BMJ Open

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

| | |
|---|---|
| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2016-014151 |
| Article Type: | Research |
| Date Submitted by the Author: | 06-Sep-2016 |
| Complete List of Authors: | McNaughton, Amanda; Medical Research Institute of New Zealand, Respiratory Medicine; Wellington Hospital, Respiratory Medicine<br>Weatherall, Mark; University of Otago Wellington,<br>Williams, Mathew; Medical Research Institute of New Zealand,<br>McNaughton, Harry; Medical Research Institute of New Zealand<br>Aldington, Sarah; Wellington Hospital, Capital and Coast District Health Board, Emergency Medicine<br>Williams, Gayle; Capital and Coast District Health Board, Community Health Services<br>Beasley, Richard; Medical Research Institute of New Zealand, |
| Primary Subject Heading: | Respiratory medicine |
| Secondary Subject Heading: | Patient-centred medicine |
| Keywords: | Chronic Obstructive Pulmonary Disease, Pulmonary Rehabilitation, Singing |
| | |

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

Amanda McNaughton[1,2], Mark Weatherall[3], Mathew Williams[1], Harry McNaughton[1], Sarah Aldington[1,4], Gayle Williams[5], Richard Beasley[1,2]

[1] Medical Research Institute of New Zealand, Wellington, New Zealand

[2] Department of Respiratory Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[3] Department of Medicine, University of Otago, Wellington, New Zealand

[4] Department of Emergency Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[5] Department of Community Health, Capital and Coast District Health Board, Wellington, New Zealand

Corresponding author:

Amanda McNaughton

Medical Research Institute of New Zealand,

Wellington Hospital

Private Bag 7902

Wellington 6021 New Zealand

0064 27 838 6925

amanda.mcnaughton@ccdhb.org.nz

## ABSTRACT

**Objective** Singing group participation may benefit patients with chronic obstructive pulmonary disease (COPD). Previous studies are limited by small numbers of participants and short duration of hospital-based singing group intervention. This study examined the feasibility of long-term participation in a community singing group for patients with COPD who had completed pulmonary rehabilitation (PR).

**Methods** This was a mixed methods pilot study. Patients with COPD who had completed PR were recruited to a new community-based singing group which met weekly for over one year. Measurements at baseline, four months and one year comprised comprehensive pulmonary function tests including lung volumes, six minute walk tests (6MWT), Clinical COPD Questionnaire (CCQ), Hospital Anxiety and Depression Scale (HADS), and hospital admission days for acute exacerbation of COPD (AECOPD) for one year before and after joining singing group. Individual interviews and a focus group provided data for the qualitative assessment which is reported separately.

**Findings** Of 28 initial participants, 21 completed four-month, and 18 completed one-year assessments The mean attendance was 85.4%. The 6MWT at one year improved by 62.2 (95% CI 26.9 to 97.5) m compared to baseline P=0.002. There was an important reduction in residual volume after four months; 130 (95% CI 3 to 250) ml, P=0.046, and a reduction in the HADS Anxiety Score after one year of 1.1 (95% CI 0.3 to 1.9) points, P=0.009. Mean (SD) hospital admission days for AECOPD were 3.6 (7.9) before, and 2.7 (7.3) after joining the singing group, p=0.40 for the difference.

**Conclusions** Our findings support the feasibility of long-term participation in a community singing group for breathless adults with COPD and provide evidence of improved exercise capacity and lung function, and a reduction in anxiety.

**Strengths and limitations of this study:**

- The mixed-methods design of this study provides a broad perspective on a novel intervention.
- The inclusion of an unselected cohort of COPD patients, and the real-world community setting of the singing group supports generalisability of the findings.
- High retention rates with one-year follow-up support the feasibility of this intervention.
- This is the first report of serial lung volume measurements in COPD patients attending a singing group over one year.
- This is a relatively small cohort study.

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD), characterised by persistent airflow limitation that is usually progressive, is an increasingly common syndrome.[1] Common symptoms include progressive breathlessness, cough and sputum production as well as anxiety and depression.[2,3] The chronic breathlessness in COPD is physically limiting and socially isolating, adding further to depression and anxiety.[4] Current pharmacological options have limited benefits and significant adverse effects driving the need for cost-effective, non-pharmacological, person-centred, community-based interventions.[5–8] Pulmonary Rehabilitation (PR) is one of the most effective therapies for COPD, improving quality of life, exercise tolerance, and breathlessness.[9] An important research question is how the benefits of PR can be sustained and augmented.[10]

