**EXPLORING THE OUTCOMES OF SINGING AND
DIAPHRAGMATIC BREATHING IN PARTICIPANTS WITH
ASTHMA**

by

Carina Daugherty
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SINGING, DIAPHRAGMATIC BREATHING, AND ASTHMA

Abstract

This study investigated the effects of singing and/or breathing. Sixty participants with asthma partook in weekly singing ($n=22$), breathing ($n=20$) and singing and breathing ($n=18$) sessions over four weeks. Peak expiratory flow rate (PEFR) and forced expiratory volume during the first second (FEV1) were measured prior to and following each session, along with a breathlessness questionnaire (MBS). An asthma control questionnaire (ACQ) was completed weekly. Wellbeing measures included a psychological distress measure (GHQ) and a quality of life measure (SGRQ), completed during the first and last sessions. There was a significant improvement in MBS, PEFR, and GHQ measures over four weeks. Components of SGRQ (symptoms and impacts) also improved. There were no significant group differences in breathing or wellbeing measures. Participants enjoyed practicing more when singing was combined with breathing. While all conditions were beneficial for participants with asthma, individuals may demonstrate greater adherence to singing.

Keywords: asthma, singing, diaphragmatic breathing,
singing and health, singing and wellbeing

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Exploring the Outcomes of Singing and Diaphragmatic Breathing in Participants with Asthma

Health psychology has been increasingly contributing to the medical world (Hepworth, 2006). Primary contributions of health psychology have included promotion of health and well-being, prevention and treatment of illness, as well as assessing psychological factors that accompany health and illness (Hatala, 2012; Hepworth, 2006). Health psychologists view health as more than solely an absence of illness. To be in a state of health encompasses social, psychological and physical wellness (Taylor & Sirois, 2012). Recognition of the limitations of the biomedical approach, which focuses on biological explanations of illness, has created room for advances in health psychology (Taylor & Sirois, 2012). In 1977, George Engel proposed the need for expansion of the biomedical model to include patients' social, psychological, and cultural factors in addition to biological factors. This expansion of the biomedical model is known as the biopsychosocial model (Engel, 1977; Gick, 2011; Hatala, 2012). Support for the use of the biopsychosocial model has been rising and examination of multiple factors is increasingly being used to understand disease, health and illness (Hatala, 2012).

Research on chronic illness is imperative for health psychologists. More than half of the Canadian population suffers from a chronic illness, which in turn creates enormous health care costs (Taylor & Sirois, 2012). Sometimes there is no cure for chronic illness; however, there are ways chronic illness can be managed. Management may typically include taking medication, making behavioural changes (i.e. healthier diet, exercise, and stress management) and working with a health care provider. Self-management, which emphasizes the patients' responsibility to manage and monitor their symptoms, is

especially important for chronic illness (Newman, Steed, & Mulligan, 2004; Taylor & Sirois, 2012). Self-management should also include managing one's psychological and social responses to the chronic illness, in addition to maintaining a reasonable quality of life (Newman et al., 2004). This is important because the prevalence of psychological distress and diminished quality of life are especially high in individuals with chronic illness (Taylor & Sirois, 2012). Finding self-management strategies to address these issues is essential for the management of chronic illness, as high levels of psychological distress may increase the progression of the chronic illness through a number of ways. For example, in a study by Strine et al. (2006), participants with asthma were interviewed over the telephone to assess depression, anxiety, and health related quality of life. They found that participants with anxiety and depression had lower asthma control and more frequent doctor and emergency visits than participants with asthma and no co-morbid psychological illness. In addition, symptoms of depression and anxiety may result in decreased asthma treatment compliance (Diez et al., 2011; Strine et al, 2009). Patients with asthma who also have anxiety or depression have more asthma symptoms and are more likely to have an asthma attack than those without any mental illness (Cordina, Fenech, Vassella, & Cacciotollo, 2009; Zhang et al., 2009).

The present study explored the use of singing as a self-management tool for people with asthma. A brief description of asthma, including its symptoms, prevalence and treatment, is described below in order to better understand the rationale for the current study. This will be followed by a review of the literature on singing and health and wellbeing.

Asthma

Symptoms

Asthma is a chronic respiratory condition that is caused by interference in airways due to muscle spasms, secretion of mucus, and inflamed tissues. Those with asthma have inflamed airways which contribute to discomfort when breathing (Newman et al., 2004; Wade, 2002). Certain triggers may contribute to the narrowing of airways, causing difficulties breathing. While triggers vary depending on the individual, common triggers include dust, smoke, and pollen (Small, 2005).

Prevalence

In Canada, approximately 8.5% of those above the age of 12 have asthma and this number is increasing (Statistics Canada, 2010; The Lung Association, last updated September, 2012). Asthma poses many struggles and dangers, among Canadians. Those with asthma, especially uncontrolled asthma, are likely to have numerous absences from school or work (Fitzgerald, 2006; The Lung Association, 2012). In addition, asthma in Canada accounts for the most common reason for emergency room visits, and contributes to numerous deaths per year (The Lung Association, last updated September, 2012). While asthma may be reversible, either with treatment or improvement over time, those with asthma may be at risk for chronic obstructive pulmonary disease (COPD), one of the world's leading causes of death (Pauwells & Rabe 2004; Silva, Duane, Sherrill, Guerra, & Barbee, 2004).

Treatment

Asthma is most commonly managed with bronchodilators, which include both short acting and long acting inhalers, used to open up the airways and allow air to move

to the lungs (Lord et al., 2010). Although inhalers are commonly used to treat asthma, side effects, such as voice hoarseness and throat irritation may occur (Ihre, Zetterstrom, Ihre, & Hammarberg, 2004). Some patients may not use their inhalers as often as recommended to avoid these possible side effects (Buston & Wood, 2000). Breathing techniques may have similar benefits for those with asthma as some pharmacological treatments, and, moreover, do not result in the side effects that are common with pharmacological treatments (Slader et al., 2006). For example, controlled, diaphragmatic breathing that involves focusing on abdominal muscles (described in more detail later) may assist in increasing asthma control (Grammatopoulou et al. 2011). Diaphragmatic breathing is used by wind and brass instrumentalists. There has been some research exploring breath control in instrumentalists with asthma that resulted in decreased symptoms; however, there has been conflicting evidence (Deniz et al., 2006; Stacy, Brittain, & Kerr, 2002). Some researchers have found that wind instrumentalists display decreased pulmonary function and no differences in breathing tests when compared to non-wind instrumentalists (Deniz et al, 2006; Fuhrmann, Franklin, & Hall, 2011).

Singing

Controlled, diaphragmatic breathing that is used during wind instrument playing is also used during singing (Stacy, Brittain, & Kerr, 2002). Although there has been limited research in this area, some authors have suggested that breathing involved during singing may assist those with asthma and chronic obstructive pulmonary disease (COPD). Research has demonstrated that singing may assist in improving quality of life and psychological wellbeing in individuals (Clift & Hancox, 2001). The impact that singing has on asthma was the focus of this study. In the next section I will outline the literature

on singing in respect to the three factors of the biopsychosocial model (biological, psychological, and social).

Psychological Benefits of Singing

Singing has been found to be effective in reducing psychological distress. Participants in a choir reported improved mental health (including feeling uplifted, decreased depressed mood) as a result from singing (Bungay & Skingley, 2011). In a study by Clift and Hancox (2001) participants in a choir were asked how singing is good for their health. Responses included feeling more positive after singing (61%), feeling less stressed (12%) and feeling calmer (10%).

Research has also explored singing and psychological wellbeing in non-choral members. Decreased total depression and anxiety scores were found as a result from singing in post-knee surgery patients was found in a study by Giaquinto et al., (2006; as cited in Gick, 2011, p.16). In their study, Magill, Levin & Spodek (2008) found a decline in distress in cancer patients who participated in a 20 minute singing session (as cited in Gick, 2011, p.17). Results from Pavlaku's (2009) study indicated that singing was effective for increasing positive affect and promoting a sense of relaxation in a group of women with eating disorders. These women also reported that singing assisted in allowing them to feel more connected to their bodies, as well as feeling a sense of distraction from their problems (as cited in Gick, 2011, p. 17).

Singing has been found to be effective in promoting mental wellbeing in seniors. In Houston, McKee, Carroll, & Marsh's (1998) study, older adults in a residence home participated in a humorous dance and sing-a-long. Other participants were in a control group which consisted of the residents' normal routines. A significant decrease in

depression and anxiety were found in those who participated in the sing-a-long compared to participants in the control group.

There has been a fair amount of research exploring the effects of singing in patients with dementia. Psychological benefits such as increased mood, decreased depression and anxiety, as well as increased smiling as a result from singing have been reported (Daugherty, 2011; Gick, 2011). A case study by Ridder & Aldridge (2005) found promising results from singing for those with dementia. The participant included in this study experienced a significant decrease in anti-psychotic medication after participating in 20 singing sessions.

Overall, singing has been demonstrated as a behaviour that may assist in decreasing psychological distress in healthy participants, as well as participants with various health deficiencies. Singing may be a non-pharmacological way to assist individuals' control over their asthma through improving their mental wellbeing and eliminating the psychological distress that accompanies chronic illness, such as asthma.

Social Benefits of Singing

Singing in a group is believed to increase social interactions between individuals. Olderog Millard & Smith (1989) observed the social interaction of patients in their middle stages of Alzheimer's disease. Participants attended singing groups as well as discussion groups. The researchers found that following the singing sessions participants were more likely to walk with and sit with their peers.

Singing also provides social benefits for participants without dementia. Many choir members report that choral singing brought them social benefits that included making new friends, feeling a part of a group, and by having the opportunity to interact

with others (Bungay & Skingley, 2011; Clift & Hancox, 2001). In their study, looking at participants in an all male choir, Faulkner & Davidson (2006) found that singing in harmony with each other promoted social connection with one another (as cited in Gick, 2011, p. 21).

Biological Benefits of Singing

There have been various biological health benefits from singing. Some studies found that participants had better immunity following singing. Immunity benefits were found from solo singing and choral singing (Gick, 2011). Stress response as a result from singing was examined in professional and non-professional singers. Valentine and Evans (2001) found that while solo singing may increase stress response (i.e., cortisol, heart rate), choral singing was associated with decreased heart rate (as cited in Gick, 2011, p. 22).

Breathing. In this next section, I focus on breathing as a biological benefit of singing. There has been some research on the effects of singing on respiratory function. Researchers have suggested that singing may assist in improving lung function in participants (Clift et al., 2009). I outline the existing literature on singing and pulmonary function in healthy participants, those with COPD, as well as participants with asthma

Healthy participants. Adult participants have reported respiratory related improvements in studies exploring singing and well-being (Clift & Hancox, 2001). In a study looking at the perceived health benefits from singing in a choir, the most reported physical health benefit was improvement in lung function. Many participants reported more controlled breathing and a couple of participants felt that singing assisted in improving their asthma symptoms (Clift & Hancox, 2001). These results were also found

in a similar study by Clift et al. (2009). In this study, singers in choirs from three different countries reported their perceived health benefits from singing. The most reported health benefit from singing was improvement in lung function and breathing. There were many reports of improved asthma and bronchitis as a result of singing. Limitations from this study include the inability to generalize findings to all age groups due to the sample of older participants ($M = 58$ years of age), in addition to the use of self-reported data. It is difficult to determine if lung function was improved due to the lack of physical breathing measures.

Bungay and Skingley (2008) designed a study to evaluate the Silver Song Club Project, a program designed to allow those over 60 years of age an opportunity to sing with others. They were interested in exploring any benefits members from the program experience, as well as any ideas on how the program may be improved. Participants reported that singing in the program benefited them by improving their respiratory function. One participant reported that singing helped improve their asthma by expanding their lungs. Other benefits reported included improved memory, improved well-being, relaxation and distraction from pain.

Purcell and Kagan (2007) found that employees in the workplace reported improved breathing, lung function, posture, and awareness of diaphragm as a result of singing. Participants in this study were recruited through a university e-mail to all staff members inviting them to attend singing workshops in the university. The workshops were also open for students to attend. There were ten university employees who attended the workshops regularly. One participant in the study felt that singing could be good for their asthma. It was not reported in the article if other participants had asthma.

Participants with COPD. Some researchers have explored the use of singing for patients with COPD and have found promising results. In their study, Bonilha et al. (2009) explored the effects that singing had on participants with COPD. Fifteen participants attended weekly singing classes while another fifteen participants attended handicraft sessions. The classes were one hour in length and occurred for duration of 24 weeks. The singing group consisted of a singing teacher leading breathing exercises (in which participants were told to focus on diaphragmatic movement) and vocal warm-ups followed by singing Brazilian folk songs. Participants in the control group attended handicraft lessons. Participants in both groups engaged in relaxation exercises led by a physiotherapist.

The results from this study indicated that participants in the singing group experienced an increase (improvement) in maximal expiratory pressure, where participants exhale with as much effort as possible following a deep breath in, while participants in the control group experienced a decrease in maximal expiratory pressure. Both groups displayed improvement in quality of life, measured by the Saint George's Respiratory Questionnaire (SGRQ). Those in the singing group, when compared to the control group, also demonstrated significant improvements in inspiratory capacity (the measure of air breathed in forcefully), self-reported breathlessness (demonstrated by the Borg scale rated from zero (not breathless) to ten (maximal breathlessness)), and oxygen saturation (which measures the amount of oxygen present in the blood). In addition, participants in the singing group had a tendency to cough at the end of singing classes; the authors of this study suggested that this result may have been due to an elimination of sputum.

Bonilha et al. (2009) concluded that the controlled, diaphragmatic breathing of singing may assist in training and strengthening expiratory muscles, which may lead to improved symptoms of COPD, exercise endurance, as well as quality of life. One of the limitations of this study is the inclusion of relaxation, breathing, and vocal exercises in the singing group. These additional activities make it difficult to attribute changes to singing; however the researchers suggest that breathing and vocal exercises are important in singing, as well as respiration.

Lord et al. (2010) also explored the effects of singing on participants with COPD. In their study, 28 participants with COPD received a 30 minute session on breathing control and technique, led by physiotherapists. Participants were randomly assigned to either a singing group, consisting of one hour singing classes twice weekly for six weeks, or a control group, engaging in no further activities. The singing group was led by a vocal instructor who taught participants about relaxation, posture, and vocal exercises. Participants in this group were provided with a CD with songs to practice at home. Breathing measures were collected using the breath hold test, where an individual holds their breath following maximal inspiration, and single breath counting, where individuals count for as long as possible along to a timed metronome after inhalation. Improvements in anxiety, measured using the Hospital Anxiety and Depression Questionnaire (HAD), were seen in the participants in the singing group. There were no improvements in breathing measures as a result of singing, however there were improvements in self-reported physical health, measured by the Short Form-36 questionnaire (SF36). This questionnaire measures both mental and physical health. Improvement in SGRQ scores was seen in both groups. No participants reported any negative experiences. In addition,

96% of participants rated the workshops as enjoyable and 81% noticed a physical difference. Many positive changes that were reported involved improvements in breath control.

