Full-Length Article

Changes in Spirometry, Quality of Life and Well-Being in Persons with Asthma following Singing, Diaphragmatic Breathing, and Singing and Diaphragmatic Breathing: *A Pilot Study*

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Abstract

Singing and diaphragmatic breathing were explored as interventions for asthma symptoms, quality of life, and well-being. 60 participants (mean age = 29.7, 45 females) were assigned to singing, breathing, or singing plus breathing conditions. Breathlessness, vitality, and spirometry were measured pre and post intervention at 4 weekly group sessions; respiratory quality of life and well-being were assessed at first and fourth sessions. Asthma control and home practice were measured weekly. Some spirometry, quality of life and well-being measures improved, with no differences among conditions. Practice duration was significantly longer in singing than in breathing conditions, and practice enjoyment tended to be higher in singing plus breathing than in breathing conditions. Limitations and implications for singing research and interventions are discussed.

Keywords: ***asthma, singing, diaphragmatic breathing, breathing*** multilingual abstract | **mmd.iammonline.com**

Introduction

Asthma is a chronic respiratory disease characterized by inflammation and obstruction of the lungs and bronchial airways, and includes symptoms of coughing, wheezing, and feelings of breathlessness [1]. Worldwide prevalence of asthma is estimated at 300 million [1]. Asthma has a high disease burden, especially in severe cases, including health care visits, morbidity and mortality [1]. Asthma treatment involves long-acting, anti-inflammatory controller medication, and short-acting medication for immediate relief, as well as education on environmental triggers [1,2].

Asthma well-being burden is also high [2]. Hyperventilation [1,2] and panic and anxiety [2] are associated with asthma, and contribute to exacerbation of asthma symptoms, and lower quality of life [1,2]. Breathing exercises used on their own, or as part of adjunctive non-pharmacological therapy that incorporates them (e.g., yoga [1], didgeridoo playing [3]), are sometimes used in asthma treatment and to help control hyperventilation, panic and anxiety; breathing exercises have been shown to improve quality of life and are encouraging, although inconclusive, for improvement in respiratory symptoms [1,2].

Singing interventions that incorporate vocal exercises [4] or explicit instruction in diaphragmatic breathing have also recently been used as adjunctive treatment for respiratory conditions including COPD in adults [5-8], cystic fibrosis [9], and asthma in children [4,10] and other ages [10]. Positive outcomes include increased peak expiratory flow rate in asthma (speed of air exhaled following maximum inhale) [4,10] and increased maximal expiratory pressure in COPD [5] and cystic fibrosis [9], and improvements in quality of life [5,9,11]. However, community singing groups run by non-medical personnel may not include explicit breathing training; nonetheless, controlled breathing and involvement of respiratory muscles required to reach or hold notes are part of singing [4-7,9-12] and are potential mechanisms for respiratory improvement. Singing may also improve well-being (e.g., mood) and quality of life in people with asthma, given that such benefits are often found in studies of healthy people who engage in group community singing [11,13,14].

The purpose of the present pilot study was to explore potential benefits of informal group singing without inclusion of breathing exercises for people with asthma. We compared singing only, breathing only, and singing plus breathing group interventions on outcomes of respiration, asthma quality of

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life and well-being. We predicted that if singing requires explicit breathing training for improvement in respiration, then participants in the singing only condition should show fewer respiratory benefits than those in breathing and singing plus breathing conditions.

Methods

Participants

60 subjects with a self-reported diagnosis of asthma were recruited through campus posters, the university's psychology research participation pool, the university electronic newsletter, newspapers, Facebook, and snowball referral from friends (see *Figure 1*). Participants received partial course credit (only if a student) or a small honorarium for participation.

Design and Controls, Procedure and Interventions

Design and Controls

A pre-post design assessed change within participants over time, between conditions, and the time x condition interaction. Participants were assigned to conditions using partial block randomization (for every three participants one was assigned randomly to one of the three conditions, within scheduling constraints), in order to distribute possible effects of time of year or season equally across conditions.