There is a growing interest in the therapeutic potential of singing for COPD. Singing involves inspiratory expansion (using the diaphragm, external intercostal, and accessory muscles), active exhalation (incremental recruitment of abdominal and internal intercostal muscles) and optimal posture.[11] Singing, therefore, has the potential to improve breathing control and posture, and theoretically to reduce residual volume (RV), which is a manifestation of lung hyperinflation. Improvement in psychological wellbeing has been reported in healthy subjects and people with a variety of chronic conditions participating in singing groups.[12–14]

Two randomised controlled trials of singing group interventions in COPD report improvements in quality of life and reduction in anxiety, although not in lung function.[15,16], One study examining the effects of adding therapeutic singing to PR programme showed no benefit in quality of life or exercise tolerance,[17] whilst two studies have reported improvement in maximal expiratory pressure.[18,19] The limitations of these studies include small sample sizes and short duration, hospital-based intervention.[15–19] Combined with the heterogeneity of disease severity, phenotypes, comorbidities and treatment regimens of COPD, the clinical and physiological benefits of singing group interventions are likely to have been underestimated. What remains unknown is whether singing group participation as an intervention, is acceptable and sustainable longer term, to an unselected group of COPD patients

and whether the benefits can be achieved in real-world conditions. The effects of singing group participation on hyperinflation and lung function in COPD patients also remain unclear.

We are interested in the potential of singing group participation for patients with COPD as a means to sustain the benefits of PR. We wished to study this in real world conditions (amateur singing group facilitator leading free, weekly, sessions in a community hall), particularly looking at lung function including lung volumes, exercise capacity, and wellbeing. The purpose of this mixed methods cohort study was to assess the feasibility of community singing group participation for one year, for breathless patients with COPD who have completed PR. We report here the quantitative results of the study, the qualitative results are reported separately.[20]

## METHODS

This was a prospective cohort study. Patients with COPD or another chronic lung disease, who had completed an eight-week, hospital-based PR programme, and were attending a weekly maintenance community PR exercise class, were invited by the PR nurse to join a new community-based singing group for the purposes of this study. The group was based in Wellington New Zealand. In our institution, patients are enrolled in PR programmes if they have chronic lung disease and a Modified Medical Research Council dyspnoea scale of at least grade 2. We report on those participants with physician-diagnosed COPD based on GOLD criteria.[21] There were no further recruitment restrictions based on age, severity of disease, cognition, singing ability, or co-morbidities. The study was approved by the Wellington Hospital Research Governance Group, and all patients gave written informed consent. The trial was prospectively registered at www.anzctr.org.au, registry number ACTRN12615000736549.

### Data collection

Patient demographics, pulmonary function tests, six-minute walk test (6MWT), Hospital Anxiety and Depression Scale (HADS)[22] and the Clinical COPD Questionnaire (CCQ)[23] were measured at baseline, four months and one year after enrolment. Spirometry and lung volumes including forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), total lung capacity (TLC), residual volume (RV), functional residual capacity (FRC) and inspiratory capacity (IC) were measured according to ATS/ERS standards (body volume constant plethysmography Masterlab, Erich-Jaeger, Wurzburg, Germany). Reference values were those of the European Community for Coal and Steel (ECCS). Short-acting bronchodilator therapy was withheld for four hours prior to testing, and patients were tested when clinically stable, and not within two weeks of an exacerbation. Six-minute walk test (6MWT) was performed according to international guidelines [24]

The respiratory scientist performing the pulmonary function tests was blind to the results of previous assessments. Questionnaires were self-completed. Each patient's electronic health record was searched for admissions where the primary discharge code was an acute exacerbation of COPD.

Hospital admission data for acute exacerbation of COPD were recorded for the 12 months before and 12 months after, enrolment.

**Singing group intervention**

The singing group (Sing Your Lungs Out) met for one hour, weekly, in an urban community hall, continuously throughout the study period. An amateur singing group facilitator (SGF) led the group and a PR nurse attended all sessions. Each rehearsal comprised a five minute warm up session, 35 minutes singing, a five minute warm down and 15 minutes social morning-tea time. It was run free of charge to patients. The SGF and the group chose the singing repertoire together, including a wide mix of genres (eg pop, musicals, traditional Maori songs, folk songs, rounds) with attention to the group's voice range and capacity for phrase lengths. The SGF also discussed breathing for singing techniques as the year progressed and as the group gained confidence. No music reading ability was required. We made CD recordings of songs to allow practice at home. Collaboration with a local boys' high school developed from student piano accompaniment to working with the senior boys' chorale including some joint performances. Over the year, the participants delivered six public performances, supported by the senior chorale from the local school on four occasions.

**Analysis**

Continuous variables were compared using paired t-tests for most variables. Hospital admission days were right skew and were compared with a paired Wilcoxon test and Hodges-Lehmann estimator of the difference. No adjustment has been made for multiple statistical testing. SAS version 9.4 was used.