A limitation in this study is the lack of a control group participating in a group activity. The use of a control group would allow for comparisons to be made to determine if singing offers greater benefits than a different group activity. There may have been social benefits that existed from singing in a group that helped reduce anxiety. Another limitation is the short duration of the study. Participants reported that they were just beginning to notice differences by the end of the two weeks. Other participants felt that the practicing outside of the singing classes allowed them to maintain any perceived benefits. The authors indicate that this suggests that participants should attend singing classes for a longer duration than six weeks.

Participants with asthma. Some researchers explored the effects of singing in children with asthma. Wade (2002) found benefits of singing in school aged children (aged seven to fourteen) with asthma. In this study all participants attended singing and muscle relaxation groups accompanied by background music. The singing groups included vocal exercises, followed by singing songs. The order of the two conditions alternated (i.e. sometimes participants attended the singing group first, other times participants attended the relaxation group first). Peak expiratory flow rates (PEFR), a measure of the speed of air exhaled after inhaling, were either improved or maintained after the singing groups (TruZone, 2001; Wade, 2002). There was only one occurrence where peak flow levels were higher after the relaxation group than the singing group. Wade concluded that the combination of relaxation techniques and singing may be

beneficial for reductions of asthma symptoms. She also recommended that that the relaxation be presented before the singing, as singing seemed to produce the maximum increase of peak flow levels, therefore, having relaxation following singing would not increase peak flow levels any further. In addition, the researchers suggested that the relaxation may have been useful to prepare participants for singing by allowing them the chance to relax their muscles prior to singing. Relaxation is important when singing, as relaxed muscles and a relaxed jaw assists in producing a natural tone; tension may interfere with this (Sipley, 1997).

Eley and Gorman (2008) found different results than Wade (2002) when they explored the effects of singing in children and adults with asthma. In their study, Eley and Gorman were interested in comparing the effects of didgeridoo playing and singing on participants' asthma symptoms. Aboriginal school children and adults in Australia attended weekly lessons for six months. Males were taught how to play the didgeridoo, a traditional Aboriginal wind instrument, while females attended vocal lessons. Females sang because it is not considered culturally acceptable for them to play the didgeridoo (Eley & Gorman, 2008). Many of the adults were unable to attend weekly lessons due to their health. A significant improvement in respiration function, as measured by peak expiratory flow rates (PEFR), occurred in males, while a non-significant improvement in respiration function occurred in females. Males and females noticed improvements in their asthma symptoms, and males displayed a trend of improved quality of life. Female adults enjoyed the breathing exercises more than they enjoyed singing. The authors suggested that the males seemed to experience more benefits because they were

comfortable playing the didgeridoo from the beginning, while females felt slightly hesitant about singing surrounded by peers.

Eley and Gorman (2010) conducted a similar study to their previous one. Participants included in this study were between the ages of 6-77 with asthma. Similar to their previous study, male participants were provided with didgeridoo lessons while female participants received vocal lessons, which included breathing and singing instruction. All music lessons took place one hour a week over 26 weeks. Participants reported that the music lessons (including singing and didgeridoo) assisted with their asthma, improved their breathing, the distance that they were able to run, and improved their overall health. Similar to the results in their previous study, male participants demonstrated more improvement in quality of life than female participants. Based on the results of the spirometry tests, males had increased forced expiratory volume (FEV1; a measurement of the amount of air that can be exhaled during the first second of expiration), peak expiratory flow rate (PEFR), and forced vital capacity (FVC) which is the maximum amount of air one can exhale after a maximal inhale (Morris, 1979). Females only demonstrated an increase on PEFR values. All participants reported improvements in their overall health. While this is one of the only known studies exploring singing in adults with asthma, the authors did not indicate whether results varied based on age (Gick, 2011).

Breathing

Non-Singing Breathing Techniques

Based on the presented literature on singing and its effect on participants with asthma and COPD, it is unclear whether breathing is needed to experience the benefits of

singing, as breathing was often a component of the singing interventions (Gick, 2011). In order to evaluate how breathing may be an effective component in singing in improving pulmonary function, I will review breathing techniques that have been useful in controlling asthma symptoms. In addition, I will provide a summary of the literature evaluating the use of these breathing techniques in wind instrument playing in healthy participants and participants with a respiratory condition (i.e. asthma, COPD). Lastly, I will discuss the use of breathing for non-asthma benefits.

Breathing Retraining. In their literature review, Dechman & Wilson (2004) explored the different effects of engaging in pursed lip breathing and diaphragmatic breathing. During pursed lip breathing, participants breathe in through their nose and breathe out slowly through pursed lips. Past research exploring these breathing techniques in patients with COPD was included in their review. Based on past research findings, they concluded that both pursed lip and diaphragmatic breathing are helpful for slowing down the breathing rate in patients with COPD. Pursed lip breathing has also been found to assist in decreasing dyspnea, a term used to refer to shortness of breath. There is very little research on the use of diaphragmatic breathing as a method to decrease dyspnea however; one study found that diaphragmatic breathing resulted in no change in dyspnea. Although the literature on diaphragmatic breathing is limited, the authors conclude that it may not provide any further benefits for COPD than pursed lip breathing. It is unclear if these findings would be similar for patients with asthma.

A common component of treatment for respiratory illnesses, such as asthma, is breathing retraining. During breathing retraining, patients are taught how to breathe during certain strenuous activities and how to slow down their breathing

(Grammatopoulou et al., 2011). In their study, Grammatopoulou et al. (2011) were interested in evaluating the effect of breathing retraining on asthma control. Eighty participants, between the ages of 18-60 with mild to moderate asthma, were recruited from a Greek hospital. Participants were randomly assigned to either the experimental group, receiving breathing retraining, or the control group, receiving their usual asthma care. This six month study consisted of participation in twelve breathing retraining sessions for the first month, and individual practice at home for the remainder of the five months. The breathing retraining sessions, held three times a week, were conducted by a physiotherapist and included instructions on how to engage in diaphragmatic and nasal breathing, as well as how to breathe during asthma exacerbations compared to their normal breathing. During diaphragmatic breathing, patients are encouraged to focus on their abdominal muscles. The abdomen expands as patients breathe in and contracts as patients breathe out (Dechman & Wilson, 2004). Nasal breathing involves breathing in through the nose with no specific attention given to diaphragm muscles. Nasal breathing is in contrast to mouth breathing, which involves inspiration through the mouth and is typically used in singing, rather than the nose (Slader et al., 2006). Participants who attended the breathing retraining sessions experienced decreased hyperventilation, as well as increased quality of life and improvements in asthma control. Spirometry, a respiratory test used to measure pulmonary function impairment (Morris, 1976), was used in this study. Participants who underwent breathing retraining demonstrated a significant increase in their forced expiratory volume in the first second (FEV1). The results from this study support the notion that breathing techniques may assist in improving asthma

control. The present study did not separate nasal and mouth breathing from diaphragmatic breathing.

In their double blind study, Slader et al. (2006) found conflicting results on the effects of breathing techniques in participants with asthma. They compared nasal breathing to upper body exercising in participants with stable asthma. Participants were randomly assigned to one of two groups. The first group participated in nasal breathing exercises ($n=28$) and the second group engaged in upper body exercises and applied both mouth breathing, which is typically used in singing, and nasal breathing techniques ($n=29$). These exercises were shown to participants through video instruction which included directions to manage symptoms first by breathing rather than using the inhaler; participants were asked to complete the exercise twice daily for twenty eight weeks. Results indicated that both groups used their reliever inhaler less frequently and there were few differences between the two groups, although participants in group two demonstrated significantly improved scores on the Asthma Control Questionnaire (ACQ).¹ The researchers in the study concluded that both groups benefited equally from their assigned exercise and that the video instruction, rather than the type of breathing, may have assisted asthma. It was suggested that instruction to manage symptoms first by engaging in breathing exercises rather than use their inhaler, assisted in decreasing reliever inhaler use in both groups. This study may also suggest that nasal breathing, which is usually recommended to patients with asthma (L. Taylor, RRT., personal communication, June 5th, 2012), may not be more beneficial than breathing through the mouth, which is normally used when singing.

¹ This is a validated seven item self-report scale that contains questions relating to patients' asthma during the previous seven days; questions one to six are self-reported while the seventh item on the measure requires completion by a clinical professional (Juniper, Guyatt, Cox, Ferrie, & King, 1999).

Wind Instrument Playing. Playing wind instruments may assist in decreasing asthma symptoms due to practiced breathing and strengthening of the diaphragm. Researchers have found that wind instrumentalists possess larger vital capacities, assisting with breathing and decreasing asthma symptoms, than non-wind instrumentalists (Pepping, 2009). Playing a wind instrument may have similar breathing benefits as singing (Stacy, Brittain, & Kerr, 2002). There have been conflicting results in research exploring the effects of playing a wind instrument.

Lucia (1994) found promising benefits as a result of wind instrument playing in participants with asthma. Participants in this study included teenagers with asthma: eight wind musicians and ten non-wind musicians. Results from this study showed a trend of decreased asthma symptoms, fear/panic responses and mood changes for wind instrumentalists. Wind musicians in this study reported an increased ability to cope with their asthma. It was concluded that wind instrument playing may be helpful as a tool to assist those with asthma.

While Lucia et al. (1994) found promising benefits of wind instrument playing, contrasting results have been found in other research. In their study, Deniz et al. (2006) investigated pulmonary function as a result of wind instrument playing in 34 male military band musicians. Musicians were compared to a control group of non-musicians. The results from the study indicate that wind instrument players tend to have decreased pulmonary function compared to non-wind instrumentalists. The authors suggest that this result may be due to a presence of bronchial asthma, which is the most common respiratory disease found in wind instrument musicians. Breathing tests should be used in future studies to determine if there is any presence of asthma in the participants so that

this can be controlled for (Deniz et al., 2006). Another explanation of the results, presented in this article, is that musicians who play wind instruments tend to breathe in large amounts of air. This has been found to be a potential irritant to the lungs. This may be of concern when considering the impact that singing has on individuals with asthma.

Similar to the study by Deniz et al. (2006), Fuhrmann, Franklin, & Hall (2011) explored respiratory function in brass and wind instrument musicians to non-brass and wind instrument musicians. Fifty-five woodwind or brass musicians and forty non-musicians, all non-smoking with no respiratory condition, participated in this study. There were no differences in spirometry measures between musicians and non-musicians. The authors of this study conclude that there are no differences in respiratory function between wind musicians and non-musicians and that musicians' ability to maintain breath support is due to having learned how to control their breathing rather than improvement in lung function.

Overall, it is unclear what impact exists from breathing and use of diaphragm muscles on respiratory function. While some researchers have found benefits from playing a wind instrument, others have found decreased pulmonary function. Research is needed to investigate this in participants with an existing respiratory condition.

Other applications of non-singing breathing techniques. While breathing techniques have been used for managing respiratory conditions, (i.e. Dechman & Wilson, 2004) these techniques have also been used for other purposes. Practiced breathing techniques have been found to be helpful in stress management. For example, one study explored the use of breathing techniques in school principals who often experience chronic job stress. The results from this study suggested that the practice of controlled

breathing assisted in stress management. Participants reported many benefits that included improved ability to function effectively at work, improved focus on the present moment, enhanced ability to problem solve with peers. Some participants even reported better sleep, improvement in sleep apnea, and more energy (Van der Merwe & Parsotam, 2011).

Breathing techniques have been found to improve blood pressure and heart rate in participants in cardiac rehabilitation. Breathing in this study involved maintaining focus to one's breathing while applying a pursed lip technique (Gilbert, 2003). Improvement in pain threshold was found in participants who practiced relaxing deep and slow diaphragmatic breathing, where participants were told to maintain awareness of their breathing while fixating on a focal point (Busch et al., 2012)..

Controlled breathing can also be practiced through yoga. During yoga, one engages in controlled breathing as a way to promote relaxation (Pilkington, Kirkwood, Rampes, & Richardson, 2005). Yoga based interventions have been found to significantly reduce depression and state anxiety (Pilkinton et al., 2005). In another study, a yoga technique that combines breathing and stretching (Pranayama) resulted in significantly improved alertness and enthusiasm in participants (Wood, 1993).

The Present Study

Research on the potential benefits of singing on individuals with asthma is inconclusive (Gick, 2011). Based on findings from past research, it is apparent that many individuals enjoy singing, and in addition, commonly report improvements in respiratory health (Clift et al., 2009; Lord et al., 2010; Purcell & Kagan, 2007). The majority of the positive results have been seen in self-reported improvement in healthy participants

rather than improved physical measures in individuals with asthma. Furthermore, the majority of the research on singing and respiratory illness has involved children with asthma, or older adults with COPD (Gick, 2011). In particular, while Bonilha et al. (2009) reported that singing improved some physical measures of breathing in people with COPD, it is unclear whether this result would hold for adults with asthma.

However, it is unclear whether singing, isolated from diaphragmatic breathing, would have the same benefits. For example, Bonilha et al.'s (2009) study combined singing and diaphragmatic breathing training, and, therefore, the benefits of singing alone are unclear. While combining singing and breathing may be common in formal singing training, community singing programs do not necessarily include breathing and vocal exercises and thus the benefits of informal or community singing alone are unclear. It may be useful to isolate breathing and singing to explore the potential effects from each individually, as well as explore their joint influence on asthma control and breathing.

Indeed, based on findings from studies exploring singing while including other techniques (i.e. vocal warm-ups, posture, relaxation, or breathing instruction), researchers have found improvements in PEFV (speed of exhale following inhale) measurements, as well as quality of life (e.g. Eley, 2008; Lord et al., 2010; Wade, 2002). Furthermore, breathing techniques may have positive benefits for asthma when isolated from singing. For example, previous research findings on breathing retraining alone have found improvements in FEV1 (first second expiratory volume) and ACQ (asthma control questionnaire) results (Grammatopoulou et al. 2011; Slader et al., 2006).² Although there is some suggestion that diaphragmatic breathing alone that is used in formal singing

²Significantly better scores on the ACQ were demonstrated by students reporting that they sing when compared to students reporting that they avoid singing (Daugherty & Gick, 2012). These results were found in a pilot study conducted in April, 2012.

training may aid in asthma control, its effects on self-reported dyspnea (shortness of breath; e.g. Bonilha et al., 2009) has been scarcely examined (Dechman & Wilson, 2004).

However, a challenge in exploring non-pharmacological methods of self-management (such as singing and breathing) is the impact that participants' beliefs can have on treatment outcomes. Patients' beliefs about their treatment have been found to have an impact on the effectiveness of the treatment, as well as their adherence to treatment (Horne, 1999). Beliefs can act as a placebo effect with treatment outcomes being predicted by patients' expectations of the treatment (Haug, 2011). In order to address this challenge, it is important that participant beliefs regarding the treatment are taken into account. It is also important to assess activity enjoyment. While many individuals find singing an enjoyable experience (i.e. Bungay & Skingley, 2008), others may not find enjoyment in singing, for example, Chong (2010), found the 3.5% of 90 university students do not enjoy singing (as cited in Gick, 2011, p. 27). It is possible that individuals who report more enjoyment may experience the most benefits.