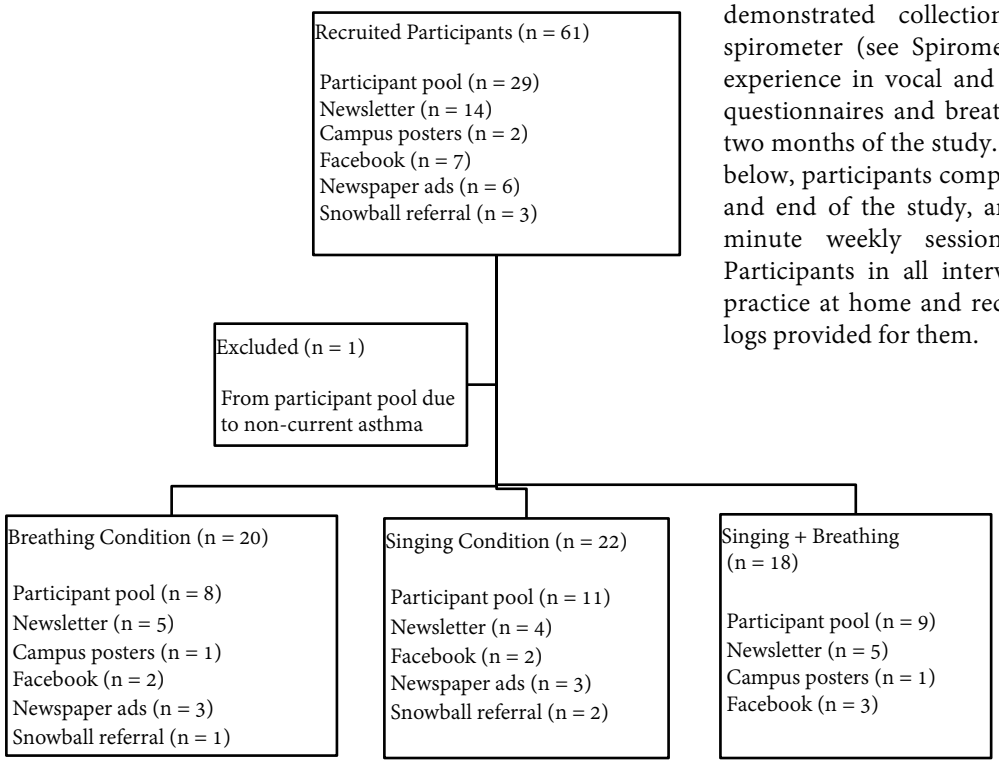

Figure 1. Flow diagram of recruitment

Although participants' initial breathing measures were better in spring than in winter, F (12, 119.35) = 2.17, p< .05, this result did not vary among conditions, F (20, 150.20) = 1.47, p = .10, and is not discussed further. Recruitment materials stated that the study was about singing and breathing for asthma. Neither participants nor the study administrator were able to be blind to condition assignment. Participants were not informed of their assigned condition until their first session.

Procedure

Ethics approval was obtained from the University Psychological Research Ethics Board. All participants completed consent forms before beginning the study, and were advised to bring their reliever inhaler to all sessions, and to not attend a session if they were experiencing many asthma symptoms or if they were feeling ill. The study took place in rooms on the university campus beginning in February 2013 and ending in mid-June 2013, with 4-week weekly group sessions running consecutively. An additional, make-up session was held at the end of 4 weeks for participants who missed a session. The second author administered the study and led the interventions; she has had vocal training and diaphragmatic breathing instruction that she uses to teach singing. She also completed a practicum at a hospital and a community health center just prior to the study, and learned established clinical practice recommendations for collecting spirometry measures; a respiratory therapist also demonstrated collection of measures using a portable spirometer (see Spirometry below). A second student with experience in vocal and breathing instruction assisted (with questionnaires and breathing exercises only) during the first two months of the study. As indicated in the Measures section below, participants completed some measures only at the start and end of the study, and others before and after each 30-minute weekly session of group intervention activity. Participants in all intervention groups were encouraged to practice at home and record their practice details in practice logs provided for them.

Singing Only Intervention
Participants assigned to group singing sang along (with the study administrator leading) to music tracks using a karaoke machine (Venturer CD graphics karaoke system, model CDG-2) that provided lyrics and their timing to the songs. Familiar songs (e.g., *Call Me Maybe*) were selected based on feedback from graduate and honors students. A final list was compiled that also incorporated songs with a variety of ranges (e.g., sung by male and female singers; see Appendix 1). At session 1, participants were given a CD of all songs. Songs were rotated weekly, moving from the start to the end of the list, and were repeated based on participant preferences (as indicated in practice logs or by request). Participants were encouraged to stand while singing. No breathing instruction was provided.

Breathing Only Intervention
Participants assigned to group breathing engaged in diaphragmatic breathing. Each session began with instructions to place their hands on the diaphragm while seated to become aware of diaphragmatic movement while breathing. Participants stood for the remaining 11 exercises, with a few exercises used per session. Diaphragmatic breathing exercises used in this study are common exercises used in formal singing training and had been formally demonstrated to the researchers by vocal coaches. Participants were provided with a booklet of all 11 exercises (see "Methods – Breathing Exercises", Supplemental Material, for a description of all exercises).

Singing plus Breathing Intervention
Participants assigned to group singing plus breathing performed both diaphragmatic breathing and singing. Prior to singing along with karaoke tracks as described above in Singing, they practiced breathing exercises as described above in Breathing, and were reminded to apply them while singing, including during home practice using the booklet and CD.

Measures

Spirometry
The study administrator collected spirometry measures pre and post each weekly intervention using a portable device Koko Peak Pro 6 PDS343110 (purchased by the authors from, and distributed by, Roxon Medi-Tech Montreal, Quebec). This spirometer meets guidelines set by the American Thoracic Society [15] and includes accuracy of ± 10% for PEFR, ± 5% for FEV1, and airway resistance < 2.5cm H2O/l/sec. Participants were given their own mouth and nose pieces. Spirometry was administered to participants between 10:30 a.m. and 5:30 p.m. at the same time every week. Participants were encouraged to engage in effortful breathing by inhaling as deeply as possible followed by a quick exhale while maintaining proper posture. Similar to the procedure followed by others (e.g., Engen [6]), maximum effort was ensured by taking three measures, and recording the best attempt.