## RESULTS

Twenty-eight participants enrolled in the singing group in five months: October 2014 to February 2015. Five participants withdrew within one month of enrolment due to disinterest or recruitment to another study. Twenty-three (82%) participants attended the singing group for at least one year and had measurements at enrolment and after four months. Twenty participants were reassessed after 12 months: one had undergone lung transplant and two had such frequent exacerbations that stable follow-up testing was not possible. At baseline assessment, twenty-one participants had COPD as defined by GOLD criteria[21] but two participants had normal FEV1/FVC ratio on spirometry with a clinical diagnosis of interstitial lung disease. They continued to attend singing group but are excluded from this analysis. Figure 1 shows the study overview.

The participants with COPD had a wide range of disease severity and comorbidities. Mean (SD) FEV1% at baseline was 60.3 (21.1), median 57.1, range 14.6-110. Six patients (29%) had an FEV1 at baseline of less than one litre. Common comorbidities were bronchiectasis, congestive cardiac failure, diabetes, and obesity. Six of 21 (29%) were Māori, consistent with the higher prevalence of COPD in Māori in New Zealand who constitute only 6% of the total population over 50 years.[25] The mean (SD) attendance rate for the 12 months was 85.4% (12.1). Table 1 shows characteristics of the study population at baseline.

Table 1 Characteristics of the study population

| | N=21 | |
|---|---|---|
| Age years mean (SD)* | 68.8 (9.8) range 51 to 91 | |
| Sex n (% ) | | |
| Men | 8 (38) | |
| Women | 13 (62) | |
| Ethnicity n (%) | | |
| European | 14 (67) | |
| Maori | 6 (29) | |
| Asian | 1 (5) | |
| Smoking history n (%) | | |
| Current smoker | 1 (5) | |
| Ex-smoker | 18 (86) | |
| Never smoker | 2 (10) | |
| COPD severity[a] n (%) | | |
| BODE score: 0-2 | 4 (19) | |
| 3-4 | 8 (38) | |
| 5-6 | 6 (29) | |
| 7-10 | 3 (14) | |
| Continuous long term domiciliary oxygen therapy n (%) | 2 (10) | |
| Comorbidities[b] n (%) | | |
| Bronchiectasis | 3 (14) | |
| Heart failure | 6 (29) | |
| Diabetes | 7 (33) | |
| Anxiety on treatment | 5 (24) | |
| Atrial fibrillation | 8 (38) | |
| Ischaemic Heart Disease | 5 (24) | |
| | | |
| **Clinical characteristics *** | Mean (SD) | Range |
| FEV1 (L) | 1.3(0.5) | 0.6-2.6 |
| FEV1 (% predicted) | 60.3 (21.1) | 14.6-110.3 |
| FVC (L) | 2.85 (0.9) | 1.8-4.9 |
| FVC (%predicted) | 103.5 (26.9) | 53.4-160.4 |
| FEV1/FVC | 0.47 (0.14) | 0.22-0.68 |
| TLC (L) | 6.38 (1.99) | 3.57-11.3 |
| RV (L) | 3.39 (1.52) | 1.67-8.52 |
| SpO2 at rest (%) | 95.4 (2.3) | 89-99 |
| 6MWT (m) | 299.6 (110.1) | 132-508 |
| BMI (kg/m$^2$) | 29.1 (7.6) | 20.1-53.0 |
| Questionnaires* | | |
| CCQ | 2.11 (0.83) | 0.4-3.3 |
| HADS anxiety | 5.8 (2.8) | 1-11 |
| HADS depression | 4.1 (2.3) | 1-10 |
| HADS total | 9.9 (4.6) | 2-21 |

**a:**BODE score- The body-mass index, airflow obstruction, dyspnoea and exercise capacity index in COPD [26] **b** Some participants had multiple comorbidities.

FEV1- forced expiratory volume in one second, FVC- forced vital capacity, TLC- total lung capacity RV- residual volume, SpO2-oxygen saturation measured by a pulse oximeter, 6MWT- six-minute walk test, BMI- body mass index, CCQ- clinical COPD questionnaire, HADS- hospital anxiety and depression score.

There was strong evidence for an increase in 6MWT after four months, with a mean increase of 28.4m, increasing further to 62.2m at one year. HADS Anxiety scores were lower at one year with a mean change from baseline of -1.1. Lung function tests showed a reduction in RV, mean decrease 130 ml, and total lung capacity, mean decrease 150 ml, after four months, but no significant differences at 12 months compared to baseline. The questionnaire and clinical measurements, and their changes are shown in Table 2.

