991). Expectancy model of fear, anxiety and panic. *Clinical psychology review*, 11, 141-153.
- Ries, A., Bauldoff, G., Carlin, B., Casaburi, R., Emery, C., Mahler, D., et al. (2007). Pulmonary rehabilitation. *Chest*, 131 (5), 4S-42S.

- Robert-McComb, J., Tacon, A., Randolph, P., & Caldera, Y. (2004). A pilot study to examine the effects of a mindfulness-based stress reduction and relaxation program on levels of stress hormones, physical functioning and submaximal exercise responses. *The journal of alternative and complementary medicine*, 10 (5), 819-827.
- Roisin, R., Rabe, K., Anzueto, A., Bourbeau, J., Calverley, P., & Casas, A. (2008). Global strategy for the diagnosis management and prevention of Chronic Obstructive Pulmonary Disease. *GOLD*, 1, 108.
- Rosenzweig, S., Reibel, D., Greeson, J., Edman, J., Jasser, S., McMearty, K., et al. (2007). Mindfulness-based stress reduction is associated with improved glycemic control in type 2 diabetes mellitus: A pilot study. *Alternative therapies in health and medicine*, 13 (5), 36-38.
- Sephton, S., Salmon, P., 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 and Rheumatism*, 57 (1), 77-85.
- Shea, S., Walter, J., Pelley, K., & Guz, A. (1987). The effect of visual and auditory stimuli upon resting ventilation in man. *Respiration Physiology*, 68, 345-357.
- Sin, D., Stafinski, T., Ng, Y., Bell, N., & Jacobs, P. (2002). The impact of chronic obstructive pulmonary disease on work loss in the United States. *American journal of respiratory and critical care medicine*, 165 (5), 704.
- Skarbek, A. (1970). A psychophysiological study of breathing behavior. *The British journal of psychiatry*, 637.
- Slagter, H., Lutz, A., Greischar, L., Nieuwenhuis, S., & Davidson, R. (2008). Theta phase synchrony and conscious target perception: Impact on intensive mental training. *Journal of cognitive neuroscience*, 21 (8), 1536.
- Spicuzza, L., Gabutti, A., Porta, C., Montano, N., & Bernardi, L. (2000). Yoga and chemoreflex response to hypoxia and hypercapnea. *Lancet*, 356, 1495.
- Stein, M. (2009). Neurobiology of generalized anxiety disorder. *The journal of clinical psychiatry*, 70 (suppl 2), 15.
- Takahashi, T., Murata, T., Hamada, T., Omori, M., Kosaka, H., Kikochi, M., et al. (2005). Changes in EEF and autonomic nervous activity during meditation and their association with personality traits. *International journal of psychophysiology*, 55 (2), 199.
- Tanner, M., Travis, F., Gaylord-King, C., Haaga, D., Grosswarld, S., & Schneider, R. (2009). The effects of the transcendental meditation program on mindfulness. *Journal of clinical psychology*, 65 (6), 574-589.