Forced Expiratory Volume in the First Second (FEV1)
FEV1 is the amount of air exhaled during the first second following a maximum inhale and has been used by other researchers as a measure of lung function [6,10] and is a reliable measure used to detect asthma ($p \leq .005$) [16]. FEV1 as measured by the Koko Peak Pro correlates with physician evaluation of asthma (rho = .42; $p = .001$) [17].

Peak Expiratory Flow Rate (PEFR)
PEFR is a measure of the speed of air exhaled following a maximum inhale and is a reliable measure for the detection of asthma ($p \leq .005$) [16] and has been used by other researchers as a measure of lung function [4,10].

Asthma questionnaires
Participants completed the following self-report measures of asthma.

The Modified Borg Scale (MBS)
The MBS [18] assesses breathlessness rated on a Likert-type scale ranging from 0 (no breathlessness) to 10 (maximum breathlessness). The MBS is considered valid and reliable for measuring shortness of breath [19], and has been used in COPD research [5,6]. Because scores were highly positively skewed, they were recoded to 0 to 3, with 0 = 0, 1 = slight (.5 = very very slight, 1 = very slight), 2 = moderate (2 = slight, 3 = moderate), and 3 = severe (4-10: somewhat severe, severe, very severe, and very very severe). The MBS was measured weekly, pre and post intervention.

Asthma Control Questionnaire (ACQ)
The ACQ is a self-report measure of asthma symptoms experienced within the previous 7 days [20]. 6 items (e.g., "On average, during the past week, how bad were your asthma symptoms when you woke up in the morning") are rated on a 7 point scale (0 to 6). Mean scores are computed where higher scores indicate worse control. The seventh item requiring a response from a clinical staff member was excluded. With the seventh item removed, the ACQ still demonstrates high validity (ICC = .96) and reliability (ICC = .82, $\alpha = .98$) [20], including at session 1 in the present study ($\alpha = .83$). The ACQ was measured weekly, pre-intervention.

Saint George's Respiratory Questionnaire (SGRQ)
The SGRQ is a valid and reliable measure of respiratory quality of life used in research with COPD [5]. Seventeen questions measure perceptions of respiratory symptoms and the degree to which they disrupt patients' lives [21]. Subscales consist of questions about symptoms (8 items; e.g., chest trouble), activities (16 items; e.g., those that contribute to breathlessness), and impacts (26 items; e.g., fear caused by breathlessness). Subscale and overall totals range from 0 to 100 where higher scores mean higher impairment. The SGRQ was measured before intervention activity at both sessions 1 and 4. Total SGRQ has demonstrated good reliability in a sample of asthma participants (α = .86) [22] and also in the present sample (α = .71 at session 1).

The following 4 well-being measures were based on recent research of benefits of singing [11,13].

Vitality
The vitality scale [23] (α = .80-.89 [24]; α = .89 in the present study) includes six items about subjective feelings of vitality (e.g., "I feel energized") that increased after choral singing [14]. Items are rated on a Likert-type scale from 1 (not at all true) to 7 (very true). Mean scores are computed with higher scores indicating higher vitality. Vitality was measured weekly, both pre and post intervention.

General Health Questionnaire (GHQ)
The GHQ is a valid and reliable (α =.78-.95; α = .90 in the present sample) measure of distress [25]. 12 items are rated on a 4-point Likert-type scale from 1 (i.e. 'not at all') to 4 (i.e. 'much more than usual') and include questions on ability to concentrate, enjoyment of daily activities, and feelings of happiness or depression. Total scores are computed with higher scores indicating higher distress. The GHQ was completed pre-intervention at sessions 1 and 4.

Satisfaction with Life Scale (SWLS)
SWLS is a widely used and reliable measure of global life satisfaction (α = .87; α = .88 in the present sample) [26]. Five items (e.g., "In most ways, my life is close to my ideal") are measured on a Likert-type scale ranging from 1 (strong disagreement) to 7 (strong agreement) and summed, where higher scores indicate higher life satisfaction. SWLS was completed pre-intervention at both sessions 1 and 4.

Positive and Negative Affect Scale (PANAS)
The PANAS is a common, reliable measure of mood [27]. Ten positive (e.g., interested; α = .86-.90; α = .91 in the present sample) and 10 negative (e.g., nervous; α = .84-.87; α = .88 in the present sample) [27] moods are rated during a certain time (in this study, the past week) on a 5-point Likert-type scale ranging from 1 (very slightly or not at all) to 5 (extremely). Positive and negative scores are summed with higher scores indicating higher positive and negative moods, respectively. The PANAS was completed pre-intervention at both sessions 1 and 4.

Descriptive measures
At session 1, before any intervention activity, participants completed measures of demographics and use of asthma medication; beliefs that each of singing and breathing would help their asthma (rated on separate Likert-type scales where 1= do not think it would help to 4 = strongly believe it would help); and current practice of singing and breathing exercises. Participants also rated their enjoyment of singing and/or breathing on separate Likert-type scales, where higher scores indicate higher enjoyment (1 = do not enjoy to 5 = very much enjoy).