Table 2: Changes from baseline in lung function, questionnaires and hospital admission days.

| | Mean (SD) | | | Difference from baseline (95% CI) | |
|---|---|---|---|---|---|
| **Variable** | **Baseline N=21** | **Four months N=21** | **One year N=18** | **Four months** | **One year** |
| FEV1 (L) | 1.32 (0.5) | 1.34 (0.5) | 1.44 (0.5) | 0.02 (-0.01 to 0.06) P=0.21 | 0.04 (-0.04 to 0.12) P=0.32 |
| FEV1% | 60.3 (21.1) | 61.9 (22.3) | 64.5 (20.2) | 1.6 (-0.1 to 3.4) P=0.065 | 2.4 (-1.5 to 6.3) P=0.22 |
| FVC (L) | 2.85 (0.9) | 2.81 (0.92) | 2.91 (0.97) | -0.04 (-0.15 to 0.06) P=0.38 | -0.03 (-0.16 to 0.10) P=0.65 |
| FVC% | 103.5 (26.9) | 103.1 (30.4) | 107.0 (24.8) | -0.5 (-4.5 to 3.6) P=0.81 | -0.3 (-5.0 to 4.4) P=0.90 |
| FEV1/FVC | 0.47 (0.14) | 0.48 (0.13) | 0.50 (0.12) | 0.01 (-0.004 to 0.03) P=0.13 | 0.01 (-0.003 to 0.03) P=0.10 |
| TLC (L) | 6.38 (1.99) | 6.22 (1.86) | 6.23 (1.7) | -0.15 (-0.29 to -0.02) P=0.023 | -0.04 (-0.21 to 0.13) P=0.63 |
| TLC% | 117.8 (20.9) | 115.2 (20.2) | 116.4 (20.8) | -2.6 (-4.8 to -0.4) P=0.021 | -0.7 (-3.6 to 2.2) P=0.62 |
| RV (L) | 3.39 (1.52) | 3.27 (1.44) | 3.22 (1.18) | -0.13 (-0.25 to -0.003) P=0.046 | 0.03 (-0.18 to 0.24) P=0.78 |
| RV% | 156.1 (59.9) | 150.2 (57.1) | 145.7 (44.1) | -5.9 (-11.5 to -0.3) P=0.04 | -0.1 (-8.9 to 8.8) P=0.99 |
| IC (L) | 2.29 (0.86) | 2.35 (0.83) | 2.33 (0.87) | 0.06 (-0.03 to 0.15) P=0.18 | -0.07 (-0.18 to 0.04) P=0.19 |
| IC% | 107.2 (27.2) | 110.1 (25.7) | 108.6 (24.3) | 3.0 (-1.8 to 7.7) P=0.21 | -2.9 (-9.3 to 3.4) P=0.35 |
| IC/TLC | 0.37 (0.09) | 0.39 (0.09) | 0.38 (0.09) | 0.02 (0.001 to 0.03) P=0.037 | -0.01 (-0.03 to 0.01) P=0.49 |
| RV/TLC | 0.52 (0.09) | 0.52 (0.09) | 0.52 (0.09) | -0.01 (-0.02 to 0.01) P=0.45 | 0.01 (-0.02 to 0.03) P=0.61 |
| 6MWT (m) | 299.6 (110.1) | 328.0 (118.4) | 376.5 (103.6) | 28.4 (5.1 to 51.7) P=0.019 | 62.2 (26.9 to 97.5) P=0.002 |
| CCQ | 2.11 (0.83) | 2.08 (0.86) | 2.31 (1.04) | -0.03 (-0.31 to 0.26) P=0.84 | 0.27 (-0.04 to 0.57) P=0.09 |
| HADS Anxiety | 5.8 (2.8) | 5.81 (3.52) | 4.67 (3.2) | 0 (-1.2 to 1.2) P=0.99 | -1.1 (-1.9 to -0.3) P=0.009 |
| HADS Depression | 4.1 (2.3) | 3.19 (2.56) | 4.0 (3.91) | -0.9 (-2.1 to 0.2) P=0.11 | -0.1 (-1.5 to 1.4) P=0.93 |

| | | | | | |
|---|---|---|---|---|---|
| HADS Total | 9.9 (4.6) | 9.0 (5.7) | 8.7 (6.4) | -0.9 (-3.0 to 1.2) P=0.37 | -1.2 (-2.9 to 0.5) P=0.17 |
| | | | | | |
| | | **12 months prior to enrolment** | **12 months after enrolment** | **HL estimator (95% CI)** | |
| **Hospital admission days for AECOPD N=20* Mean (SD)** | | 3.6 (7.9) | 2.7 (7.3) | -1.0 (-8.5 to 3.0) P=0.40 | |

FEV1, Forced expiratory volume in 1 s; FVC, forced vital capacity; TLC, total lung capacity; RV, residual volume; FRC, functional residual capacity; IC, inspiratory capacity. Spirometric reference values from European Community for Coal and Steel (ECCS). Short-acting bronchodilator therapy withheld for four hours before testing, patients were tested when clinically stable, and not within two weeks of an exacerbation. Six-minute walk test (6MWT) performed according to international guidelines.[24] AECOPD, Acute exacerbation of COPD. * Excluding one patient who had lung transplant between 4 months and 1-year follow-up assessments.