Objectives. The main objectives of this study are to evaluate whether breathing training is an essential element of singing's purported effects (i.e., is singing still beneficial when diaphragmatic breathing training is not included?), to explore the combined and separate effect of singing and diaphragmatic breathing in an adult asthma population, to collect objective breathing measures as a function of singing and/or breathing training, and to evaluate any overall psychological outcomes that may be associated with the interventions. To that end, I explored an intervention using three groups: singing alone, diaphragmatic breathing alone, and singing together with diaphragmatic breathing.

I hypothesized that:

- 1) Weekly breathing measures (MBS, PEFr, and FEV1) may improve across the four sessions. I predicted that those in the singing and breathing group would show the most improvement. Since diaphragmatic breathing has been found to help some people with respiratory problems (e.g., Bonilha et al., 2009) and because individuals often find singing enjoyable and therefore may practice more (i.e. Lord et al., 2010), the combination of the two activities may be the most beneficial.
- 2) Weekly asthma control (ACQ) may improve over the four sessions. Again, it is predicted that ACQ may show the most improvement for participants in the singing and breathing group.
- 3) Respiratory related quality of life (SGRQ) and general health (GHQ) may improve over the four sessions, with singing and breathing demonstrating the most improvement.
- 4) One exploratory hypothesis was to examine data from the practice logs to determine if any one group will practice for a longer duration than other groups. In addition, I was interested in exploring if any one group would enjoy practicing more than the other two groups.

Method

Participants

Participants for this study initially consisted of Carleton University undergraduate students with self-reported asthma. Information about students' asthma had been collected in a mass testing questionnaire distributed at the beginning of the school year

(September, 2012). Questions were asked about asthma diagnosis, severity, and inhaler use. Students indicating a self-reported diagnosis of asthma from the mass testing questionnaire were initially contacted by e-mail to participate in this study; participants who had not responded by e-mail were later contacted by telephone. Additional students with asthma were recruited through Carleton University's online Sona system. As an attempt to recruit more students to participate in the study, a poster was displayed in Carleton University's Health and Counseling Clinic and on various bulletin boards across campus. In order to increase the sample size, I also recruited non-students with asthma to participate. A poster ad was placed in the South Nepean Community Health Centre, in their lung health room, as well as on Facebook.com (see Appendix A). A recruitment poster was also displayed in the EMC newspaper for two weeks (in various regions around Ottawa between March 14-28, 2013) as well as the Ottawa Citizen (displayed March 9, 13, and April 12, 2013). As a final attempt to recruit participants, a recruitment notice was sent to students and faculty in Carleton University's e-newsletter *Today@Carleton*. In addition, I briefly presented the study to students in three different non-psychology undergraduate classes (first year philosophy, second year statistics and third year law). Table 1 includes a summary of the number of participants recruited for each method of recruitment.

Table 1
Method of Participant Recruitment

Method of Recruitment	% (<i>n</i>)
Mass Testing	9.6 (16)
E-mail	6 (6)
Telephone	6 (6)
Today@Carleton Ad	8.4 (14)
Online Sona System	6 (6)
Newspaper Ads	6 (6)
Facebook	4.2 (7)
Other (i.e. referral by a friend)	1.8 (3)
Carleton U Bulletin Poster	.60 (1)
Carleton U Health Clinic Poster	.60 (1)
South Nepean Community Health Centre	0 (0)
Classroom Recruitment	0 (0)

Sixty participants were recruited to take part in this study (singing $n = 22$, breathing $n = 20$, singing and breathing $n = 18$). Forty-five females and 15 males with ages ranging from 15 – 66 years ($M = 29.7$, $SD = 15.35$) participated in this study. The Asthma Control Questionnaire (ACQ) completed during session one indicated that participants had relatively controlled asthma (Juniper, Bousquet, Abetz, & Bateman, 2006). The majority of participants identified Roman Catholic as their religion (28.3%) and Caucasian as their ethnicity (63.3%). Of the sixty participants, 28.3% of participants reported that they perform breathing exercises for a variety of reasons (13.3% breathe as a component of yoga, 11.7% breathe in meditation, 13.3% breathe for musical reasons, 3.3% breathe as indicated by a clinician, and 5% indicated other reasons for practicing breathing exercises). Less than half of the participants reported that they sing on a daily basis (35%). A summary of participant demographic information can be found in Table 2.

Table 2
Summary of Participant Demographic Information

Variable	% (n)
Ethnicity	
Caucasian	63.3 (38)
African American/Canadian	10 (6)
Asian	10 (6)
Other	10 (6)
Hispanic	5 (3)
Native American	1.7 (1)
Religion	
Roman Catholic	28.3 (17)
Other	25 (15)
Protestant	21.7 (13)
Atheist	11.7 (7)
Muslim	6.7 (4)
Jewish	1.7 (1)
Buddhist	1.7 (1)

Measures

Demographics. Participants were asked to provide demographic information such as their age, gender, ethnicity and religion. Participants were also asked about their engagement, and enjoyment, in singing and breathing. In addition, participants were asked how much they believed that singing and breathing would benefit their asthma (see Appendix B).

Asthma Control Questionnaire (ACQ). The ACQ is a valid self-report questionnaire where participants provide information pertaining to their asthma symptoms within the previous seven days. The ACQ has seven items, each containing a seven point rating scale ranging from zero to six (Juniper, 1999). The seventh item was not included in this study, as it required a response from a clinical staff member.

Permission was granted for the use of this questionnaire. The six items of the ACQ can be found in Appendix C.

The Modified Borg Scale (MBS). This scale allowed participants to rate their perceived breathlessness on a Likert-type scale ranging from one (no breathlessness) to 10 (maximum breathlessness). Although no specifics were given, this scale was reported by Kendrick, Baxi, & Smith (2000) to be a valid and reliable method for measuring shortness of breath when compared to other measurements of dyspnea (Borg, 1982; Engen, 2005; Kendrick, Baxi, & Smith, 2000; see appendix D).

Breath Hold Test. This breathing test, used in Lord et al.'s (2010) study, is used as a measure of hyperventilation, which occurs when one breathes rapidly, resulting in aggravated asthma symptoms (Thomas, McKinley, Freeman, & Foy, 2001). This test involves timing the length one can hold their breath following inspiration (see Appendix E). Breath hold times were completed in the practice log, which is described in more detail below.

Forced Expiratory Volume in the First Second (FEV1). This measure of the amount of air exhaled during the first second is a commonly used spirometry measure in those with respiratory illness. FEV1 was measured for each participant with the use of the Koko Peak Pro; a portable device. Participants were each given their own mouth and nose pieces for breathing measures (I kept both the mouth and nose pieces for each participant, labeled with their names in case participants forgot to bring them to their sessions). A strong correlation has been reported between FEV1 measures from a digital home monitoring system and FEV1 from a pulmonary laboratory ($r=.99$; Finkelstein et al., 1993). To obtain the most accurate measures, participants must be engaging in effortful breathing and were encouraged to do so. Recommendations on obtaining

accurate spirometry measures in article by Enright (2003) were used.³ Recommendations include how to instruct the patient to breathe, encouraging them to take maximum breaths, as well as proper posture. Maximum effort was also ensured by having participants attempt this measure three times; the best attempt was recorded. This approach has been used in past research (Engen, 2005; Wade, 2002).

Peak Expiratory Flow Rate (PEFR). This is a respiratory measure of the speed of air exhaled following a maximum inhale (TruZone, 2001). Similar to FEV1 measurement, PEFR was measured using the Koko Peak Pro and participants used their individual mouth and nose pieces when breathing was measured. While this is a common measure in spirometry, it was important that all steps were taken to ensure maximum participant effort. This was done by following the same guidelines as outlined for measurement of FEV1, including participant instruction, encouragement, posture, in addition to recording the best of three attempts.

Saint George's Respiratory Questionnaire (SGRQ). The SGRQ is a valid measure of health impairment for those with asthma and COPD. It has also been used for measurement of other respiratory diseases. This questionnaire contains 17 questions, with various items measuring perceptions of respiratory symptoms and the degree to which these symptoms disrupt patients' lives (Jones, 2009). The questionnaire is divided into three components; symptoms, activities, and impacts. A total score is computed taking into account the three different components. Questions in this scale include items asking participants how often they have had chest trouble (i.e. symptoms), which

³ I completed my practicum (PSYC 5903) at Somerset West Community Health Centre and the Ottawa Hospital Rehabilitation Centre where I had the opportunity to observe spirometry testing on patients. The guidelines that were used from Enright's (2003) article are in line with the observations made and the techniques learned during my practicum.

activities contribute to breathlessness (i.e. activities), and any fear, panic, or embarrassment that may be experienced as a result of breathlessness (i.e. impacts). All answers to questions are provided and participants are asked to check off the appropriate response. One exception is the last open-ended question, in which participants are asked if their chest trouble interferes with their participation in any activity. This questionnaire has been used in previous research as a measure of health related quality of life (Bonilha et al., 2009). Permission for use of this questionnaire in this study was granted. The SGRQ is presented in Appendix F.

General Health Questionnaire (GHQ). This reliable (alpha coefficients ranging from .78 - .95) and valid 12-item questionnaire is commonly used to assess psychological wellbeing (Jackson, 2007). Participants indicated how often each item affects them on a scale ranging from one (i.e. 'not at all') to four (i.e. 'much more than usual'). This questionnaire includes questions on ability to concentrate, enjoyment of daily activities, feelings of happiness or depression (see Appendix G).

Diaphragmatic Breathing Guide. This guide contained instructions on diaphragmatic breathing exercises and was used to assist me in demonstrating these techniques to participants. These exercises were designed by vocal instructors (Tammy Jones & Tammy Raybould, Nepean School of Music, personal communication) who granted permission for their use in this study and are used by other vocal instructors, including myself (see Appendix H).

Practice Log. This original practice log assisted in keeping track of how often participants sang and/or practiced diaphragmatic breathing outside of the sessions. The practice log also contained which songs and diaphragmatic breathing exercises

participants practiced. This assisted in evaluating which songs and exercises are preferred. In addition, this log contained space for participants to record their breath hold times (described above; see Appendix I).

Procedure

Consent forms were distributed to participants at the beginning of the first session. Participants were informed that a component of this study was to explore how individuals with asthma react to singing and breathing. Prior to the first session participants were advised to bring their reliever inhaler for all sessions, as a precaution. In addition, participants were advised not to attend a session if they were having a ‘bad asthma day’ (i.e., they were experiencing many symptoms, were very short of breath, etc.) or if they were feeling ill. This was done to ensure accuracy of breathing measures (i.e. PEFr and FEV1), which may have been impacted by many asthma symptoms or illness. Participants were informed that there would be an additional ‘make-up’ session at the end of the four weeks for those who were unable to attend all four sessions. At the end of the study, participants were given a debriefing form explaining the purpose of the study, as well as informational resources for individuals with asthma.

Design and schedule of measures. Figure 1 illustrates the design of the study. Eligible participants were assigned to one of three groups; singing, diaphragmatic breathing, or singing and diaphragmatic breathing. While I intended to assign participants randomly to conditions, this became impossible as participants were not always available. I assigned partly using block randomization. That is, for every three participants I attempted to assign one participant to each condition, as schedules permitted. It should

be noted that participants did not know which group activity they were assigned to until their first session.

Figure 1. *Summary of Procedure*

Due to the predicted attrition and resulting small sample of participants who completed all four sessions, participants served as their own controls in the first session by completing breathing measures before and after completing demographics and other questionnaires, and before performing any assigned activities (e.g., singing). In particular, during session one, participants in all three groups completed the breathlessness measure (the MBS), and I collected baseline breathing measures (PEFR and FEV1) immediately following that completion. All participants then completed all of the questionnaires, as well as other questionnaires for a related but separate study.⁴ Completion of all questionnaires took approximately 30 minutes. Following questionnaire completion, breathing measures and the MBS were collected again. These measures taken before and after 30 minutes of questionnaire completion provided an individual control measure for each participant to serve as a comparison to values taken before and after performing 30 minutes of their assigned group activity (e.g., singing).⁵ Participants partook in their assigned group activity for approximately 30 minutes immediately following completion of control measures. Following participation in their activity, breathing measures were collected a third time, following the third completion of the MBS. In addition, I demonstrated the breath hold test to participants (for all three groups) and suggested that participants record their own breath hold time at home using the practice logs to observe any progress.

In all subsequent sessions (sessions two to four, and the ‘make-up’ session five), participants’ breathing measures were collected, following completion of the MBS.

⁴Note that B.Cog.Sc student, Laura Inostroza, collected additional psychosocial measures (i.e. vitality, personality, mood, etc.) as part of her honours thesis.

⁵Breathing measures collected after the 30 minutes of questionnaire completion acted as an after measure for the controls, as well as a before measure for activities.

While breathing measures were collected, participants completed their weekly ACQ. Participants then completed 30 minutes of their assigned activity. Immediately following the activity, the MBS was completed again, followed by breathing measures. During the last session of the study, participants were also asked to complete the GHQ and the SGRQ for the second and final time.

Singing condition. Participants assigned to the singing group sang along to music tracks using a karaoke machine (Venturer CD graphics karaoke system, model CDG-2). The karaoke machine was a useful tool for this study as it provided the lyrics to the songs and indicated when the lyrics were to be sung. A variety of songs were used for this study. Songs such as *Call Me Maybe*, *Y.M.C.A.*, and *Celebration* were commonly sung. I often chose songs based on participant preferences which were indicated both in their written practice logs, or verbally. Participants were encouraged to stand while singing. While the vast majority of participants did stand during singing, there were a few who chose to remain seated.

Participants sang as a group for 30 minutes once a week for a four-week duration. At the beginning of the study, participants were given a CD of the songs that would be sung during the group sessions. They were asked to practice the songs on the CD at home and to record the amount of time practiced in their practice log, which was provided to them during the first session. There was no breathing instruction provided to participants in this group (see Appendix J for a list of songs that were used).

Breathing condition. In the second group, participants engaged in diaphragmatic breathing exercises 30 minutes once weekly over a period of four weeks. Breathing exercises were demonstrated by the researchers, who in addition to myself included the

aforementioned Laura Inostroza. We have had vocal training and have received diaphragmatic breathing instruction. We instructed a variety of approximately 11 different exercises. I instructed the exercises that were most familiar to me (exercises one to seven), while Laura Inostroza instructed the exercises she was most familiar with. We each instructed a few exercises per session (however, I instructed all breathing exercises during the last 2-3 months of sessions when Laura was no longer available to attend sessions). I began each breathing session by instructing participants to begin associating their breathing with diaphragmatic movement. Participants were seated during this time and were advised to place their hands on their diaphragm to become aware of diaphragmatic movement. Participants stood up for the remaining exercises. Each session ended with tai chi influenced breathing exercises. Other breathing exercises were instructed in between and varied each week. Participants were provided with a booklet of the breathing exercises and were asked to practice these exercises at home and record them in their practice logs, as well as record the amount of time practiced.