Practice Log
This original practice log measured daily amount (in minutes) of singing and/or breathing practice outside of the sessions during the past week. Participants also indicated their enjoyment on a scale of 1 to 5 (1 = did not enjoy practicing at all, 5 = very much enjoyed practicing). Mean values were computed for practice enjoyment and duration (log transformed for analyses due to positive skew) over the 4 weeks. The practice log also contained songs and breathing exercises practiced by participants, which assisted in assessing preferred songs and exercises.

Data Analysis
Chi-squared analyses for categorical (e.g., gender) variables, and two-factor (condition x completion status) multivariate analyses of variance (MANOVA, using Wilks' Lambda) for continuous variables, were conducted using SPSS version 21 to test for initial differences among conditions, and between completers of all 4 sessions and non-completers who dropped out of the study. To test outcomes, measures completed at sessions 1 and 4 were analyzed with a two factor (within-factor time x between-factor condition) repeated measures ANOVA. Mean (over 4 weeks) practice duration and enjoyment were analyzed with a one-factor (condition) ANOVA.

ACQ, spirometry and vitality were analyzed with multilevel linear modeling (MLM) using HLM7. MLM is a type of regression [28] and is useful in interventions where participants are assessed at different time points (pre and post activity at each of 4 sessions in this study). MLM can assess change within individuals over time, differences between conditions, and the time x condition interaction (i.e., whether

change over time varied between conditions), and is thus ideally suited to the design of the present study [28] (see "Data Analysis", Supplemental Material, for more details on MLM).

Results

Preliminary Analyses of Session 1 Characteristics

Participant characteristics at session 1 are presented in *Tables 1* (descriptives and measures taken at Sessions 1 and 4) and *2* (measures taken at each of 4 sessions). Participants reported well controlled asthma as indicated by low scores on the ACQ and MBS. Most participants reported taking medications, the most common (30%) of which was Ventolin (many participants only reported "puffer" or "inhaler"). There were no differences among conditions in medication use, demographics, prior participation in singing and breathing, or attrition (75%, 77%, and 84% in breathing, singing and breathing plus singing, respectively), all *p*s > .05. However, there were more male (40%) than female (13.3%) non completers, $x^2(1) = 3.47$, $p < .001$. Initial quality of life, well-being, spirometry, and beliefs did not differ among condition, multivariate $F(26, 70) = 1.15$, ns, and between completers and non-completers, multivariate $F(13, 35) = .81$, ns; and condition and completion did not interact, multivariate $F(26, 72) = .73$, ns.

Changes in Well-Being and Quality of Life between Session 1 and Session 4

Table 1 (bottom) reports the means for measures assessed at Sessions 1 and 4 for participants who completed all sessions. A 2 (time) x 3 (condition) repeated measures MANOVA of sessions 1 and 4 mood (PA and NA), SWLS, GHQ , and total SGRQ was significant only for time, multivariate $F(5, 39) = 3.40$, $p = .014$. Univariate results indicated that NA, $F(1, 43) = 9.66$, $p = .003$, and distress (GHQ), $F(1, 43) = 13.49$, $p = .001$, decreased significantly. There was a trend that SWLS increased, $F(1, 43) = 3.11$, $p = .085$. PA did not increase, $F(1, 43) = 2.35$, $p = .13$. A repeated measures MANOVA of SGRQ subscales was explored and revealed that symptoms, $F(1, 45) = 4.96$, $p = .03$, and impacts, $F(1, 45) = 5.38$, $p = .02$, but not activities, $F(1, 45) = 1.36$, ns, subscales decreased significantly. There were no condition or time x condition effects on any measures.

Practice Logs

Thirty-two participants (11 breathing, 11 singing plus breathing, 10 singing) completed practice logs. Total breathing practice per week ranged from 0 to 72 minutes, and total singing practice ranged from 0 to 250 minutes per week, collapsed across condition. Practice over 4 weeks differed significantly among condition, multivariate $F(4, 56) = 2.72$, $p < .05$, on both mean weekly duration, $F(2, 29) = 3.42$, $p < .05$, and mean enjoyment (1-5 scale), $F(2, 29) = 3.96$, $p < .05$. Breathing participants ($M = 10.85$, $SD = 12.52$) practiced significantly less than singing participants ($M = 38.40$, $SD = 39.83$), $p = .05$, and tended to enjoy practicing less ($M = 3.37$, $SD = 1.11$) than singing plus breathing participants ($M = 4.30$, $SD = .77$), $p < .06$. Singing participants possibly felt *able* to sing longer than breathing participants, as some noted in their ad hoc comments.

Changes in Asthma Control, Spirometry, and Vitality across Sessions

MLM regression analyses (summarized in *Table 3*) indicate significant improvements in breathlessness (MBS), PEFR and vitality (see *Table 2* for means, bolded), with no significant changes in FEV1 and ACQ, over the 4 sessions. There were no effects of condition or interaction of condition with time. *Figure 2* illustrates the PEFR improvement over time, collapsed across condition.