Figure 2 displays individual patient line plots of 6 minute walk test distance of each participant at baseline, 4 months and one year.

## DISCUSSION

The results of this study show that participation in a weekly community-based singing group for one year is associated with increased exercise capacity, reduced anxiety, and improved lung function in patients with COPD. The high attendance rate over one year, (mean 85.4%), supports the acceptability, feasibility, and enjoyment of this intervention. Factors favouring generalisability of these findings are the broad inclusion criteria, COPD patients recruited from typical public hospital pulmonary rehabilitation service and singing group intervention requiring no special training.

We were surprised by the high long-term attendance rate (mean 85.4%) for this cohort of patients with significant respiratory disease and comorbidities. The qualitative data from this mixed methods study showed that most participants had not been previously interested in singing and considered the singing group a fun social activity more than music practice.[20] The reduction in HADS anxiety scores confirms previous research [15] but this is the first report of statistically and clinically significant improvements in respiratory function and 6MWT with this type of intervention. The mean reduction in HADS anxiety of -1.1 at one year, did not exceed minimal clinically important difference (MCID) of 1.32.[27] The mean increase in 6MWT of 62.2m at one year was greater than the MCID of

30m.[28] The small reduction in RV after four months supports the findings of a previous small study.[19] This is the first report of serial RV measurement in COPD patients attending a singing group over one year. Although the reduction in hospital admission days for AECOPD was not statistically significant, the point estimate was almost one day less per participant in the year attending singing group, compared to the year before starting (excluding the patient who has a lung transplant during the year). If this is a genuine reduction then, at a daily hospital bed day rate of approximately $NZ800 (GBP400), this represents a saving of $14080 for this group of 20 patients. The actual cost of running the singing group for 12 months was approximately $NZ4000. Therefore this low-cost intervention could potentially be very cost effective.

Strengths of this study, are the inclusion of an unselected cohort of patients with COPD, high retention rates with one-year follow-up, comprehensive pulmonary function tests, and mixed-method design in a real world community context. Previously reported studies of singing intervention for COPD have generally been of short duration, none longer than 24 weeks, mostly 6-10 weeks.[15,16,18,19] In contrast to studies using professional singing teachers and physiotherapists, we used amateur singing group facilitators, with musical experience and strong group facilitation skills. Limitations of the study include that the 6MWT was only performed once at each visit, but participants had all done at least two 6MWT as part of their recent PR programmes so any learning effect is likely to have been minimised.[29] All participants received usual medical care; so therapeutic changes may have affected some, but not all, of the participants. This is a relatively small cohort study without a control group so both type I and type II errors are possible.

Our findings are also relevant to the question of sustaining the benefits of pulmonary rehabilitation. All our participants had completed a PR programme- the improvements described here are additional. A possible mechanism for singing group effectiveness is the promotion of physical activity which is considered to be a critical component of PR.[30] Our qualitative data showed that for many patients, attending the weekly singing group was a most enjoyable highlight of their week and often their only outing.[20] Our finding of a reduction in RV after four months, but not 12 months, may

reflect a positive effect of singing on respiratory muscles and expiratory airways pressure that is subsequently overtaken by the natural history of the decline in lung function in COPD. In contrast to other studies[15–18] our singing group intervention focussed on fun group singing with no specific breathing exercises. The impact of breathing exercises alone or in addition to singing remains uncertain.[31] Our group met weekly with singing duration of 35 minutes, and no explicit practice at home. It is possible that there is a dose-response relationship, with increased benefit with more frequent singing group classes and singing practice at home. From our experience, longer classes would not be well tolerated by COPD patients.

Our qualitative analysis showed singing group participation was associated with an increased sense of social connection, purpose and meaningful participation which may, in turn, have ameliorated anxiety.[20] Although there seems to be an association between anxiety in COPD patients, and their health status, the frequency of AECOPD and hospitalisation, it is complex.[32][32][32] However, the reduction in anxiety and increased exercise capacity observed in this study points to the potential for reducing readmissions and supports the use of exercise capacity and readmission for AECOPD, as primary outcome measures for a future randomised controlled trial (RCT).

We believe our results are generalizable because of our broad inclusion criteria, recruitment from a typical hospital PR programme and the use of amateurs for singing group facilitation. We have made available on-line our “10 practical top tips” document for setting up and running a community singing group for people living with COPD. We have been able to sustain this intervention long term, free to patients, as it was set up and financed by a charitable trust. The singing group is still going strong after twenty-two months with high attendance including almost all of the founding members, avoiding the ethical issue of withdrawing the intervention at study completion.