Singing and breathing condition. Participants in the third group engaged in both diaphragmatic breathing and group singing. Similar to group one, participants sang along to karaoke tracks; however, prior to singing, they were shown diaphragmatic breathing exercises and were reminded to apply the learned breathing techniques while singing. Just like the breathing group, I began each session by instructing participants to begin associating their breathing with their diaphragm movement. Each session also ended with tai chi based exercises. Consistent with the other groups, sessions were also held for 30 minutes, once weekly for a duration of four weeks. Participants in this group were

also asked to record, in their practice log, the time spent practicing both breathing and singing, as well as the breathing exercises and songs used.

Results

Preliminary Analyses

Data cleaning. I assessed all data for entry errors by double checking entered values and examining frequency tables for any out of range values. I considered scores that fell beyond a standardized value of 3.00 (vs. 3.29 due to the small sample size, Davis, personal communication, January 10, 2012) to be a univariate outlier. One participant had outlying scores on the Asthma Control Questionnaire (ACQ) measure for weeks three and four. One participant had outlying scores on the forced expiratory volume (FEV1) measure for the first reading of sessions three and four. These outlying scores were adjusted to within 3.00 standard deviations from the mean. I ran a missing value analysis to explore if data were missing completely at random (MCAR). Little's test was not significant, $\chi^2(678) = 685.41, p = .414$, indicating data are MCAR.

I examined all variables for skewness and kurtosis by dividing the skewness and kurtosis statistic by their corresponding standard error. A value greater than 3.00 was considered to be significantly skewed or kurtotic. The impact component of the Saint George's Respiratory Questionnaire (SGRQ) for session four had a slight positive skew. Original data were retained in order to avoid transforming scores at one time point; this variable was normally distributed for session one, as were the total SGRQ scores for sessions one and four (Tabachnick & Fidell, 2007).

Weekly practice enjoyment was found to be slightly negatively skewed. A reverse score square root transformation corrected this skew, but did not change

statistical conclusions. Original data were retained for easier interpretation. Weekly practice duration was found to be significantly positively skewed and kurtotic. A log transformation improved normality.

The Modified Borg Scale (MBS) was found to have a significant positive skew, along with outliers. Since the vast majority of scores fell between 0-3, I recoded the variables on a scale of 0-3 instead of the original 0-10. This drastically improved outliers and normality of the measure.

Assumptions of linearity and homoscedasticity were examined with the use of scatterplots. The majority of the variables appeared to meet the assumption of linearity. The variable for ACQ session two and the variable for the activity component for SGRQ session four appeared slightly curvilinear. A square root transformation of the activity component for the SGRQ slightly improved linearity between the variables. However, because the transformation did not change statistical conclusions and in order to avoid transforming variables at one time point, untransformed data were retained.

A few of the relationships between variables appeared heteroscedastic (e.g. ACQ sessions two vs. four, ACQ session one vs. SGRQ session four, ACQ session one vs. SGRQ symptoms component of session four, ACQ four vs. SGRQ session four). While transformations improved some of these variables, statistical results did not change. In order to avoid transforming variables at one time point, original data were retained (Tabachnick & Fidell, 2007).

Multivariate outliers of all variables of interest were examined using Mahalanobis distances. No scores fell beyond the cut off, $\chi^2(20) = 45.31, p = .001$, indicating no presence of multivariate outliers. Multicollinearity was examined through tolerance and

variance inflation factor (VIF) values. Tolerance values less than .2 and VIF values greater than 10 were considered problematic (Davis, personal communication, March 2012). There were no VIF variables exceeding the value of 10. The MBS, SGRQ, and FEV1 breathing measures were associated with Tolerance values less than .2. I used the condition index values, along with their associated variance proportions to assist in determining if these variables were problematic (Tabachnick & Fidell, 2007). There were no gross violations of condition index. In addition, it should be noted that the highest correlated variables were PEFr and FEV1 breathing measures, $r = .67$, $n = 57$, $p < .001$.

Analysis of completers and month of study participation. There were twelve participants who did not complete all four sessions of the study. I used a multivariate analysis of variance (MANOVA) to explore if there were any differences in participants who dropped out of the study versus participants who completed the study. The results from the MANOVA indicated that there were no overall multivariate significant differences in beliefs, asthma control (ACQ), general health (GHQ), respiratory related quality of life (SGRQ), or session one baseline, reading one, and reading two breathing measures (MBS, PEFr, FEV1), Wilk's Lambda = .76, $F(9, 43) = 1.50$, $p > .10$.⁶

Participant attendance for each session can be found in Table 3.

⁶ Although the multivariate analysis was non-significant, I noted that there was a univariate difference in singing beliefs. Those who dropped out of singing had lower beliefs that singing could improve their asthma ($M = 3.5$, $SD = 1.00$) than those who completed the study ($M = 2.47$, $SD = 0.62$). In addition, those who dropped out of the breathing group had higher singing beliefs ($M = 1.80$, $SD = 0.84$) than those who completed the study ($M = 2.57$, $SD = 0.85$), $F(2, 57) = 3.92$, $p < .05$. I also noticed a marginal gender effect. More males dropped out of the study (40%) than females (13.3%), $\chi^2(1) = 3.47$, $p = .06$.

Table 3
Participant attendance at each session (n)

	Session one	Session two	Session three	Session four
Breathing Group	20	18	17	15
Singing Group	22	20	18	17
Singing and Breathing Group	18	18	18	16

A MANOVA was also used to assess any differences in breathing measures based on the month of participation. There was a significant effect of month of participation (baseline breathing measures were better for participants who completed the study during later months), Wilk's Lambda = .59, $F(12, 119.35) = 2.17, p < .05$. There was, however, no group x month differences, Wilk's Lambda = .55, $F(20, 150.20) = 1.47, p = .10$.

Analysis of baseline to reading one breathing measures. I ran a repeated measures analysis of variance (ANOVA) to compare baseline and reading one breathing measures from session one. A significant improvement was found in the MBS scores from baseline to reading one, $F(1, 51) = 6.97, p < .05$. There was a significant decrease from baseline to reading one in PEFr measures, $F(1, 51) = 4.24, p < .05$, and in FEV1 scores $F(1, 51) = 5.30, p < .05$. There were no significant group differences in these measures. Means and standard deviations for baseline and reading one measures can be found in Table 4.

Table 4

Means and Standard Deviations of Baseline and Reading One MBS, PEFr, and FEV1 Measures

	Group					
	Breathing		Singing		Singing and Breathing	
	Mean	SD	Mean	SD	Mean	SD
MBS Baseline	1.22	.55	1.32	.82	1.23	.66
MBS Reading One	.89	.76	1.21	.71	1.12	.60
PEFR Baseline	299.17	123.05	307.63	79.65	314.41	107.46
PEFR Reading One	296.28	100.84	277.47	75.51	308.76	133.11
FEV1 Baseline	3.00	1.06	3.05	.71	2.96	.75
FEV1 Reading One	2.85	.90	2.87	.56	2.84	.67

Note. Improvement in the MBS is represented by a decreased score while an improvement in PEFr and FEV1 is represented by an increased score.

Multilevel Modelling Analyses

Multilevel modeling was used to address hypothesis one (breathing measures MBS, PEFr, and FEV1 would improve over the four sessions and that singing and breathing would demonstrate the most improvement) and hypothesis two (ACQ would improve over the four sessions and singing and breathing would demonstrate the most improvement). All analyses were completed with the use of HLM7 software. Multilevel modelling (MLM) is able to analyse data that is collected at more than one level where individuals or variables may be nested within higher units, such as treatment conditions (Luke, 2004). MLM is also effective with handling longitudinal data that contain missing values and uneven time points from repeated measures (Luke, 2004). The present study measured variables over time, within participants (level one) and between participants (levels two). Other statistical methods (such as ANOVA, repeated measures or analysis of covariance (ANCOVA)) pose limitations for analysing this type of data. Limitations include not taking into account individual change over time, not including drop out participants in the analysis, and including time as a fixed effect rather than a random effect which ignores individual variability over time (Luke, 2004; Tasca & Gallop, 2009).

Due to the number of limitations of other methods of analyses, MLM was the preferred method of analyses in the present study.

To analyse pre (reading one) and post (reading two) breathing measures (PEFR, FEV1, and MBS) I conducted separate analyses for reading one and reading two scores. This was done because I expected that any possible improvement within sessions (i.e. from reading one to reading two within a single session) might not carry over to the start of the next session.⁷

When I added a level one predictor to the models (i.e. time point), I added the variable group mean centered. This was done for the purpose of having the intercept represent the expected variable outcome for a participant who completed the average time point of the study, relative to all of the other participants in their group. This assisted with adjusting for differences between groups (Gallop & Tasca, 2009; Nezlek, 2011). This is in contrast to entering the variable grand mean centered where the intercept would be interpreted as the expected variable outcome for a participant who completed the average time point, relative to all of the participants in the study (Nezlek, 2011).

I added covariates to models, as appropriate, based on the correlations between covariates and the outcome variables. Covariates were added if they were moderately correlated to the outcome variable. Please see Appendix K for correlations of session one measures. Session four variable correlations are displayed in Appendix L.

I used four different models for my multilevel analysis: (a) the null model; (b) random intercepts model; (c) means as outcomes model; and the (d) random intercepts and slopes model (Woltman et al., 2012). The MLM equations are included in Appendix

⁷ I also examined a model where all eight time points were included (four reading one measures and four reading two measures). The results from both methods were very similar, therefore I will be only be reporting separate model results.

M. The null model was used for calculation of the interclass correlation (ICC) which demonstrated whether the majority of the variance was between participants or within participants (Davis, Egan, Dubouloz, Kubina, & Kessler, 2013). The random intercepts model provides information about within participant differences over time from session one to session four (level one; Tasca & Gallop, 2009). The means as outcomes model explores group differences on a particular outcome variable. Finally, the random intercepts and slopes model was used to assess between participant changes over the four sessions (Tasca & Gallop, 2009). In this model the main effects and interactions of time (level one) and group (level two) were assessed (Woltman et al., 2012).

Hypothesis one: MBS, PEFr and FEV1 may improve across the four sessions with the singing and breathing group showing the most improvement.

MBS. I examined participants' MBS responses (level 1 outcome variable) and their assigned group (level 2 predictor variable). I assessed the MBS reading one scores (measured at the beginning of each session) and the MBS reading two scores (measured at the end of each session). As indicated above, the reading one and reading two scores were examined separately.

MBS reading one. I began with a null model for calculation of the interclass correlation (ICC). The ICC for this model was calculated as $ICC = 0.46 (\tau_{00} / \tau_{00} + \delta^2; 0.25/0.25 + 0.29; \text{Woltman et al., 2012})$. This indicates that 46% of variance is between persons (level 2), while 54% of variance is within persons (level 1; Nezlek, 2011). This relatively high ICC value also supports the use of MLM for analyses (Luke, 2004; Nezlek, 2011).

Next I ran a random intercepts model. To do this, I added the time point variable, group mean centred. The time point variable indicated which session the MBS was completed. The results from this model indicated a non-significant decrease in reading one MBS scores across the four sessions, $b = -0.03$, $SE = 0.04$, $t(59) = -0.90$, $p > .10$.

I then proceeded to run a means as outcomes model to address the second part of the first hypothesis that participants in the singing and breathing group may experience more asthma benefits than those in the singing alone or breathing alone groups. To address this hypothesis, I added group, dummy coded, as a level 2 predictor. The singing and breathing group was used as the comparison group in the dummy coding. This was done to adequately address the hypothesis. The regression coefficient did not support the hypothesis that participants in the singing and breathing group experienced significantly more improvement in MBS scores than those in the breathing group, $b = -0.18$, $SE = 0.19$, $t(57) = -0.98$, $p > .10$, or the singing group, $b = 0.11$, $SE = 0.18$, $t(57) = 0.60$, $p > .50$.

In the final random intercepts and slopes model, I tested for differences in MBS reading one scores, between groups, over time. To do this, I included time point, group mean centred (level 1 predictor) and group, dummy coded (level 2 predictor), in the model. There was no significant difference between MBS scores over time between the singing and breathing group and the breathing alone group, $b = 0.02$, $SE = 0.10$, $t(57) = 0.22$, $p > 0.50$ or participants in the singing alone group, $b = -0.09$, $SE = 0.07$, $t(57) = -1.27$, $p > 0.10$.

I ran the model again, however this time controlling for session one ACQ, GHQ, and Saint George's Respiratory Questionnaire (SGRQ), as these variables were

moderately correlated with reading one MBS scores. These variables were entered into the model grand mean centered (Nezlek, 2011). There were no significant differences after controlling for these variables.⁸

MBS reading two. I ran a null model, with MBS reading two as the outcome variable, in order to calculate the ICC. The ICC for this model was calculated as $ICC = 0.56 (0.34/0.34 + 0.27; \text{Woltman et al., 2012})$. This indicates that 56% of variance is between persons (level 2), while 44% of variance is within persons (level 1; Nezlek, 2011).

Next I ran a random intercepts model. To do this, I added time point, group mean centred, as a level one predictor variable. As predicted, the results from this model indicated a significant decrease in reading two MBS scores over the course of the study, $b = -0.11, SE = 0.37, t(59) = -2.99, p < .01$. The effect size for this model was calculated as $0.18 (\delta^2 \text{ null} - \delta^2 \text{ random} / \delta^2 \text{ null}; 0.27 - 0.22/0.27)$ indicating that the addition of time point as a level one predictor explains 18% of variance in MBS reading two measures (Tasca & Gallop, 2009).

I then proceeded to run a means as outcomes model to address hypothesis 4 that participants in the singing and breathing group may experience more asthma benefits than those in the singing alone or breathing alone groups. To address this hypothesis, I added group, dummy coded (with singing and breathing as the comparison group) as a level 2 predictor. Participants in the singing and breathing group did not experience more improvement in MBS scores than those in the breathing group, $b = -0.16, SE = 0.20, t(57) = -0.82, p > .10$, or singing group, $b = 0.07, SE = 0.21, t(57) = 0.36, p > .50$.

⁸ Baseline MBS was not included as a covariate because it was too highly correlated with MBS reading one. Beliefs were also not included as covariates because they were not significantly correlated with MBS reading one measures.

In the final random intercepts and slopes model, I tested for differences in MBS reading two scores, between groups, over time. To do this, I included time point, group mean centred (level 1 predictor) and group, dummy coded (level 2 predictor), in the model. There was no significant difference between MBS scores over time between the singing and breathing group and the breathing alone group, $b = 0.05$, $SE = 0.09$, $t(57) = 0.53$, $p > 0.50$, or the singing alone group, $b = -0.00$, $SE = 0.09$, $t(57) = -0.03$, $p > 0.50$. I ran the model again, however this time controlling for session one ACQ as well as baseline MBS, session one GHQ and session one SGRQ (all group mean centered; Nezlek, 2011), as these variables were all moderately correlated with reading two measures of the MBS. There were no significant differences after controlling for all of these variables.⁹

PEFR. I examined participants' peak expiratory flow rate (PEFR) breathing measures (level 1 outcome variable) as a function of session (level one predictor) and their assigned group (level 2 predictor variable). Analogous to the MBS results reported above, I assessed the PEFR reading one scores (measured at the beginning of each session) and the PEFR reading two scores (measured at the end of each session). The reading one and reading two scores were examined separately. Unlike analyses for the MBS, no covariates were used for reading one and reading two PEFR analyses because baseline PEFR was too highly correlated with them, and singing and breathing beliefs, ACQ, GHQ, and SGRQ scores were not correlated with PEFR reading one measures.