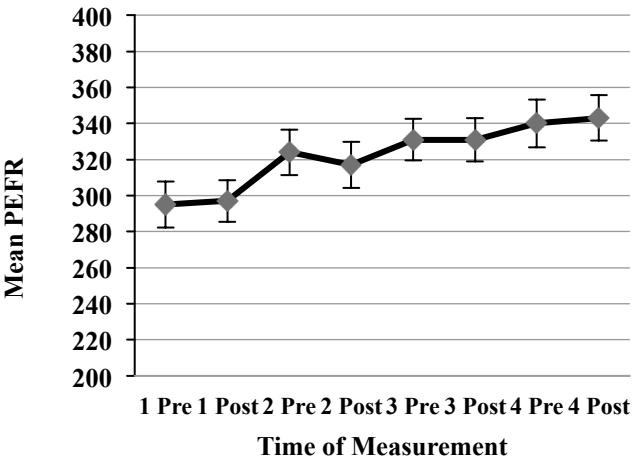

Figure 2. Mean Peak Expiratory Flow Rate (PEFR) *averaged across all participants' measures taken pre and post activity (singing, breathing or singing plus breathing) at each of 4 sessions.*

Measure	Total (n=60)	Breathing (n=20)	Singing (n=22)	Singing Breathing (n=18)
Session 1[a]				
Female	75	75	73	78
Caucasian	63[b]	50	73	67
Asthma medication	88	85	95	83
Sing at least weekly	78	75	73	88
Breathing exercise	28	25	23	39
Session 1[c] (Range)				
Age (15-66)	29.70 (15.35)	30.15 (15.16)	32.77 (17.30)	25.44 (12.64)
Enjoy Singing (1-5)	4.00 (1.12)	4.31 (.87)	3.39 (1.14)	4.37 (1.09)
Enjoy Breathing (1-4)	3.28 (1.13)	3.00 (1.00)	3.33 (1.37)	3.43 (1.13)
Singing belief (1-4)	2.63 (.93)	2.55 (.94)	2.36 (.79)	3.06 (.97)
Breathing belief (1-4)	3.31 (.79)	3.20 (.83)	3.23 (.87)	3.53 (.62)
Sessions 1 and 4[d]				
GHQ 1	**13.93 (6.18)**	12.50 (3.08)	15.12 (6.82)	13.94 (7.29)
GHQ 4	**10.67 (6.51)**	11.50 (6.94)	10.65 (6.60)	10.13 (6.20)
SGRQ Total 1	**31.15 (14.11)**	29.83 (12.37)	33.16 (17.19)	30.25 (12.59)
SGRQ Total 4	**30.14 (14.10)**	29.37 (12.75)	30.24 (16.16)	30.76 (13.85)
SGRQ Symptoms 1	**48.65 (18.35)**	42.19 (11.16)	55.95 (21.89)	46.96 (17.97)
SGRQ Symptoms 4	**44.42 (18.17)**	36.85 (14.44)	48.05 (20.39)	47.66 (17.68)
SGRQ Impacts 1	**21.98 (15.17)**	20.48 (14.80)	23.38 (16.13)	21.91 (15.30)
SGRQ Impacts 4	**19.64 (15.01)**	18.77 (16.50)	21.27 (14.74)	18.72 (14.66)
SGRQ Activity 1	38.13 (16.65)	39.68 (13.74)	38.81 (21.55)	35.95 (13.74)
SGRQ Activity 4	40.59 (19.32)	43.47 (14.64)	36.52 (23.26)	42.22 (19.03)
PA 1	32.15 (8.91)	29.27 (7.56)	30.53 (9.32)	36.87 (8.27)
PA 4	33.57 (7.97)	31.67 (7.18)	32.65 (6.39)	36.53 (9.81)
NA 1	**21.94 (8.50)**	22.13 (8.25)	20.59 (8.81)	23.27 (8.75)
NA 4	**19.34 (8.08)**	19.80 (6.77)	18.94 (8.16)	19.33 (9.60)
SWLS 1	22.50 (7.61)	21.90 (7.74)	21.18 (6.96)	24.60 (8.24)
SWLS 4	23.74 (7.43)	23.20 (6.75)	22.82 (7.72)	25.33 (7.98)

Table 1: Descriptive Measures at Session 1, and Measures taken at both Sessions 1 and 4 per Condition and Total, Collapsed across Condition; *GHQ, General Health Questionnaire; SGRQ, St. George Respiratory Questionnaire; PA, Positive mood; NA, Negative mood; SWLS, Satisfaction with Life Scale.* [a] *Values are percentages;* [b] *10% African American/Canadian, 10% Asian, 5% Hispanic, 1.7% Native American, 10% unspecified;* [c] *Values are means, standard deviations are in ( ). Belief is believe effective for asthma;* [d] *Means are based on n = 48 who completed 4 sessions: 15 in Breathing, 17 in Singing and 16 in Singing Breathing. Due to missing data from 2 participants, GHQ values are based on n = 14 in the breathing condition, and SWLS 4 and PA4 are based on n = 15 in the Breathing and Singing condition; Bonferroni post hoc tests were conducted for main effects from MANOVA or ANOVA; Bolded text for GHQ, SGRQ, and NA indicates significant differences between sessions 1 and 4 in total, for all participants.*

Discussion

Significant improvements in PEFR, vitality, and symptoms and impacts respiratory quality of life; and significant decreases in negative mood, distress, and breathlessness were obtained in people with self- reported asthma following 4-week group interventions of singing, breathing and singing plus breathing. These findings support research showing respiratory and well-being benefits of singing for respiratory disease (COPD [5], CF [9]; asthma [10]). To the best of our knowledge, our study is the first to separate breathing and singing.