## CONCLUSIONS

Our findings support the feasibility of long-term participation in a community singing group for breathless adults with COPD and provide evidence of improvement in lung function and

exercise capacity, and reduction in anxiety. These results can inform sample size and selection of outcome measures for a future RCT. A study of community singing group participation as an alternative to PR for those who decline PR is underway: ACTRN12616000584437. We provide links to two short videos of this singing group and a "10 practical top tips" document for setting up a community singing group for people living with COPD which we hope will inform, motivate and encourage others to set up singing groups.

https://www.dropbox.com/sc/boc5sr7hkcbi6tz/AAAlbUQqOWyvDeJGTnoXVcg-a?preview=NO_Graphics_02.mp4

https://www.youtube.com/watch?v=fduau0jV09o

http://www.mrinz.ac.nz/pdfs/How_to_set_up_SYLO.pdf

**Acknowledgements** We are grateful to Ruth Collingham and Jackie McAuliffe for running the *Sing Your Lungs Out* Singing Group and to all the patients for their participation.

**Contributors** AM conceived the idea of the study, designed the protocol, wrote the first and final drafts of the manuscript, was the senior investigator, and will act as guarantor**.** SA, HM, MWi, GW, MWe, RB helped design and plan the study and helped write the first and final drafts of the manuscript. GW, AM recruited patients to the study. MWi, AM collected data. MWe was responsible for the analysis.

**Funding** This study was supported by the Medical Research Institute of New Zealand. Sing Your Lungs Out is run by the COPD Choir Trust, a volunteer-run registered charity, which received grants in 2015 from the Wellington City Council and Infinity Foundation Community Trust.

**Competing interests** None

**Ethics approval** This study was approved by the Wellington Hospital Research Governance Group on 23 September 2014

**Data sharing** No additional data are available

**REFERENCES**

1 Mannino DM, Buist AS. Global burden of COPD: risk factors, prevalence, and future trends. *Lancet* 2007;**370**:765–73. doi:10.1016/S0140-6736(07)61380-4

2 Rennard SI, Vestbo J. Natural histories of chronic obstructive pulmonary disease. *Proc Am Thorac Soc* 2008;**5**:878–83. doi:10.1513/pats.200804-035QC

3 Yohannes AM, Alexopoulos GS. Depression and anxiety in patients with COPD. *Eur Respir Rev* 2014;**23**:345–9. doi:10.1183/09059180.00007813

4 Martinez Rivera C, Costan Galicia J, Alcázar Navarrete B, *et al.* Factors Associated with Depression in COPD: A Multicenter Study. *Lung* 2016;**194**:335–43. doi:10.1007/s00408-016-9862-7

5 Kew KM, Dias S, Cates CJ. Long-acting inhaled therapy (beta-agonists, anticholinergics and steroids) for COPD: a network meta-analysis. In: Kew KM, ed. *Cochrane Database of Systematic Reviews*. Chichester, UK: : John Wiley & Sons, Ltd 2014. doi:10.1002/14651858.CD010844.pub2

6 NICE. Chronic obstructive pulmonary disease in over 16s: diagnosis and management | Guidance and guidelines | NICE. 2010.https://www.nice.org.uk/guidance/CG101 (accessed 21 Aug2016).

7 Agusti A. The path to personalised medicine in COPD. *Thorax* 2014;**69**:857–64. doi:10.1136/thoraxjnl-2014-205507

8 Ernst P, Saad N, Suissa S. Inhaled corticosteroids in COPD: the clinical evidence. *Eur Respir J* 2014;:525–37. doi:10.1183/09031936.00128914

9 McCarthy B, Casey D, Devane D, *et al.* Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2015;**2**:CD003793. doi:10.1002/14651858.CD003793.pub3

10 Celli BR, Decramer M, Wedzicha J, *et al.* An official American Thoracic Society/European Respiratory Society statement: research questions in COPD. *Eur Respir J* 2015;**45**:879–905. doi:10.1183/09031936.00009015

11 Watson A. Breathing in Singing. In: Welch G, Howard D, Nix J, eds. *The Oxford Handbook of Singing*. Oxford University Press 2014. doi:10.1093/oxfordhb/9780199660773.013.10

12 Clift S, Hancox G, Morrison I, *et al.* Choral singing and psychological wellbeing: Quantitative and qualitative findings from English choirs in a cross-national survey. *J Appl Arts Heal* 2010;**1**:19–34.