- Taylor, S., Cox, B., Heimberg, R., Ledley, D., Holaway, R., Steward, S., et al. (2007). Robust dimensions of anxiety sensitivity: development and initial validation of the anxiety sensitivity index-3. *Psychological assessment*, 19 (2), 176-188.
- Travis, F., & Wallace, K. (1997). Autonomic patterns during respiratory suspensions: Possible markers of transcendental consciousness. *Psychophysiology*, 34, 39-46.
- Ulusahin, & Aydin. (2000). Depression, anxiety comorbidity, and disability in tuberculosis and chronic obstructive pulmonary disease patients: Applicability of GHQ-12. *General Hospital Psychiatry*, 23 (2), 77.
- van den Hurk, P., Janssen, B., Giommi, F., Barendregt, H., & Gielen, S. (2010). Mindfulness meditation associated with alterations in bottom-up processing: Psychophysiological evidence for reduced reactivity. *International Journal of Psychophysiology*, 1-7.
- van Leeuwen, S., Muller, N., & Melloni, L. (2009). Age effects on attentional blink performance in meditation. *Conscious cognition*, 18 (3), 593-9.
- Vestergaard-Poulsen, P., van Beek, M., Skewes, J., Bjarkam, C., Stubberup, M., Bertelsen, J., et al. (2009). Long-term meditation is associated with increased gray matter density in the brain stem. *NeuroReport*, 20 (2), 1.
- Villien, F., Yu, M., Barthelemy, P., & Jammes, Y. (2005). Training to yoga respiration selectively increases respiratory sensation in healthy man. *Respiratory physiology and neurobiology*, 146, 85-96.
- Vogele, C., & von Leupoldt, A. (2008). Mental disorders in Chronic Obstructive Pulmonary Disease (COPD). *Respiratory Medicine*, 102 (5), 764.
- Von Leupoldt, A. (2008). The unpleasantness of perceived dyspnea is processed in the anterior insula and amygdala. *American Journal of Respiratory Critical Care Medicine*, 177.
- Von Leupoldt, A., Taube, K., Henjhus, M., Dahme, B., & Magnusen, H. (2009). The impact of affective states on the perception of dyspnea in patients with chronic obstructive pulmonary disease. *Chest*, 135, 129-134.
- Wachholtz, A., & Pargement, K. (2005). Is spirituality a critical ingredient of meditation? Comparing the effects of spiritual meditation, secular meditation, and relaxation on spiritual, psychological and cardiac and pain outcomes. *Journal of behavioral medicine*, 28 (4), 369-383.
- Wachholtz, A., & Pargement, K. (2008). Migraines and meditation: does spirituality matter. *Journal of behavioral medicine*, 31, 351-366.
- Wahl, A., Hanestad, B., Wentzel-Larson, T., Henriksen, A., & Bentsen, S. (2008). What determines subjective health status in patients with chronic obstructive

pulmonary disease: Importance of symptoms in subjective health status of COPD patients. *Health and quality of life* , 6 (1), 115.

Walach, H., Buchheld, N., Bueenmuller, V., Kleinknecht, N., & Schmidt, S. (2006). Measuring minfulness - the Freiburg Mindfulness Inventory (FMI). *Personality and individual differences* , 40, 1543-1555.

Wallace, A., & Shapiro, S. (2006). Mental balance and well-being. *American Psychologist* , 61 (7), 690-701.

Wallace, R., Benson, H., & Wilson, A. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology* , 221 (3), 795.

Wallace, R., Mills, P., Orme-Johnson, D., Dillbeck, M., & Jacobe, E. (1983). Modificatoin of the paired H reflex through the RM and TM-Sidhi program. *Experimental neurology* , 79 (1), 77.

Wang, C., Collet, J., & Lau, J. (2004). The effect of Tai Chi on health outcomes in patients with chronic conditions. *Archives Internal Medicine* , 164, 493-501.

Watz, Waschki, & Magnussen. (2008). Physical activity in patients with COPD. *The European Respiratory Journal* , 33 (2), 262.

Wolkove, N., Kreisman, H., Darragh, D., Cohen, C., & Frank, H. (1984). Effect of transcendental meditation on breathing and respiratory control. *Journal of applied physiology: respiratory, environmental and excercise physiology* , 56 (3), 607.

Wood, Fairbairn, Elmes, & Fletcher. (1959). The significance of respiratory symptoms and the diagnosis of chronic bronchitis in a working population. *British Journal of Medicine* , 257 (2), 5147.

Yeh, S., Yukawa, M., Anzei, Y., Richards, T., & Mahurin, R. (2008). Modeling the impact of COPD on the brain. *International journal of chronic obstructive pulmonary disease* , 3 (3), 429.

Zvolensky, M., Gibson, L., Vujanovic, A., & Feldner, M. (2008). Posttraumatic stress disorder and anxious and fearful reactivity to bodily arousal: A test of the mediating role of nicotine withdrawal severity among daily smokers in 12-hr nicotine deprivation. *Experimental clinical psychopharmacology* , 16 (2), 144.