PEFR reading one. I began with a null model, with PEFR reading one as the outcome variable, for the purpose of calculating the ICC. The ICC for this model was

⁹ Beliefs were not included as covariates because they were not significantly correlated with MBS reading two scores.

calculated as 0.77 ($6905.11/6905.11 + 2023.89$). This indicates that there is potentially 77% of PEFr variability between participants, suggesting that there is not much within participant variability (Luke, 2004; Wech & Heck, 2004; Woltman et al., 2012).

I ran a random intercepts model with PEFr as the outcome variable. In this model, time point was added as a level one predictor. Contrary to the first reading of the MBS analysis, first reading PEFr measures did improve over the sessions. This finding was significant, $b = 13.92$, $SE = 3.44$, $t(59) = 4.04$, $p < .001$. The effect size for this model was calculated as 0.42 ($2023.89 - 1178.51/2023.89$), indicating that time point explains 42% of variance in PEFr reading one measures.

I ran a means as outcomes model with group, dummy coded, as a level two predictor variable. Results did not support the hypothesis that singing and breathing would have more benefits than breathing alone, $b = -3.77$, $SE = 28.5$, $t(57) = -0.13$, $p > .50$, or singing alone, $b = -19.59$, $SE = 27.96$, $t(57) = -0.70$, $p > .10$.

The random intercepts and slopes model was used to assess differences in PEFr reading one measures between groups (level 2) over time (level 1). There were no significant differences in PEFr reading one values between groups over time. Specifically, singing and breathing did not result in significantly improved scores overtime compared to the breathing alone group, $b = 3.47$, $SE = 8.65$, $t(57) = 0.40$, $p > .50$, or singing alone, $b = 3.78$, $SE = 8.59$, $t(57) = 0.44$, $p > .50$.

PEFr reading two. I began with a null model, with PEFr reading two as the outcome variable, for the purpose of calculating the ICC. The ICC for this model was calculated as 0.79. ($6880.68/6880.68 + 1816.78$). This indicates that there is approximately 79% of PEFr variability between participants, suggesting that there is not

much within participant variability (Luke, 2004; Wech & Heck, 2004; Woltman et al., 2012).

I ran a random intercepts model with PEFr reading two as the outcome variable. In this model, time point was added as a level one predictor. The results from this model indicated that, across sessions, PEFr measures improved significantly overall, at second reading, $b = 14.90$, $SE = 3.12$, $t(59) = 4.78$, $p < .001$. The effect size for this model was calculated as 0.46 ($1816.78 - 972.77/1816.78$), indicating that time point explains 46% of variance in PEFr reading two measures.

I ran a means as outcomes model with group, dummy coded, as a level two predictor variable. The regression coefficient did not support the hypothesis that singing and breathing would have more benefits than breathing alone, $b = -30.55$, $SE = 28.23$, $t(57) = -1.08$, $p > .10$, or singing alone, $b = -9.81$, $SE = 27.62$, $t(57) = -0.35$, $p > .50$. The random intercepts and slopes model was used to assess differences in PEFr reading two measures between groups (level 2) over time (level 1). There were no significant differences in PEFr reading two values between groups over time. Specifically, singing and breathing did not result in significantly improved scores over the course of the study compared to the breathing alone group, $b = 1.88$, $SE = 7.87$, $t(57) = 0.24$, $p > .50$, or singing alone $b = 4.69$, $SE = 7.69$, $t(57) = 0.61$, $p > .50$.

FEV1. I examined participants' forced expiratory volume in the first second (FEV1) breathing measures (level 1 outcome variable) and their assigned group (level 2 predictor variable). I assessed the FEV1 reading one scores (measured at the beginning of each session) and the FEV1 reading two scores (measured at the end of each session). The reading one and reading two scores were examined separately. No variables were

used as covariates for both reading one and reading two FEV1 measures. This is because baseline FEV1 was too highly correlated, and singing and breathing beliefs, ACQ, GHQ, and SGRQ scores were not correlated with FEV1 reading one or reading two measures.

FEV1 reading one. I began with a null model, with PEFR reading one as the outcome variable, for the purpose of calculating the ICC. The ICC for this model was calculated as 0.84. $(0.41/0.41 + 0.08)$. This indicates that most of the variance (84%) is between participants (Luke, 2004; Wech & Heck, 2004; Woltman et al., 2012).

The random intercepts model was assessed with FEV1 reading one as the outcome variable and time point as the level one predictor variable. In this model, there were no significant findings between time point and FEV1 reading one scores, $b = 0.01$, $SE = 0.02$, $t(59) = 0.35$, $p > .50$. This result confirms the ICC finding that there is not much within participant variance for FEV1 reading one.

I ran a means as outcomes model with group, dummy coded, as a level two predictor variable. Singing and breathing did not result in significantly improved FEV1 reading one scores when compared to breathing alone, $b = -0.06$, $SE = 0.22$, $t(57) = -0.28$, $p > .50$, and singing alone, $b = 0.00$, $SE = 0.21$, $t(57) = 0.00$, $p > .50$.

The random intercepts and slopes model did not support differences in FEV1 reading one scores over time, between groups. Participants in the singing and breathing group did not have significantly different FEV1 scores overtime than participants in the breathing alone group, $b = -0.02$, $SE = 0.06$, $t(57) = -0.33$, $p > .50$, or singing alone $b = -0.02$, $SE = 0.06$, $t(57) = -0.26$, $p > .10$.

FEV1 reading two. I began with a null model, with FEV1 reading two as the outcome variable, for the purpose of calculating the ICC. The ICC for this model was

calculated as $0.87 (0.41/0.41 + 0.06)$. This indicates that most of the variance (87%) is between participants (Luke, 2004; Wech & Heck, 2004, Woltman et al., 2012).

The random intercepts model was assessed with FEV1 reading two as the outcome variable and time point as the level one predictor variable. In this model, there were no significant findings between time point and FEV1 reading two scores, $b = 0.01$, $SE = 0.02$, $t(59) = 0.75$, $p > .10$.

I ran a means as outcomes model with group, dummy coded, as a level two predictor variable. Singing and breathing did not result in significantly improved FEV1 reading two scores when compared to breathing alone, $b = -0.20$, $SE = 0.21$, $t(57) = -0.99$, $p > .10$. Singing and breathing did not result in significantly improved FEV1 reading one measures compared to the singing alone group, $b = 0.03$, $SE = 0.19$, $t(57) = 0.18$, $p > .50$.

The random intercepts and slopes model did not support differences in FEV1 reading two scores over time, between groups. Participants in the singing and breathing group did not have significantly different FEV1 scores overtime than participants in the breathing alone group, $b = -0.01$, $SE = 0.04$, $t(57) = 0.29$, $p > .50$, or singing alone group, $b = 0.05$, $SE = 0.04$, $t(57) = 1.20$, $p > .10$.

Hypothesis two: ACQ may improve over the four sessions with the most improvement seen in the singing and breathing group.

ACQ. I analysed the ACQ using the same four models as previously presented. The ACQ was measured once a week and therefore was modeled using four time points (session one through session four). Time point for ACQ analysis was also entered group mean centered.

I began the ACQ analysis with a null model which included ACQ as the outcome variable. The ICC for this model was calculated as 0.48 ($0.23/0.23 + 0.25$). This suggests that there is approximately equal variability between participants (48%) and within participants (52%).

Next I ran a random intercepts model to assess ACQ changes over time. To do this, I added time point, group mean centered, as a level one predictor. The results from this model indicated a non-significant improvement in ACQ scores across the four sessions, $b = -0.05$, $SE = 0.04$, $t(59) = -1.45$, $p > .10$.

I then proceeded to run a means as outcomes model to assist in addressing hypothesis two (participants in the singing and breathing group may experience the most improvement in ACQ). To address this hypothesis, I added group, dummy coded (singing and breathing as the comparison group), as a level 2 predictor. The regression coefficient did not support that participants in the singing and breathing group experienced more improvement in ACQ scores than those in the breathing alone group, $b = -0.11$, $SE = 0.18$, $t(57) = -0.64$, $p > .50$, or in the singing alone group, $b = -0.004$, $SE = 0.18$, $t(57) = -0.02$, $p > .50$.

I used the final random intercepts and slopes model to explore differences in ACQ scores, between groups, over time. In this model, time point (group mean centered) was included as a level one predictor and group, dummy coded, was included as a level two predictor. ACQ scores, over time, did not significantly differ between singing and breathing and breathing alone, $b = -0.05$, $SE = 0.09$, $t(57) = -0.59$, $p > 0.50$, or singing

alone, $b = -0.01$, $SE = 0.09$, $t(57) = -0.16$, $p > 0.50$. Results from these models did not change when controlling for GHQ session one.¹⁰

Summary. Reading one breathing measures did not demonstrate any significant changes over sessions, with the exception of PEFr. Hypothesis two was partially supported; both MBS and PEFr reading two measures were found to have significant improvements over the course of the study, collapsed across group. The prediction that the singing and breathing group would demonstrate the most changes was not supported as there were no group differences for any of the reading one or reading two breathing measures. There was also no significant time x group interaction for MBS, PEFr, or FEV1. Hypothesis two was not supported as the analysis for the ACQ failed to demonstrate significant effect of time, group, or time x group interaction. Adding appropriate covariates to the models did not change the results.

Hypothesis 3: Singing and diaphragmatic breathing together may result in improved SGRQ scores and improved GHQ scores. I used a one-way analysis of variance (ANOVA) to evaluate if there were significant differences in the Saint George's Respiratory Questionnaire (SGRQ) and the General Health Questionnaire (GHQ) session one scores between the three groups. The results from the one-way ANOVA indicated that there were no differences in session one SGRQ scores $F(2,58) = 0.65$, $p > .05$, or session one GHQ scores, $F(2,59) = .46$, $p > .10$. This indicated that the groups did not differ on these measures at the beginning of the study.

I used a repeated measures ANOVA to compare differences in SGRQ and GHQ between session one and session four, among the three groups. Decreased scores in the

¹⁰ Beliefs were not included as covariates because they were not significantly correlated with ACQ measures. SGRQ was also not included as a covariate because it was too highly correlated with ACQ measures.

SGRQ and GHQ indicate improvement. Overall, there were no significant differences between groups for the GHQ, $F(2,44) = .13, p > .10$, or for the SGRQ, $F(2,44) = .09, p > .10$. There was a significant main effect of time for the GHQ, $F(1,44) = 13.46, p = .001$ indicating less distress at the fourth session compared to the first session. The interaction between group and time failed to reach significance for SGRQ, $F(2,44) = 1.05, p > .10$, and GHQ, $F(2,44) = 1.52, p > .10$. It should be noted that although there were no group effects or interactions, participants in the singing group displayed the greater improvement in GHQ scores from session one ($M = 15.12, SD = 6.82$) to session four ($M = 10.65, SD = 6.60$). Means and standard deviations of the GHQ and SGRQ can be found in Table 5. Results from the repeated measures ANOVA can be found in Table 6.

Table 5

Means and Standard Deviations of GHQ and SGRQ for sessions one and four

	Group					
	Breathing		Singing		Singing and Breathing	
	Mean	SD	Mean	SD	Mean	SD
GHQ S1	12.50	3.08	15.12	6.82	13.94	7.29
GHQ S4	11.50	6.94	10.65	6.60	10.13	6.20
SGRQ S1	30.03	12.81	33.16	17.19	30.25	12.59
SGRQ S4	29.17	13.21	30.24	16.16	30.76	13.85

Table 6

Summary of Repeated Measures ANOVA for GHQ and SGRQ

	Sum of Squares	df	Mean Square	F
GHQ Time	223.54	1	223.54	13.46*
GHQ Group	16.28	2	8.14	0.13
GHQ Time x Group	50.60	2	25.30	1.52
SGRQ Time	27.77	1	27.77	1.19
SGRQ Group	69.30	2	34.65	0.09
SGRQ Time x Group	49.12	2	24.56	1.50

* $p = 0.001$

I also explored the subscales of the SGRQ (symptoms, impacts, and activities) to see if scores differed among groups from session one to session four. There were no significant differences in these subscales between groups. There was a main effect of time the symptoms component, $F(1,45) = 4.96, p < .05$, and the impacts component, $F(1,45) = 5.38, p < .05$. Means and standard deviations of the SGRQ subscales can be found in Table 7. A summary of these results can be found in Table 8.

Table 7

Means and Standard Deviations of SGRQ subscales for sessions one and four

	Group					
	Breathing		Singing		Singing and Breathing	
	Mean	SD	Mean	SD	Mean	SD
Symptoms S1	42.19	11.16	55.95	21.89	46.96	17.97
Symptoms S4	36.85	14.44	48.05	20.39	47.66	17.68
Impacts S1	20.48	14.80	23.38	16.13	21.90	15.30
Impacts S4	18.77	16.50	21.27	14.74	18.72	14.66
Activity S1	39.69	13.74	38.81	21.55	35.95	13.74
Activity S4	43.47	14.64	36.52	23.26	42.23	19.03

Note. Improvement is represented by a decreased score.

Table 8

Summary of Repeated Measures ANOVA for SGRQ subscales

	Sum of Squares	df	Mean Square	F
Symptoms Time	418.24	1	418.24	4.96*
Impacts Time	130.43	1	130.43	5.38*
Activity Time	160.42	1	160.42	1.63
Symptoms Group	2513.60	2	1256.80	2.29
Impacts Group	127.53	2	63.76	0.14
Activity Group	247.59	2	123.80	0.22
Symptoms Time x Group	318.17	2	159.08	1.89
Impacts Time x Group	9.09	2	4.54	0.19
Activity Time x Group	321.55	2	160.78	1.64

* $p < .05$

Exploratory analyses

Practice Logs. I used a one-way analysis of variance (ANOVA) to explore if there were any differences in practice enjoyment between the three groups. Note that not all participants completed their practice logs. There were 11 participants from the breathing group, 10 participants from the singing group, and 11 participants from the singing and breathing group who were included in the practice log analyses. A significant difference of practice enjoyment was found $F(2,29) = 3.96, p < .05$. Because a significant difference was found between the groups, I compared each group using the Tukey HSD post hoc test to determine which groups significantly differed. The mean practice enjoyment for the breathing group ($M = 3.37, SD = 1.11$) was significantly lower than the mean practice enjoyment for the singing and breathing group ($M = 4.30, SD = .77$). The mean practice enjoyment for the breathing group was also lower than the mean practice enjoyment for the singing group ($M = 4.27, SD = .63$), however this difference was not significant. There was also a non-significant difference between mean practice enjoyment between the singing and singing and breathing groups.