13 Clark I, Harding K. Psychosocial outcomes of active singing interventions for therapeutic purposes: a systematic review of the literature. *Nord J Music Ther* 2012;**21**:80–98. doi:10.1080/08098131.2010.545136

14 Reagon C, Gale N, Enright S, *et al.* A mixed-method systematic review to investigate the effect of group singing on health related quality of life. *Complement Ther Med* 2016;**27**:1–11. doi:10.1016/j.ctim.2016.03.017

15 Lord VM, Cave P, Hume VJ, *et al.* Singing teaching as a therapy for chronic respiratory disease--a randomised controlled trial and qualitative evaluation. *BMC Pulm Med* 2010;**10**:41. doi:10.1186/1471-2466-10-41

16 Lord VM, Hume VJ, Kelly JL, *et al.* Singing classes for chronic obstructive pulmonary disease: a randomized controlled trial. *BMC Pulm Med* 2012;**12**:69. doi:10.1186/1471-2466-12-69

17 Goodridge D, Nicol JJ, Horvey KJ, *et al.* Therapeutic Singing as an Adjunct for Pulmonary Rehabilitation Participants With COPD: Outcomes of a Feasibility Study. *Music Med* 2013;**5**:169–76. doi:10.1177/1943862113493012

18 Bonilha AG, Onofre F, Vieira ML, *et al.* Effects of singing classes on pulmonary function and quality of life of COPD patients. *Int J COPD* 2009;**4**:1–8. doi:10.2147/COPD.S4077

19 Pacheco C, Costa A, Amado J, *et al.* Singing in chronic obstructive pulmonary disease patients: A pilot study in Portugal. *Rev Port Pneumol* 2014;**20**:225–8. doi:10.1016/j.rppneu.2014.02.009

20 McNaughton A, Aldington S, Williams G, *et al.* Sing Your Lungs Out: A qualitative study of a community singing group for people with Chronic Obstructive Pulmonary Disease (COPD). *BMJ Open* 2016;**In Press**.

21 Global Strategy for Diagnosis, Management, and Prevention of COPD - 2016 - Global Initiative for Chronic Obstructive Lung Disease - GOLD. http://goldcopd.org/global-strategy-diagnosis-management-prevention-copd-2016/

22 Bjelland I, Dahl A, Haug T, *et al.* The validity of the Hospital Anxiety and Depression Scale: an updated literature review. *J Psychosom* 2002.

23 van der Molen T, Willemse BWM, Schokker S, *et al.* Development, validity and responsiveness of the Clinical COPD Questionnaire. *Health Qual Life Outcomes* 2003;**1**:13.

24 ATS Statement: Guidelines for the Six-Minute Walk Test. *Am Thorac Soc Am J Respir Crit Care Med* 2002;**166**:111–7. doi:10.1164/rccm.166/1/111

25 Ministry of Health New Zealand. District health board Maori health plans profiles and needs assessments. 2015.http://www.health.govt.nz/publication/dhb-maori-health-profiles

26 Celli BR, Cote CG, Marin JM, *et al.* The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *NEJM* 2004;**350**:1005–12. doi:10.1056/NEJMoa021322

27 Puhan MA, Frey M, Büchi S, *et al.* The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease. *Health Qual Life Outcomes* 2008;**6**:46. doi:10.1186/1477-7525-6-46

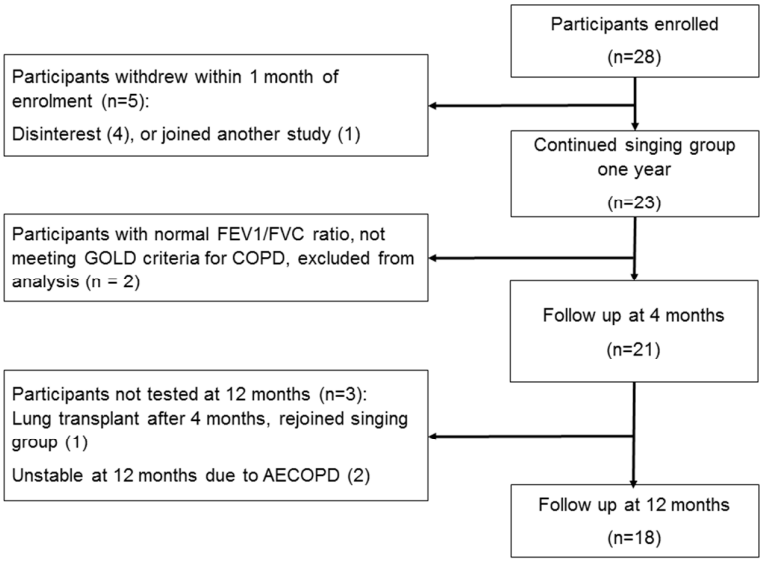
28 Holland AE, Nici L. The Return of the Minimum Clinically Important Difference for 6-Minute-Walk Distance in Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med* 2013;**187**:335–6. doi:10.1164/rccm.201212-2191ED