The lack of differences in respiratory benefits among the 3 conditions suggests that singing may not require explicit breathing instruction to result in respiratory improvement, and also supports research indicating that breathing alone can result in some respiratory improvement in asthma [1]. Mechanisms responsible for improvements in well-being, quality of life, and respiration are beyond the scope of the present study; possibilities include involvement of respiratory muscles in singing [4-7,9-12], reduction in anxiety with breathing [2,11] and support from engaging in activity with others with asthma [11].

Study limitations include recruitment of participants with self-reported asthma. Although a respiratory therapist helped train the study administrator, no medical personnel confirmed diagnoses and collected spirometry data. Moreover, the same Master's psychology student both led the interventions and collected spirometry data; ideally, personnel collecting spirometry data would be blind to condition.

The fact that more males dropped out (possibly due to lack of interest in group activity or the small number of males) is troubling and limits generalizability. Notably, male attrition was equivalent in each group; song choice thus likely did not contribute to attrition, or there would have been lower male attrition from the breathing condition. In addition, participants were not assigned completely randomly to conditions, and there was no "no-intervention" group to control for naturally occurring changes. Interventions were brief, with no follow up. Indeed, no change in FEV1 may be due to the brevity of our intervention [29], and no change in SGRQ activities and the ACQ may be due to participants' well controlled asthma that has little room for improvement. Future research is needed with participants with more severe asthma using longer interventions.

Measure	Session	Total M (SD)	Br M (SD)	Singing M (SD)	Singing + Br M (SD)
MBS	**1 Pre**	**1.09 (69)**	.89 (.74)	1.24 (.70)	1.12 (.60)
	1 Post	**1.14 (.86)**	1.00 (.73)	1.28 (.83)	1.17 (1.04)
	2 Pre	**1.20 (.70)**	1.00 (.59)	1.50 (.76)	1.06 (.64)
	2 Post	**1.13 (.75)**	.94 (.56)	1.25 (.79)	1.17 (.86)
	3 Pre	**1.04 (.82)**	.81 (.75)	1.06 (.80)	1.22 (.88)
	3 Post	**1.04 (.76)**	.88 (.70)	1.11 (.76)	1.11 (.83)
	4 Pre	**1.10 (.72)**	1.27 (.70)	1.06 (.56)	1.00 (.89)
	4 Post	**.79 (.65)**	.80 (.77)	.88 (.49)	.69 (.70)
PEFR	**1 Pre**	**295.28 (96.16)**	298.40 (102.34)	277.47 (75.51)	310.61 (110.01)
	1 Post	**297.10 (89.52)**	282.85 (107.07)	296.31 (71.81)	313.89 (89.97)
	2 Pre	**324.07 (94.22)**	333.22 (105.64)	317.25 (72.67)	322.41 (108.07)
	2 Post	**316.69 (95.12)**	302.22 (117.80)	320.85 (71.34)	327.12 (96.82)
	3 Pre	**331.44 (82.83)**	339.82 (97.64)	330.94 (75.17)	323.59 (78.68)
	3 Post	**331.08 (87.04)**	310.35 (94.72)	344.94 (77.64)	337.12 (89.79)
	4 Pre	**339.98 (90.90)**	345.47 (114.64)	323.41 (81.12)	353.27 (77.05)
	4 Post	**342.83 (87.72)**	326.00 (107.24)	347.41 (70.68)	353.75 (87.24)
FEV1	1 Pre	2.85 (.70)	2.82 (.86)	2.87 (.56)	2.88 (.67)
	1 Post	2.87 (.63)	2.72 (.74)	2.89 (.64)	2.99 (.47)
	2 Pre	2.93 (.69)	2.97 (.72)	2.95 (.60)	2.88 (.77)
	2 Post	2.89 (.77)	2.81 (.79)	2.97 (.80)	2.89 (.74)
	3 Pre	2.93 (.68)	2.84 (.77)	2.99 (.60)	2.96 (.68)
	3 Post	2.91 (.67)	2.77 (.75)	3.06 (.65)	2.89 (.60)
	4 Pre	2.85 (.79)	2.80 (.93)	2.86 (.83)	2.88 (.63)
	4 Post	2.87 (.69)	2.73 (.80)	2.94 (.68)	2.93 (.63)
Vitality	**1 Pre**	**4.52 (1.27)**	4.62 (1.27)	4.14 (1.20)	4.89 (1.30)
	1 Post	**5.08 (1.25)**	4.92 (1.35)	4.98 (1.13)	5.36 (1.27)
	2 Pre	**4.50 (1.28)**	4.39 (1.35)	4.45 (1.26)	4.66 (1.28)
	2 Post	**4.83 (1.43)**	4.56 (1.46)	4.87 (1.47)	5.04 (1.39)
	3 Pre	**4.61 (1.27)**	4.49 (.98)	4.56 (1.50)	4.77 (1.32)
	3 Post	**5.05 (1.39)**	4.70 (1.31)	5.20 (1.47)	5.22 (1.40)
	4 Pre	**4.73 (1.44)**	4.70 (1.16)	4.53 (1.62)	4.97 (1.53)
	4 Post	**5.06 (1.37)**	4.78 (1.03)	5.03 (1.52)	5.36 (1.49)
ACQ	1 Pre	1.24 (.72)	1.17 (.74)	1.23 (.72)	1.33 (.74)
	2 Pre	1.19 (.70)	1.14 (.63)	1.29 (.70)	1.12 (.80)
	3 Pre	1.13 (.59)	1.15 (.52)	1.12 (.52)	1.13 (.73)
	4 Pre	1.13 (.72)	.94 (.61)	1.22 (.65)	1.22 (.88)