A one-way ANOVA was used to explore differences in practice duration between the three groups. A significant difference was found, $F(2,29) = 3.42, p < .05$. The Tukey HSD test was used to detect which groups significantly differed. The mean practice duration for the singing group ($M = 1.37, SD = .52$) was significantly higher than the mean practice duration for the breathing group ($M = .82, SD = .41$). The mean practice duration for the singing and breathing group ($M = 1.22, SD = .52$) was non-significantly higher than the breathing group. Please see Table 9 for descriptive statistics of practice duration and enjoyment.

Table 9

Practice Duration and Enjoyment Means and Standard Deviations

	<i>N</i>	Mean	<i>SD</i>	<i>SE</i>	95% Confidence Interval for Mean	
					Lower	Upper
Breathing Duration	11	0.82	0.41	0.12	0.56	1.12
Singing Duration	10	1.37	0.52	0.16	1.00	1.75
Singing & Breathing Duration	11	1.22	0.52	0.16	0.87	1.58
Breathing Enjoyment	11	3.37	1.11	0.34	2.62	4.12
Singing Enjoyment	10	4.27	0.63	0.20	3.82	4.72
Singing and Breathing Enjoyment	11	4.30	0.77	0.23	3.78	4.82

Note. The enjoyment measure ranged from 1 (“I did not enjoy practicing”) to 5 (“I very much enjoyed practicing”).

Participant Comments

I recorded participant comments regarding the sessions throughout the study.

Many participants in the breathing group mentioned that the breathing exercises made them feel ‘lightheaded’, especially when breathing for a length of time. This did not seem to be problematic for those in the singing and breathing group. Others reported that breathing exercises were helpful. One participant mentioned that practicing the learned breathing exercises was helpful during an asthma attack experienced while skiing. Another participant verbalized that the breathing exercises helped induce sleep.

There were some positive comments relating to singing. One participant felt that the breathing test using the Koko Peak Pro (used to measure PEFr and FEV1) felt easier following singing. Another participant expressed that they felt ‘clearer’ after singing. Singing was also reported as helpful for clearing the lungs, having more control over

one's breathing, and feeling more alert. One participant mentioned that singing higher pitched songs was difficult as it requires more breath.

Discussion

The purpose of this study was to compare combined singing and diaphragmatic breathing, as well as isolating each activity to explore the potential asthma benefits in adults with asthma. Perceived breathlessness (MBS) and speed of air (PEFR) improved over the four weeks for all participants. There was no improvement in asthma control (ACQ) or amount of air exhaled during the first second (FEV1). Although breathing measures improved, the results from this study did not support the hypothesis that participants in the singing and breathing group would demonstrate the most improvement, as compared to either activity alone. Moreover, there were no significant group differences in breathing measures.

Similar results were found for the general health questionnaire (GHQ), a measure of psychological distress, and respiratory related quality of life (SGRQ). Participants demonstrated significantly improved measures in the GHQ from session one to session four. While there was no significant difference in the total score for the SGRQ, the symptoms and impacts components of the SGRQ improved significantly from session one to session four. The results from the GHQ and SGRQ analysis also failed to support the hypothesis that those in the singing and breathing group would improve the most in GHQ and SGRQ scores, as there were no significant group differences in these measures.

Breathing Measures

The current study was the first known study to isolate singing and diaphragmatic breathing. Previous research has found an improvement in PEFR as a result from singing

with the incorporation of breathing and/or vocal exercises (i.e. Eley & Gorman, 2010; Wade, 2002). The present study demonstrated that diaphragmatic breathing alone, singing alone, and a combination of the two activities all assist in improving PEFV measures in adults with asthma.

Although research exploring shortness of breath measures from diaphragmatic breathing has been limited, one study found that diaphragmatic breathing resulted in no improvement in dyspnea (shortness of breath; Dechman & Wilson, 2004). The results from the present study indicate that diaphragmatic breathing assists in improving self-perceived dyspnea, measured by the MBS. Bonilha et al. (2009) also found improvement in MBS as a result of a combination of singing and breathing in participants with COPD. The current results add to this finding by supporting the use of singing and breathing in decreasing dyspnea in participants with asthma. In addition, the results indicate that singing alone, without incorporating breathing exercises, was also effective in decreasing dyspnea.

In this study, no significant differences were found in FEV1 measures as an effect of time or group. In their study, Eley & Gorman (2010), also failed to find significant improvement in FEV1 measures as a result of singing (which also included breathing). Moreover, FEV1 failed to demonstrate significant improvement in the breathing only group, unlike what was found in past research. In their study, Grammatopoulou et al. (2011) found that breathing retraining (which included diaphragmatic and nasal breathing) improved FEV1 measures in participants with asthma. This finding was not supported in the present study as FEV1 measures did not improve in either singing, breathing or singing and breathing groups.

It seems that while participants may demonstrate improvement in speed of air (PEFR) as a result from singing, the amount of air exhaled during the first second (FEV1) remains unchanged. While Grammatopoulou et al. (2011) found improvements in FEV1, their study occurred for six months. It is possible that FEV1 may require longer than four weeks to demonstrate improvement. On the other hand, Eley & Gorman's (2010) study also occurred for approximately six months and they still failed to find significant FEV1 improvements for participants in the singing group.

ACQ measures did not improve significantly in this study. This measure has been found to improve as a result of practicing breathing exercises which included both mouth and nasal breathing, in a study by Slader et al., (2006). Grammatopoulou et al. (2011) also found improvement in asthma control (measured by the Asthma Control Test) in their study exploring diaphragmatic and nasal breathing in participants with asthma. The results from the present study did not demonstrate that breathing assisted in improving asthma control. Similar to FEV1, it is possible that more time is needed for participants to experience benefit in this measure. Slader et al.'s, (2006) study occurred for twenty eight weeks, while Grammatopoulou et al.'s (2011) study occurred for six months. Lord et al. (2010) suggested that their six week study of singing in participants with COPD may not have been long enough. One participant in their study reported that they were just beginning to notice differences at six weeks. Although there were improvements in the present study, more time may have been needed for improvements in ACQ and FEV1 measures.

Wellbeing Measures

Participants in all three groups demonstrated significant improvement in general health questionnaire scores (GHQ) from session one to session four. While there were no significant group differences, it is interesting to note that the mean GHQ score for participants in the singing alone group demonstrated the largest decrease compared to the breathing alone and singing and breathing groups. Improvement in wellbeing, as a result from singing, has been reported in other studies. In their study, Lord et al. (2010) found a decrease in anxiety and depression in participants with COPD who participated in singing classes which also incorporated posture, relaxation and vocal exercises. Improvements in mental health and wellbeing, such as decreased depression, and feeling uplifted and relaxed, have also been commonly reported in studies with healthy participants (i.e. Bungay & Skingley, 2008; Clift & Hancox, 2001). Breathing exercises, involving deep, controlled breathing, have often been used as a tool for improving mental health in wellbeing (i.e. Pilkinton et al., 2005; Van der Merwe & Parsotam, 2011). The present study supports the use of both singing and diaphragmatic breathing as a way to improve overall wellbeing. This may be particularly important for those with respiratory illness due to the high prevalence of comorbid anxiety and depression in these individuals (i.e. Strine et al., 2006). Singing, breathing, or a combination of the two activities, may be a useful method to assist in improving overall wellbeing in participants with asthma.

While the total score of the SGRQ did not change significantly in the present study, the symptoms and impacts components of the questionnaire did improve from session one to session four. The symptoms component addresses participants' perception of their recent respiratory symptoms, while the impacts component addresses the burden

of their respiratory illness in a psychosocial context. This finding is similar to the results on this measure in Bonilha et al.'s (2009) study exploring singing in participants with COPD. The most noteworthy changes in the SGRQ in Bonilha et al.'s (2009) study were also related to the symptoms and impacts components. It seems that while singing and breathing assist participants' perception of their symptoms, as well as decreasing the psychosocial impact of their respiratory condition, singing and breathing does not seem to impact their daily activities. Furthermore, for the present study, it is possible that the activity component of the SGRQ failed to demonstrate a significant improvement because the majority of the participants had well controlled asthma. The activity related questions, such as getting breathless while sitting or lying down, getting washed or dressed, etc., may not have affected these participants.

Practice Logs and Adherence

Although not everyone completed the practice logs, participants in the singing and breathing group enjoyed practicing significantly more than participants in the breathing group. Those in the singing group also enjoyed practicing more than those in the breathing group; however this result was not significant. Individuals seem to enjoy breathing exercises more when they are combined with the opportunity to sing. Practice duration was significantly higher in the singing group than in the breathing group, and was non-significantly higher than the singing and breathing group. This may have been associated with the enjoyment of singing. It may also have been that participants felt that they could sing for a longer period of time than they could practice breathing exercises. Many participants reported feeling lightheaded after engaging in diaphragmatic breathing

for a long period of time. There were no negative comments regarding singing for a long period of time.

Moreover, twelve participants did not complete the present study, and the breathing group had the largest percentage of dropouts. The participants in the singing and breathing group seemed to be the most adherent, as only two participants dropped out of this group. Overall, there were mixed reactions for participating in singing alone and breathing alone groups. While most participants were happy to attend the singing groups, a few were apprehensive about singing at first. On the other hand, many participants in the breathing alone group were disappointed that they would not have an opportunity to sing. One participant even dropped out of the study after the first session because they were not assigned to the singing group.

Furthermore, beliefs that singing and breathing would benefit asthma, was found to be associated with completion of the study. Participants in the singing condition who dropped out of the study had lower beliefs that singing would benefit their asthma than those who completed the study. Participants who dropped out of the breathing condition had higher beliefs that singing would benefit their asthma than those who stayed in the breathing condition. This may be a reflection of the many comments made by disappointed participants who were assigned to the breathing group. It is possible that individuals in the breathing group who believed that singing would be beneficial for their asthma were interested in participating in the singing sessions and therefore were less likely to adhere to the breathing treatment. As previously mentioned, participants in the breathing group commonly reported feeling lightheaded while engaging in the breathing exercises, especially when breathing for a substantial amount of time. This may have

contributed to the higher dropout rates in the breathing group compared to the singing and breathing group where participants engaged in breathing exercises for half of the amount of time.

There was also a notable gender difference in participants who completed the study compared to those who did not. Forty percent of male participants dropped out of the study, while only 13.3% of female participants did not complete the study. Due to the relatively few male participants in this study ($n = 15$), men may have felt less comfortable during sessions with mostly female counterparts.

Limitations

There were a number of limitations in this study. One limitation is the non-random assignment of participants in each of the three groups. Participants' limited schedules did not allow for much flexibility for group assignment. While assignment was kept as random as possible in this study, complete random assignment would improve a similar study. Another limitation is the use of rolling groups. While most participants attended groups with the same members, there were other participants who moved groups (due to schedule conflicts) or began later than other participants (due to trouble recruiting). This limited the study in a number of ways. First, it made the assigned activity in each session less consistent for each participant. I introduced new breathing exercises in each session, however this became disrupted as participants joined a group after the initial session began. For example, while some participants were completing session two exercises, others who joined late were on their first session. Therefore, in this scenario, participants in session one would have been exposed to some session two exercises. Second, rolling groups did not provide participants with as much opportunity

to form attachment to other group members. In some groups where the members were consistent, participants began to bond with other another, often chatting before sessions began. In one group, a participant brought a cupcake to a session because it was another participants' birthday. Participants who switched groups or began the study late did not have as much opportunity to form these social connections with others. For the purpose of this study, singing and breathing were examined as health behaviours that individuals can practice on their own to benefit asthma, therefore social relations were not as much of interest. Similar studies may benefit from exploring these social relationships and the impact they may have in adherence and improvement during the study.

In addition, a few of the participants became comfortable with the researchers, engaging in conversation before and/or after sessions. At the beginning of this study, I conducted sessions along with another researcher (an undergraduate student). The inconsistency of having two researchers present made it impossible to measure participant comfort and attachment to the researchers. Third, the rolling groups made the first session of the study difficult as this was a longer session. When participants joined a group after the initial session it was difficult to have them complete all the baseline measures in order to avoid delaying participants who were in attendance for subsequent sessions (i.e. sessions 2, 3 or 4). To correct this situation, late joining participants were asked to arrive early, however not everyone was able to do this.

Another limitation of this study was the use of baseline measures during session one. During this session, participants completed baseline measures, which included breathing spirometry measures. After 30 minutes of completing questionnaires, they completed these breathing measures again. This was done to compensate for the lack of a

no treatment control group. Instead, in this study, participants served as their own control in order to compare 30 minutes of completing questionnaires to the subsequent 30 minutes of singing and/or breathing. However, the repetition of these breathing measures was difficult for a few participants, causing them to feel breathless. This may have exhausted them before they began to participate in their assigned activity. It should be noted that one participant was so exhausted from the breathing measures of the first session, that they chose not to take the breathing measures in subsequent sessions, however wanted to continue with the study as they felt singing and breathing were beneficial.

In addition, while an analysis of the change from baseline to reading one (following the completion of questionnaires) was significant, only the breathlessness (MBS) score improved. The PEF and FEV1 measures both indicated worse scores after 30 minutes of questionnaires (likely due to the aforementioned exertion of reading one breathing measures). Thus, while the breathlessness changes as a result of singing and/or breathing should perhaps be treated with caution, especially as it is a one-item measure, the other breathing measures suggest that doing a control activity does not improve the scores. In addition, the MBS was likely influenced by the amount of exertion a participant experienced in arrival to the session, as the MBS was the first measure completed in the session.

Although there was this within session control, there was no control comparison without treatment across approximately one month - over four sessions in the present study. Nonetheless, because not all measures behaved similarly, it is unlikely that any improvements over time were due to demand characteristics (i.e., trying to please the

experimenter by reporting improved values). If demand characteristics were influencing the results then changes should have been seen in all measures. While MBS, PEFr, and GHQ measures improved, ACQ, total SGRQ, and FEV1 did not change. This suggests that the observed changes may not have been due to a demand characteristic and therefore may be valid. Although costly in terms of resources, future research would benefit from a design where breathing is measured before and after control activity on different sessions where singing interventions are not included, as well as over the duration of the entire study; the use of a more complex measure of breathlessness that is more than one item is also recommended.

There were a few additional minor limitations in this study. Sessions occurred over a five month period (February – June), participants completed the study under different environmental conditions. While the cold weather triggers asthma symptoms in some individuals, many are bothered by allergies that often occur during the spring months. In the present study, there were few variables correlated with the month participated (MBS session one reading two, as well as PEFr baseline and reading one of session one). There was an association between month of study completion and baseline breathing, such that individuals who participated in the study during later months (May-June) had better baseline breathing measures; however, there were no group differences in these measures based on month of participation. It would have been beneficial to have participants complete the study under similar circumstances. Future researchers may even consider controlling for temperature, humidity, and pollen. A final limitation is that although participants were recommended to not attend a session if they were ill, there were a few individuals who had colds. This likely would have impacted their breathing

measures. This is something that should be measured and potentially used as a covariate in future studies.