CHAPTER V

Conclusion

The goal of this study was to identify a non-invasive physiological measure of meditation uptake and to pilot test a modified mindfulness-based meditation intervention for persons with COPD. Expiration time as measured with inductive plethysmography was selected as a non-invasive measure of mindfulness uptake. The study demonstrated that change in expiration time did not correlate with change in either mindfulness or anxiety sensitivity. Although a non-invasive measure of mindfulness was not demonstrated by this study, it appears that the meditation intervention was successful. The meditation intervention developed for this study was acceptable as demonstrated by high participation rates. Effectiveness was demonstrated by a group X time increase in the CRQ mastery and CRQ emotional scale in the meditation intervention group. Two related projects were conducted in preparation for this study. A structured review of meditation interventions for chronic disease identified potential efficacy of a meditation intervention in the COPD population. Also, an assessment of breathing timing parameters in the COPD population identified the stability of these measures and their relationship with anxiety sensitivity, mindfulness and COPD specific symptoms.

The structured review of meditation interventions in chronic disease populations identified that meditation can successfully decrease anxiety, depression and chronic disease symptoms. The review was not restricted to any particular meditation intervention style or level of research quality resulting in a total of forty-two studies being included. This allowed for a broad look at current meditation research in the chronic disease population. Seven different categories of meditation intervention and six levels of research quality were identified. Results indicate many meditation interventions other than mindfulness-based stress reduction are being studied. More than half of the meditation interventions studied documented adherence to a specific theoretical system of meditation. Similarly, half of the studies used some type of randomized controlled design. The meditation interventions were also subject to a rating of intervention quality. Again we found that at least half earned an interventional quality rating of 4 or higher on a 0 – 6 scale.

Having a good number of studies identified as having high quality intervention and research design strengthens the evidence for the efficacy of meditation as an intervention for persons with chronic disease. In this review it was found that more than half of the studies demonstrated significant improvement in anxiety, depression and/or chronic disease symptoms. However, meditation did not consistently effect a positive change in these areas within specific chronic disease categories. These inconsistencies compel us to consider other factors besides specific disease categories when designing meditation interventions. Results also varied within individual research studies that

investigated more than one variable, with some showing improvement and other not, indicating that we have yet to identify clear physiological measures of meditation effectiveness.

Because this study selected breathing timing parameters as a potential measurement of meditation uptake, a preliminary analysis of respiratory rate, respiratory rate variability, expiratory time and chest/abdomen synchronization were investigated using inductive plethysmography. All four measures were stable over a ten-week period. None of the four breathing timing parameters measured correlated with COPD severity as measured by FEV1% predicted. Pearson correlations of breathing timing parameters and a variety of COPD specific variables were assessed. None of the breathing timing parameters correlated with measures of disease severity, age, dyspnea or any of the other CRQ subscales. As in persons without lung disease, these results indicate that breathing parameters are stable over time and unrelated to disease severity and can possibly be used to measure change in anxiety and/or mindfulness over time. Both respiratory rate and expiratory time positively correlated with year with COPD perhaps indicating adaptation to changes in lung function. It was also found that respiratory rate, respiratory rate variability and absolute phase angle (chest/abdomen synchronicity) positively correlated with anxiety sensitivity. Because the study lacked the ability to assess changes in respiratory volume parameters we cannot know the full impact of this correlation.

Results from the preliminary analysis of meditation in chronic disease and the stability of breathing timing parameters contribute to an understanding of the results from the study on meditation in the COPD population. Measures taken immediately after completion of the meditation intervention indicated confounding results. Respiratory rate increased and mindfulness decreased in the meditation intervention group as compared to the wait list group. Based on these results it would be interpreted that meditation was not an effective intervention for persons with COPD. However results from the structured review indicate that it is common to find non-significant results immediately post meditation intervention. In studies that continued to reinforce meditation skills or allow for meditation practice over longer periods of time it was found that results then identified significant improvements. Although it is unknown at this point if the results from this study of meditation in the COPD population would also have demonstrated positive results if taken over a longer period of time it would be wise to extend the period of assessment in future research projects.