Table 2: Pre and post means at each of 4 Sessions per Condition and Total, Averaged Across Condition*; M, Mean; SD, Standard Deviation; Br, Breathing; MBS, Breathlessness; PEFR, Peak Expiratory Flow Rate; FEV1, Forced Expiratory Flow in 1 Second; ACQ, Asthma Control Questionnaire. Pre and post are before and after condition activity. N at each of 4 sessions was: 20, 18, 17, 15 (breathing); 22, 20, 18, 17 (singing); 18, 18, 18, 16 (singing plus breathing). Bolded text indicates significant findings across time for all participants.*

Measure	*ICC*	*B*	*SE*	*t (df)*	*p*
Predictor					
MBS	.56				
Time		-.053	.018	-2.92 (59)	.005
PEFR	.80				
Time		6.889	1.459	4.72 (59)	<.001
Singing		-15.164	27.674	-.55 (57)	.57
Breathing		-17.819	28.289	-.63 (57)	.53
Singing x Time		3.271	3.758	.87 (57)	.39
Breathing x Time		-.354	3.222	-.11 (.57)	.91
FEV1	.85				
Time		.005	.009	.56	.58
ACQ	.48				
Time		-.042	.037	-1.13	.26
Vitality	.77				
Time		.059	.017	3.46	.001

Table 3: Summary of Multilevel Modeling Analyses; *ICC, intra class correlation; MBS, Breathlessness; PEFR, Peak Expiratory Flow Rate; FEV1, Forced Expiratory Flow in 1 Second; ACQ, Asthma Control Questionnaire. ICC indicates the proportion of total variance that is between participants. B and SE are regression coefficients and standard errors resulting from multilevel linear modeling analyses of measurement occasions nested within individuals. Condition (dummy coded) and condition x time were added as predictors at level 2 in additional analyses and were not significant for any measures. Condition and condition x time for PEFR are presented for illustration purposes only. For outcome variables of MBS and ACQ, higher scores indicate worse outcomes, and for PEFR, FEV1 and Vitality, higher scores indicate better outcomes.*

The result that singing was practiced more than breathing, and breathing practice was enjoyed more when it was combined with singing, suggests possible value for adherence to singing over breathing in longer interventions.

In conclusion, the present pilot study demonstrates novel findings of improvement in asthma symptoms and well-being as a result of interventions of singing on its own, without explicit breathing training, which has positive implications for community-based group singing. Benefits were also found for breathing on its own, without singing, and singing when it was combined with breathing. More controlled research is needed to replicate and extend these findings to people with more severe asthma.

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Biographical Statements

Mary L. Gick, PhD, is an associate professor of Psychology at Carleton University, Ottawa, Ontario, Canada, where she pursues research in health psychology, including research in singing, health and well-being.

Carina Daugherty graduated with a B.A and M.A in Psychology at Carleton University. Carina's research combines her interest in health psychology and passion for music; she has explored the effects of singing in seniors with dementia and adults with asthma.

Appendix 1

List of Songs and Artists Performing Them
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)

Supplemental Material

Methods – Breathing Exercises

Deep Breath In and Out. Participants were instructed to place one hand on their chest and the other on their stomach while slowly inhaling and exhaling. Participants were reminded that their diaphragm should move with their breathing (expand during inhalation and contract during exhalation) while their chest remains still.

Three Snakes (Two Short One Long). During this exercise, the diaphragm expands with a slow inhale followed by two short exhales and one long exhale. The diaphragm contracts more with each exhale.

Dog Breath (Short and Even Breaths). This exercise consists of quick inhales and exhales. It begins with an inhale followed by exhaling while pronouncing the sounds of various letters (i.e., p, k, t, f, sh, ss). A quick inhale is made in between each exhale.

The Straw. While performing this exercise, the lips remain pursed with a small opening. Participants were asked to visualize breathing through a straw. A slow inhale is made through the pursed lips while the diaphragm fills with air. Once the diaphragm has fully expanded, a quick exhale is made.