Future Research

In addition to addressing some of the limitations presented, future researchers may consider exploring musical components of singing in participants with asthma. In the present study, songs with a wide variety of keys (i.e. major or minor) and tempos (i.e. fast paced versus ballads) were used. It would be useful to explore how certain tempos of songs may have an effect on one's breathing and if a certain tempo would assist people with asthma more than others. The key of the song may impact wellbeing that is associated with singing. While singing in a major key (brighter sounding) may promote feelings of positivity, singing in a minor key (somber sounding) may induce feelings of sadness (Gick, 2011). Moreover, in the current study, one participant expressed that singing high pitched songs was difficult as it required more breath. Future researchers may also consider exploring the different outcomes that may be associated with singing a song within one's range, as well as lower and higher.

Future studies may benefit from a follow-up session after the singing and/or breathing sessions have been completed. This would assist in determining if any benefits obtained would remain over time, beyond the sessions. Other researchers may consider including an option at the end of the study that would allow participants the opportunity to engage in an activity that was not assigned to them (i.e. those in the breathing group may want to sing or vice versa). This may even prevent participants from dropping out of the study because they were not assigned to their preferred activity. In addition it may be beneficial to include a question at the end of the study that explores whether

participants intend on continuing breathing and or/singing as a way to manage their asthma.

Conclusion

This was the first known study to compare singing alone, diaphragmatic breathing alone and a combination of singing and diaphragmatic breathing in a sample of adults with asthma. Although there was no control comparison of no activity over the duration of the intervention, the results from this study suggested that all three groups benefited from their activities supporting use of singing and/or breathing as self-management behaviours for individuals with asthma. While breathing may be beneficial, singing may be an activity that participants can engage in for a longer period of time (i.e. without feelings of light headedness that accompanies breathing) and therefore may demonstrate greater adherence. In addition, participants seemed to practice singing more and enjoyed breathing more when it was accompanied by singing. This study also supports that it may not be essential to incorporate formal breathing and vocal techniques in singing to experience asthma benefits. Individuals with asthma may participate in more informal singing behaviours, such as community choirs, to experience asthma benefits in a non-pharmacological manner.

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Appendix A

Study Recruitment Poster

**Department of Psychology
Carleton University****PARTICIPANTS WITH ASTHMA NEEDED**

We are looking for volunteers with a current diagnosis of asthma to take part in a study that explores the possible effects of singing and/or diaphragmatic breathing on asthma symptoms and psychological well-being.

As a participant in this study, you would be asked to participate in breathing and/or singing sessions. In addition, you will be asked to complete various questionnaires. We will also be collecting breathing measures; we will ask that you engage in maximum inhales and exhales with the use of a portable pulmonary device. We will be encouraging you to practice breathing and/or singing at home, although it is not a necessary component of the study. You may withdraw from this study at any time and all information collected is confidential. There are no known risks for participating in this study; however, as a precaution, it is advised that you bring any rescue inhalers that you may own.

Your participation would involve: Attending 4 sessions at Carleton University. Each session will last approx. 60 minutes (the first session may last approximately 90 minutes). There are various timeslots available for participation. Please e-mail M.A. candidate Carina Daugherty (contact information below) for more information.

In appreciation for your time, you will receive **\$45** (\$10 per hour of completion)

For more information about this study, or to volunteer for this study,
please contact:

Carina Daugherty at
carina_daugherty@carleton.ca

This research has been approved by the Carleton University Ethics Committee for Psychological Research (13-021).

Appendix B

Demographics Questionnaire

- 1) What is your age? _____
- 2) What is your gender?
 - ☐ Male
 - ☐ Female
- 3) What is your height (cm): _____
- 4) What is your weight (pounds): _____
- 5) What is your ethnicity?
 - ☐ Caucasian
 - ☐ African American
 - ☐ Hispanic
 - ☐ Asian
 - ☐ Native American
 - ☐ Other. Please Specify: _____
- 6) What is your religion?
 - ☐ Roman Catholic
 - ☐ Protestant
 - ☐ Greek Orthodox
 - ☐ Jewish
 - ☐ Muslim
 - ☐ Hindu
 - ☐ Buddhist
 - ☐ Atheist
 - ☐ Other. Please Specify: _____
- 7) Do you take any medications for your asthma?
 - a. Yes, which? _____
 - b. No
- 8) Do you often perform breathing exercises?
 - a. Yes
 - b. No

- 9) If yes to #8, what kind of breathing exercises? Please check all that apply.
- a. breathing involved in yoga
 - b. breathing involved in meditation
 - c. breathing for music (i.e. singing warm-ups)
 - d. breathing as instructed by respiratory therapist or other clinician (i.e. doctor, nurse, etc.)
 - e. other. Please specify_____.

- 10) If yes to # 8, please indicate how much you enjoy performing breathing exercises from 1 (do not enjoy breathing exercises) to 5 (very much enjoy breathing exercises)

1 2 3 4 5

I do not enjoy breathing
exercises

I very much enjoy breathing
exercises

- 11) How often a week do you sing?

- a. Daily
- b. A little bit
- c. Once or twice
- d. Not at all

- 12) If you currently sing, or have sung in the past, please indicate how much you enjoy singing from 1 (do not enjoy singing) to 5 (very much enjoy singing)

1 2 3 4 5

I do not enjoy
singing

I very much enjoy singing

- 13) Do you play a woodwind or brass instrument ((i.e. flute, saxophone, harmonica)?

- a. Yes
- b. No

- 14) If yes to #13 how often a week do you play a woodwind or brass instrument?

- a. Daily
- b. A Little bit
- c. Once or twice
- d. Not at all

- 15) If yes to #13, please indicate how much you enjoy playing a wind instrument from 1 (do not enjoy playing a wind instrument) to 5 (very much enjoy playing a wind instrument)

1

2

3

4

5

I do not enjoy
playing a wind instrument
instrument

I very much enjoy
playing a wind

- 16) Do you exercise?

- ☐ Yes, 5-7 days a week
- ☐ Yes, 3-4 days a week
- ☐ Yes, 1-2 days a week
- ☐ A few times a month
- ☐ No, I don't exercise because of my asthma
- ☐ No, I don't exercise for a different reason (i.e. I don't enjoy exercising)

- 17) Based on the following list of activities, please indicate your beliefs on the effectiveness of the activities in helping your asthma symptoms by checking off the appropriate box. For example, if you strongly believe aerobic exercise would be helpful, you would check the box next to that item below.

a) Aerobic exercise (i.e. walking, running, dancing, using the elliptical, etc)

- ☐ I strongly believe this activity would help my asthma symptoms
- ☐ I moderately believe this activity would help my asthma symptoms
- ☐ I am not sure if this activity would help my asthma symptoms
- ☐ I do not think this activity would help my asthma symptoms

b) Strength training exercise (i.e. weight lifting, squats, lunges, crunches, etc.)

- ☐ I strongly believe this activity would help my asthma symptoms
- ☐ I moderately believe this activity would help my asthma symptoms
- ☐ I am not sure if this activity would help my asthma symptoms
- ☐ I do not think this activity would help my asthma symptoms

c) Meditation

- ☐ I strongly believe this activity would help my asthma symptoms
- ☐ I moderately believe this activity would help my asthma symptoms
- ☐ I am not sure if this activity would help my asthma symptoms

☐ I do not think this activity would help my asthma symptoms

d) Singing

- ☐ I strongly believe this activity would help my asthma symptoms
- ☐ I moderately believe this activity would help my asthma symptoms
- ☐ I am not sure if this activity would help my asthma symptoms
- ☐ I do not think this activity would help my asthma symptoms

e) Breathing (i.e. performing deep breathing exercises)

- ☐ I strongly believe this activity would help my asthma symptoms
- ☐ I moderately believe this activity would help my asthma symptoms
- ☐ I am not sure if this activity would help my asthma symptoms
- ☐ I do not think this activity would help my asthma symptoms

Appendix C

Asthma Control Questionnaire (ACQ)

Circle the number of the response that best describes how you have been during the past week.

- 1) On average, during the past week, how often were you woken up by your asthma during the night?
 - 0 Never
 - 1 Hardly ever
 - 2 A few times
 - 3 Several times
 - 4 Many times
 - 5 A great many times
 - 6 Unable to sleep because of asthma

- 2) On average, during the past week, how bad were your asthma symptoms when you woke up in the morning?
 - 0 No symptoms
 - 1 Very mild symptoms
 - 2 Mild symptoms
 - 3 Moderate symptoms
 - 4 Quite severe symptoms
 - 5 Severe symptoms
 - 6 Very severe symptoms

- 3) In general, during the past week, how limited were you in your activities because of your asthma?
 - 0 Not limited at all
 - 1 Very slightly limited
 - 2 Slightly limited
 - 3 Moderately limited
 - 4 Very limited
 - 5 Extremely limited
 - 6 Totally limited

- 4) In general, during the past week, how much shortness of breath did you experience because of your asthma?
 - 0 None
 - 1 A very little
 - 2 A little
 - 3 A moderate amount
 - 4 Quite a lot
 - 5 A great deal
 - 6 A very great deal

- 5) In general, during the past week, how much of the time did you wheeze?
- 0 Not at all
 - 1 Hardly any of the time
 - 2 A little of the time
 - 3 A moderate amount of the time
 - 4 A lot of the time
 - 5 Most of the time
 - 6 All the time
- 6) On average, during the past week, how many puffs/inhalations of short-acting bronchodilator (eg. Ventolin/Bricanyl) have you used each day?
- 0 None
 - 1 1-2 puffs/inhalations most days
 - 2 3-4 puffs/inhalations most days
 - 3 5-8 puffs/inhalations most days
 - 4 9-12 puffs/inhalations most days
 - 5 13-16 puffs/inhalations most days
 - 6 More than 16 puffs/inhalations most days

Appendix D

Modified Borg Scale (MBS)

Please circle the severity of your breathing:

SCALE	SEVERITY
0	No Breathlessness* At All
0.5	Very Very Slight (Just Noticeable)
1	Very Slight
2	Slight Breathlessness
3	Moderate
4	Some What Severe
5	Severe Breathlessness
6	
7	Very Severe Breathlessness
8	
9	Very Very Severe (Almost Maximum)
10	Maximum

Note. This scale was retrieved from Kendrick, Baxi, & Smith's (2000) article.

Appendix E

Instructions for the Breath Hold Test (Buteko)

- 1. Take a small, silent breath in and a small, silent breath out.
- 2. Hold your nose with your fingers to prevent air from entering your lungs.
- 3. Count how many seconds until you feel the first signs of air hunger.
- 4. At the first sign of air hunger, you will also feel the first involuntary movements of your breathing muscles. Your tummy may jerk. The area around your neck may contract.
- 5. Your inhalation at the end of the breath should be calm.
- 6. Release your nose and breathe in through it.

The following are important points to be aware of:

- 1. The breath is taken after gently exhaling.
- 2. The breath is held until the first movements of the breathing muscles. It is not a measure of the maximum length of time that you can hold your breath.
- 3. This only measures your breath hold time. It is not an exercise to correct your breathing.

Remember that you only hold your breath until the first involuntary movements of your breathing muscles. If you had to take a big breath at the end of the breath hold, then you held your breath for too long. **If you feel any discomfort with this, please refrain from doing it. Again, you should not be forcing yourself to hold your breath.**

Appendix F

Saint George's Respiratory Questionnaire (SGRQ)

This questionnaire is designed to help us learn much more about how your breathing is troubling you and how it affects your life. We are using it to find out which aspects of your illness cause you most problems, rather than what the doctors and nurses think your problems are.

Please read the instructions carefully and ask questions if you do not understand anything. Do not spend too long deciding on your answers.

Before completing the rest of the questionnaire:

Please checkmark one box to show how you describe your present health:

Very good

☐

Good

☐

Fair

☐

Poor

☐

Very poor

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P.W. Jones, PhD FRCP
Professor of Respiratory Medicine,
St. George's, University of London,
Jenner Wing,
Cranmer Terrace,
London SW17 ORE, UK.

Tel. +44 (0) 20 8725 5371
Fax +44 (0) 20 8725 5955

St. George's Respiratory Questionnaire PART 1

Questions about how much chest problem you have had over the past 3 months.

Please checkmark (✓) *one box for each question:*

- | | Most days
a week | Several
days
a week | A few days
a month | Only with
chest
infections | Not
at
all |
|--|---|---------------------------|--------------------------|----------------------------------|--------------------------|
| 1. Over the past 3 months, I have coughed: | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Over the past 3 months, I have brought up phlegm (sputum): | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Over the past 3 months, I have had shortness of breath: | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Over the past 3 months, I have had attacks of wheezing: | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. During the past 3 months, how many severe or very unpleasant attacks of chest problem have you had? | <p>Please checkmark (✓) <i>one box only:</i></p> <div style="margin-left: 100px;"> more than 3 attacks ☐
 3 attacks ☐
 2 attacks ☐
 1 attack ☐
 no attacks ☐ </div> | | | | |

6. How long did the worst attack of chest problem last:
<i>(Go to question 7 if you had no severe attacks)</i> | <p>Please checkmark (✓) <i>one box only:</i></p> <div style="margin-left: 100px;"> a week or more ☐
 3 days or more ☐
 1 or 2 days ☐
 Less than a day ☐ </div> |
|---|--|

7. Over the past 3 months, in an average week, how many good days
(with little chest problem) have you had: | <p>Please checkmark (✓) <i>one box only:</i></p> <div style="margin-left: 100px;"> No good days ☐
 1 or 2 good days ☐
 3 or 4 good days ☐
 Nearly every day was good ☐
 Every day was good ☐ </div> |
|--|---|

8. If you have a wheeze, is it worse in the morning:	<p>Please checkmark (✓) <i>one box only:</i></p> <div style="margin-left: 100px;"> No ☐
 Yes ☐ </div> |
|--|--|

St. George's Respiratory Questionnaire PART 2

Section 1

How would you describe your chest condition?

Please checkmark (✓) *one box only*:

The most important problem I have ☐

Causes me quite a lot of problems ☐

Causes me a few problems ☐

Causes me no problem ☐

If you have ever had paid employment.

Please checkmark (✓) *one box only*:

My chest problem made me stop work altogether ☐

My chest problem interferes with my work or made me change my work ☐

My chest problem does not affect my work ☐

Section 2

Questions about what activities usually make you feel breathless these days.

For *each item*, please
checkmark (✓) the box as it
applies to you *these days*:

	True	False
Sitting or lying still	☐	☐
Getting washed or dressed	☐	☐
Walking around at home	☐	☐
Walking outside on the level	☐	☐
Climbing up a flight of stairs	☐	☐
Climbing hills	☐	☐
Playing sports or games	☐	☐

St. George's Respiratory Questionnaire PART 2

Section 3

Some more questions about your cough and breathlessness these days.