Our inability to identify a respiratory breathing parameter that could measure meditation uptake was perhaps hindered by choosing expiration time as a specific breathing timing parameter to measure. Although research has shown that in health subjects, anxiety is negatively correlated with expiration time, it is perhaps the case that specific lung function decline in persons with COPD interferes with this relationship. Results from the investigation of breathing timing parameters in the COPD population indicate that perhaps breathing timing variability may be a more suitable gage of meditation uptake. Further research

needs to include both timing and volume measures in order to more fully understand this relationship.

Application to practice

What it was learned from this study is that persons with COPD are able to meditate and will participate in a meditation intervention. However, those with less anxiety and depression and those that identify meditation as helpful attend more classes. It was also identified that persons with COPD who had a high level of anxiety sensitivity attended the least number of classes. This information helps us identify important program design elements for the future. Some consideration might be to include exercises that specifically target anxiety and anxiety sensitivity in the first session, allow persons with anxiety sensitivity to attend classes via skype technology or provide structured communication with the meditation instructors by way of social media between weekly classes. Allowing time to address issues of anxiety will also need to be conducted in such manner as to not slow the pace of the class for those meditation students who are comfortable and eager to move on to more complex skills. Identifying a physiological measure that could easily identify where a person is on the spectrum between anxiety and mindfulness would help identify if meditation intervention is successful or if more and different meditation instruction is necessary.

Anecdotally, it was also learned that persons who begin to learn meditation and find it helpful often request ongoing meditation support. Two of

the three sites that conducted the meditation study continue to hold meditation classes. Staff members who have a meditation practice and have been trained by the author (RC) teach meditation at both facilities. These classes have grown in popularity at both sites demonstrating that the addition of meditation to standard pulmonary rehabilitation programs can be easily established due to the popularity of meditation as a personal practice.

Another long-term solution to providing group meditation support to persons with COPD and other chronic disease would be to refer them to spiritually based meditation groups within the community. The inclusion of spiritually based components such as compassion or loving kindness meditation exercises into a meditation intervention may assist in broadening the benefits of meditation by increasing positive affect and reducing anger through improved forgiveness of self and others (Cassel, 2009). A review of cross-sectional and pre-post research on compassionate and loving kindness meditation infers that compassionate meditation decreases negative affect in reaction to negative stimuli, improving ones ability to withstand set backs (Lutz, Brefczynski, Johnstone, & Davidson, 2008; Fredrickson, Coffey, Pek, Cohn, & Finkel, 2009; Cohn, Brown, Fredrickson, Mikels, & Conway, 2009). Connecting people with COPD or any other chronic illness to meditation support that matches their spiritual foundation will provide an intervention that extends beyond self-efficacy. This may prove to be helpful when the person is facing the prospect of continued deteriorating health. One needs some ability to continue self-care not only when they are feeling like they are successful at self care but when self care

may appear to be unsuccessful. They must tap into that place where they continue self care because they simply care about the self.

Bibliography

Cassel, E. (2009). Compassion. In S. Lopez, & C. R. Snyder (Eds.), *Oxford Handbook of Positive Psychology* (p. 695). New York, N.Y., U.S.A.: Oxford University Press.

Cohn, M., Brown, S., Fredrickson, B., Mikels, J., & Conway, A. (2009). Happiness unpacked: Positive emotions increase life satisfaction by building resilience. *Emotion*, 9 (3), 361-368.

Fredrickson, B., Coffey, K., Pek, J., Cohn, M., & Finkel, S. (2009). Open hearts build lives: Positive emotions, induced through loving-kindness meditation, build personal resources. *Journal of personality and social psychology*, 95 (5), 1045-1062.

Lutz, A., Brefczynski, J., Johnstone, T., & Davidson, R. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PlosOne*, 3 (3), e1897.