The Alphabet. This exercise begins with a slow, deep inhale (the same as the above exercise, *The Straw*). During the exhale, the alphabet is recited (spoken, not sung). Participants were asked to recite as much of the alphabet as their breathing permitted.

'*Tss*. Similar to *Dog Breath,* a quick inhale is made in between each exhale. The sound "tss" is made while exhaling. Five inhales and exhales are made, while the final exhale is held.

Gasps. Three inhales are made with the diaphragm expanding more with each breath. Following the third inhale, a sustained exhale is made.

The Count. This exercise consists of three steps; inhaling, holding the breath, and exhaling. Each step begins with a count of one (e.g., inhale for one count, hold the breath for one count, and exhale for one count). The same steps are repeated with a count of two up to a maximum of ten.

Vowels. An inhalation is made followed by the repetition of five 'ha' sounds. The diaphragm contracts while speaking the sound and expands before the sound. No breath is taken until the five sounds had been made. Following the "ha" sequence, the same process is made with the remaining vowels (i.e., he, hi, ho, hu) in addition to "bzz".

Ss. During this exercise, 'ss' is sounded out in a four note rhythm (quarter notes) following an inhale. Next, the same sound is made in a group of two, repeated four times (eighth notes). The same process repeats four times in groups of three (triplets) and in groups of four (sixteenth notes).

Puppy Pant. This exercise involves quick inhales and exhales with strict focus on abdominal movement; hands are encouraged to be kept on the waist to feel the movement.

Data Analysis

Three MLM models were tested. The base model has no predictors, and provides variance estimates in order to calculate the Intraclass Correlation (ICC) [30], which is the proportion of total variance that is between participants (level 2). The ICC essentially indicates whether a 2-level model is appropriate or whether a level-one model would suffice [30]. The unconditional linear model adds a level 1 predictor to the base model, in this case, time, and tests whether dependent measures change significantly within participants over time, from session one to session four. Finally, the conditional linear model tests differences in dependent measures over time (level 1) and among condition (level 2), and the time x condition interaction [30,31].

When a level one predictor was added to the model (e.g., time added to the base model), it was group mean centered in order to have the intercept represent the expected outcome for a participant who completed the average time point, relative to all of the other participants in their *group*. This is in contrast to entering the variable grand mean centered where the intercept would be interpreted as the expected variable outcome relative to all of the participants in the *study* [32]. ACQ, GHQ and SGRQ were added as covariates if they were moderately correlated to outcomes and were grand mean centred (see Supplementary Table for session 1 correlations).

1

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
1. MBS Pre	-																	
2. MBS Post	.51**	-																
3. PEFR Pre	-.06	-.22	-															
4. PEFR Post	-.05	-.21	.89**	-														
5. FEV1 Pre	-.04	.03	.67**	.60**	-													
6. FEV1 Post	.18	.06	.51**	.55**	.82**	-												
7. Vitality pre	-.39**	-.18	-.02	-.06	.01	-.07	-											
8. Vitality post	-.31*	-.25	.03	-.00	-.03	-.07	.82**	-										
9. ACQ	.51**	.40**	.00	-.04	-.14	-.12	-.24	-.12	-									
10. GHQ	.32*	.20	.06	.02	.01	.07	-.64**	-.53**	.35**	-								
11. SGRQ Total	.51**	.43**	.02	-.01	-.09	-.04	-.45**	-.26	.63**	.53**	-							
12. PA	-.33*	-.14	.07	.04	-.04	-.05	.79**	.71**	-.14	-.62**	-.38*	-						
13. NA	.20	.08	.22	.13	.14.	.11	-.40**	-.45**	.21	.62**	.32*	-.30*	-					
14. SWLS	-.34**	-.24	-.06	-.02	-.07	-04	.66**	.69**	-14	-.67**	-.38**	.66**	-.44**	-				
15. Singing Beliefs	-.12	.10	.06	-.04	-.03	-.12	.17	.22	.05	-.12	-.09	.40*	.10	.18	-			
16. Breathing Beliefs	.18	.26	-.10	-.04	-.02	-.02	.03	.04	-.02	-.01	.08	.13	.09	-.01	.51**	-		
17. Singing Enjoyment	-.05	-.10	.02	-.03	-.18	-.14	-.05	-.05	.23	-.02	.09	.20	.09	.09	.45**	.19	-	
18. Breathing Enjoyment	-.41	.01	.04	-.03	.15	.13	.52*	.30	-.30	-.46	-.45	.68**	-.19	.60**	.35	.12	.08	-

Supplementary Table: Pearson Correlations between Session One Variables; Abbreviations: MBS, Breathlessness; PEFR, Peak Expiratory Flow Rate; FEV1, Forced Expiratory Flow in 1 Second; ACQ, Asthma Control Questionnaire; GHQ, General Health Questionnaire; SGRQ, St. George Respiratory Questionnaire; PA, Positive mood; NA, Negative mood; SWLS, Satisfaction with Life Scale. *Note*: Singing enjoyment and breathing enjoyment are based on n = 50 and n = 18, respectively; * $p < .05$; ** $p < .01$