For *each item*, please checkmark
(✓) the box as it applies to you
these days:

	True	False
My cough hurts	☐	☐
My cough makes me tired	☐	☐
I am breathless when I talk	☐	☐
I am breathless when I bend over	☐	☐
My cough or breathing disturbs my sleep	☐	☐
I get exhausted easily	☐	☐

Section 4

Questions about other effects that your chest problem may have on you these days.

For *each item*, please checkmark
(✓) the box as it applies to you
these days:

	True	False
My cough or breathing is embarrassing in public	☐	☐
My chest problem is a nuisance to my family, friends or neighbours	☐	☐
I get afraid or panic when I cannot get my breath	☐	☐
I feel that I am not in control of my chest problem	☐	☐
I do not expect my chest to get any better	☐	☐
I have become frail or an invalid because of my chest	☐	☐
Exercise is not safe for me	☐	☐
Everything seems too much of an effort	☐	☐

Section 5

Questions about your medication. If you are taking no medication go straight to Section 6.

For *each item*, please checkmark
(✓) the box as it applies to you
these days:

	True	False
My medication does not help me very much	☐	☐
I get embarrassed using my medication in public	☐	☐
I have unpleasant side effects from my medication	☐	☐
My medication interferes with my life a lot	☐	☐

Section 6

These are questions about how your activities might be affected by your breathing.

For *each item*, please checkmark (✓) the box as it applies to you *because of your breathing*:

	True	False
I take a long time to get washed or dressed	☐	☐
I cannot take a bath or shower, or I take a long time	☐	☐
I walk slower than other people, or I stop for rests	☐	☐
Jobs such as housework take a long time, or I have to stop for rests	☐	☐
If I walk up one flight of stairs, I have to go slowly or stop	☐	☐
If I hurry or walk fast, I have to stop or slow down	☐	☐
My breathing makes it difficult to do things such as climbing up hills, carrying things up stairs, light gardening such as weeding, dancing, playing bowls or golf	☐	☐
My breathing makes it difficult to do things such as carrying heavy loads, digging the garden or shovelling snow, jogging or walking at 8 kilometres per hour, playing tennis or swimming	☐	☐
My breathing makes it difficult to do things such as very heavy manual work, running, cycling, swimming fast or playing competitive sports	☐	☐

Section 7

We would like to know how your chest problem usually affects your daily life.

For *each item*, please checkmark (✓) the box as it applies to you *because of your chest problem*:

	True	False
I cannot play sports or games	☐	☐
I cannot go out for entertainment or recreation	☐	☐
I cannot go out of the house to do the groceries	☐	☐
I cannot do housework	☐	☐
I cannot move far from my bed or chair	☐	☐

St. George's Respiratory Questionnaire

Here is a list of other activities that your chest problem may prevent you doing (you do not have to checkmark these, they are just to remind you of ways in which your breathlessness may affect you):

- Going for walks or walking the dog
- Doing things at home or in the garden
- Sexual intercourse
- Going out to church or place of entertainment
- Going out in bad weather or into smoky rooms
- Visiting family or friends or playing with children

Please write in any other important activities that your chest problem may stop you doing:

.....

.....

.....

.....

Now, would you checkmark the box (one only) which you think best describes how your chest affects you:

- It does not stop me doing anything I would like to do ☐
- It stops me doing one or two things I would like to do ☐
- It stops me doing most of the things I would like to do ☐
- It stops me doing everything I would like to do ☐

Thank you for filling in this questionnaire. Before you finish, would you check to see that you have answered all the questions.

Appendix G

General Health Questionnaire (GHQ)

During the past two-weeks, have you:

1. been able to concentrate on whatever you're doing?

1	2	3	4
better than usual	same as usual	less than usual	much less than usual

2. lost much sleep over worry?

1	2	3	4
not at all	no more than usual	rather more than usual	much more than usual

3. felt that you were playing a useful part in things?

1	2	3	4
more so than usual	same as usual	less useful than usual	much less useful

4. felt capable of making decisions about things?

1	2	3	4
more so than usual	same as usual	less so than usual	much less capable

5. felt constantly under strain?

1	2	3	4
not at all	no more than usual	rather more than usual	much more than usual

6. felt you couldn't overcome your difficulties?

1	2	3	4
not at all	no more than usual	rather more than usual	much more than usual

7. been able to enjoy your normal day-to-day activities?

1	2	3	4
more so than usual	same as usual	less so than usual	much less than usual

8. been able to face up to your problems?

1	2	3	4
more so than usual	same as usual	less so than usual	much less able

9. been feeling unhappy and depressed?

1	2	3	4
not at all	no more than usual	rather more than usual	much more than usual

10. been losing confidence in yourself?

1	2	3	4
not at all	no more than usual	rather more than usual	much more than usual

11. been thinking of yourself as a worthless person?

1	2	3	4
not at all	no more than usual	rather more than usual	much more than usual

12. been feeling reasonably happy, all things considered?

1	2	3	4
more so than usual	about the same as usual	less so than usual	much less than usual

Appendix H

Diaphragmatic Breathing Exercises

BREATHING EXERCISES**#1.) DEEP BREATH IN AND OUT**

This exercise is to help you feel where all the air is supposed to be when you're singing. It's the easiest exercise and is the base of all the other exercises.

- Stand in front of a mirror to check your posture and make sure you're doing the exercise correctly.
- First, you must be relaxed all over, especially in your chest, neck, shoulders, throat, jaw, and face. If you feel any tension, take a few deep breaths and RELAX!
- put one hand on your stomach and the other hand on your chest.
- breathe in slowly, making sure that YOUR CHEST IS NOT MOVING AND YOUR STOMACH AND RIBS ARE EXPANDING.
- once you can't breathe in anymore, blow out all the air controlled and slowly, push the air out WITH YOUR STOMACH until you have absolutely no more air left inside.

#2.) THE THREE SNAKES (2 SHORT 1 LONG)

This exercise is very similar to #1 in the way that you must keep your entire body relaxed. Also it is advised that you have somebody watch you or watch yourself in a mirror to ensure that your chest is not moving. MAKE SURE ALL THE AIR IS GOING TO YOUR STOMACH, EX: SANTA BELLY.

- breathe in slowly, making sure that your chest doesn't move and your stomach is expanding.
- controlling the air when you breath out, blow out 2 short breaths and 1 long breath. Stop the outflow of air between the breaths with your lips or tongue.
- MAKE SURE THAT YOU PUSH ALL THE AIR OUT USING YOUR STOMACH MUSCLES.

#3.) DOG BREATH (SHORT AND EVEN BREATHS)

This breathing exercise is similar to the way in which you would breathe during a song: short and even breaths.

P'	T'	K'	F'	SH'	SS'	SS'	SS'	SS'
BEAT: 1	1	1	1	4	2	2	2	2

- Visualize the exercise
- Try panting through your mouth like a dog. When you breathe, your stomach should move in and out quickly.
- now say the letters as you are panting, everywhere there is an apostrophe you should inhale.
- Put your hand on your stomach to make sure that the movement is going in and out at the correct times.
- BE SURE TO PRONOUNCE IT!!!!!!

#4.) The Straw

- Check your posture.: feet shoulder width apart and grounded
Knees slightly bent and not locked
Spine is straight (like you're being pulled up)
Arms at your sides, very relaxed
- Make a TINY hole with your lips and pretend you are breathing through a straw. SUPERSMALL!
- breathe in for as long as you can, making sure all the air is pushing down your diaphragm and expanding your ribs. BREATHE THE AIR IN SUPERSLOW!
- once you are filled with air, blow it out forcefully, like blowing out birthday candles. Make sure that your ribs stay lifted and expanded when you breathe out.

#5.) THE ALPHABET

- As we did in #4 inhale as much air as possible (super small lips, super slow intake).
- this time as you are exhaling (extremely slowly) recite the alphabet as many times as you can.
- REMEMBER NOT TO MOVE YOUR CHEST. LET YOUR STOMACH DO THE WORK!
- Each time you do this exercise, try to beat your previous record.
- Younger students who do not know their alphabet yet can use the word " singing".
- Each time try to improve on how many alphabets you can let out!

#6.) ' Tss

- Once again like all the other exercises, make sure you are relaxed all over. Check in a mirror for signs of tension.
- take in a deep breath sustained by your stomach. (all air going to your stomach, MAKE SURE YOUR CHEST IS NOT EXPANDING.)

*'Tss	*'tss	* 'tss	*'tss	*'tssssssss
Beat 1	1	1	1	HELD

- The stars represent when to take a breath. As you exhale the breath let out the 'tss sound. The last 'tss sound is held while you let out all the rest of your air.

#7.) GASPS

- Inhale on 3 equal gasps, filling your stomach with more air each time.(Big belly).
- Then let it all out in a sustained exhale.
- Time your yourself, each time try to beat your record!

Appendix I

Practice Logs

Practice Log for Singing				
Date	Songs Practiced	Singing Duration	Indicate how much you enjoyed practicing from 1 (did not enjoy practicing at all) to 5 (very much enjoyed practicing)	Breath Hold Time (in seconds)

Practice Log for Diaphragmatic Breathing				
Date	Breathing Exercises Practiced	Breathing Duration	Indicate how much you enjoyed practicing from 1 (did not enjoy practicing at all) to 5 (very much enjoyed practicing)	Breath Hold Time (in seconds)

Practice Log for Singing and Diaphragmatic Breathing						
Date	Breathing Exercises Practiced	Breathing Duration	Songs Practiced	Singing Duration	Indicate how much you enjoyed practicing from 1 (did not enjoy practicing at all) to 5 (very much enjoyed practicing)	Breath Hold Time (in seconds)

Appendix J

List of Songs

- 1) Y.M.C.A (Village People)
- 2) Johnny B. Goode (Chuck Berry)
- 3) Call Me Maybe (Carly Rae Jepsen)
- 4) I Love Rock n' Roll (Joan Jett)
- 5) Celebration (Kool and the Gang)
- 6) Moves Like Jagger (Maroon 5)
- 7) Rolling in the Deep (Adele)
- 8) Sugar Pie Honey Bunch (Four Tops)
- 9) The Middle (Jimmy Eat World)
- 10) Pokerface (Lady Gaga)
- 11) Forget You (Cee Lo Green)
- 12) Need You Now (Lady Antebellum)
- 13) My Girl (The Temptations)
- 14) Can't Help Falling in Love with You (Elvis Presley)
- 15) Summer Nights (Olivia Newton John and John Travolta)
- 16) Pumped Up Kicks (Foster the People)
- 17) How You Remind Me (Nickelback)
- 18) ...Baby One More Time (Britney Spears)

Appendix K

Pearson Correlations between Session One Variables

Correlations (and p Values) for Session One Variables

	<i>MBS Baseline</i>	<i>MBS Reading One</i>	<i>MBS Reading Two</i>	<i>PEFR Baseline</i>	<i>PEFR Reading One</i>	<i>PEFR Reading Two</i>	<i>FEV1 Baseline</i>	<i>FEV1 Reading One</i>	<i>FEV1 Reading Two</i>	<i>ACQ</i>	<i>GHQ</i>	<i>SGRQ</i>	<i>Singing Beliefs</i>	<i>Breathing Beliefs</i>
MBS Baseline	-													
MBS Reading One	.76***	-												
MBS Reading Two	.42***	.58***	-											
PEFR Baseline	-.07	-.65	-.14	-										
PEFR Reading One	-.04	-.14	-.17	.90***	-									
PEFR Reading Two	-.06	-.11	-.16	.86***	.89***	-								
FEV1 Baseline	-.02	-.05	.04	.63***	.53***	.51***	-							
FEV1 Reading One	.02	-.07	.07	.66***	.67***	.60***	.84***	-						
FEV1 Reading Two	.20	.15	.14	.53***	.51***	.55***	.80***	.82***	-					
ACQ	.32**	.51***	.34**	-.001	.002	-.04	-.20	-.14	-.12	-				
GHQ	.46***	.31*	.20	.08	.06	.02	.11	.01	.07	.35**	-			
SGRQ	.46***	.51***	.35**	-.04	.02	-.01	-.13	-.09	-.04	.64***	.53***	-		
Singing Beliefs	.14	.12	-.16	.01	-.06	-.04	.03	.03	.12	-.05	.12	.09	-	
Breathing Beliefs	-.19	-.13	-.25	.14	.10	.04	-.02	.02	.02	.02	.01	-.08	.51***	-
Month Participated	-.01	-.16	-.27*	.28**	.35**	.22	-.18	-.03	-.14	.003	-.07	-.05	-.05	.23

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix L

Pearson Correlations between Session Four Variables

Correlations for Session Four Measures

	<i>MBS Reading One</i>	<i>MBS Reading Two</i>	<i>PEFR Reading One</i>	<i>PEFR Reading Two</i>	<i>FEV1 Reading One</i>	<i>FEV1 Reading Two</i>	<i>ACQ</i>	<i>GHQ</i>	<i>SGRQ</i>	<i>Singing Beliefs</i>	<i>Breathing Beliefs</i>
MBS Reading One	-										
MBS Reading Two	.79***	-									
PEFR Reading One	-.03	.09	-								
PEFR Reading Two	.003	.11	.87***	-							
FEV1 Reading One	-.002	.27	.62***	.53***	-						
FEV1 Reading Two	.003	.21	.58***	.61***	.93***	-					
ACQ	.68***	.47***	.18	.26	.13	.12	-				
GHQ	.37*	.18	-.14	-.10	-.22	-.23	.32*	-			
SGRQ	.44**	.20	-.07	.08	-.18	-.09	.42**	.23	-		
Singing Beliefs	-.25	-.22	.02	.04	-.02	.02	-.17	.18	-.12	-	
Breathing Beliefs	-.19	-.12	.26	.27	.01	.01	.07	.08	-.12	.51***	-
Month Participated	-.07	-.02	.15	.20	-.18	-.12	.17	-.10	-.07	-.05	.23

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix M

Multilevel Model Equations

Model 1: Null Model

Level 1

$$y_{ij} = \beta_{0j} + r_{ij}$$

Level 2

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

Model 2: Random Intercepts Model

Level-1 Model

$$y_{ij} = \beta_{0j} + \beta_{1j}(\text{TIMEPOINT}_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

Model 3: Means as Outcomes Model

Level-1 Model

$$y_{ij} = \beta_0 + r_{ij}$$

Level-2 Model

$$\beta_0 = \gamma_{00} + \gamma_{01}(\text{BREATHE}_j) + \gamma_{02}(\text{SING}_j) + u_{0j}$$

Model 4 – Random Intercept and Slopes Model

Level-1 Model

$$y_{ij} = \beta_{0j} + \beta_{1j}(\text{TIMEPOINT}_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{BREATHE}_j) + \gamma_{02}(\text{SING}_j) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{BREATHE}_j) + \gamma_{12}(\text{SING}_j) + u_{1j}$$

Notes. Time point was entered group mean centered in models 2 and 4. Baseline breathing measures, ACQ, GHQ, and SGRQ were entered as Level-2 covariates, as appropriate, in model 4. Covariates were entered grand mean centered.