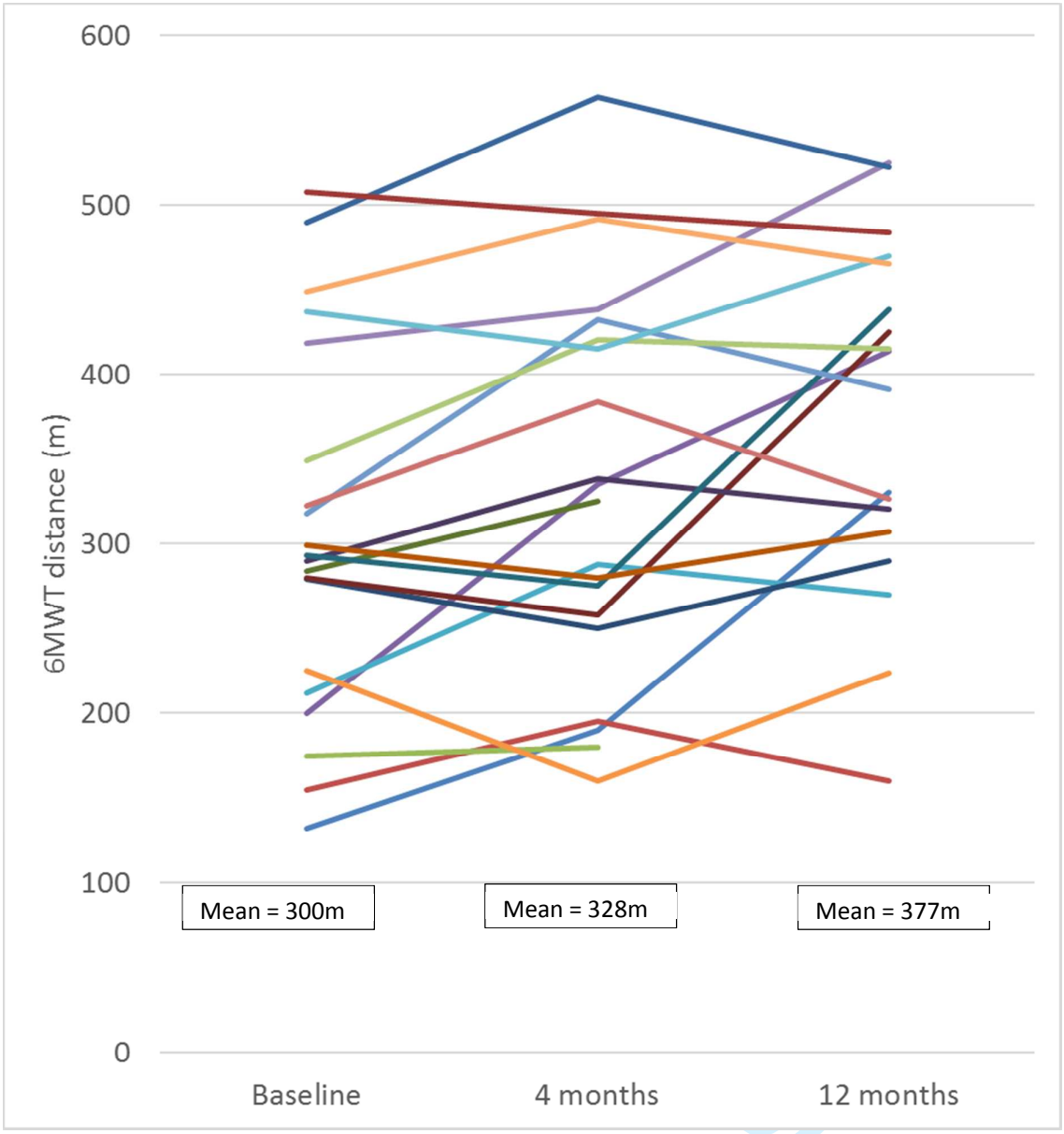
29 Holland AE, Spruit MA, Troosters T, *et al.* An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J* 2014;**44**:1428–46. doi:10.1183/09031936.00150314

30 Spruit MA, Pitta F, McAuley E, *et al.* Pulmonary Rehabilitation and Physical Activity in Patients with Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med* 2015;**192**:924–33. doi:10.1164/rccm.201505-0929CI

31 Holland AE, Hill CJ, Jones AY, *et al.* Breathing exercises for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* Published Online First: 2012. doi:10.1002/14651858.CD008250.pub2

32 Pooler A, Beech R. Examining the relationship between anxiety and depression and exacerbations of COPD which result in hospital admission: a systematic review. *Int J Chron Obs Pulmon Dis* 2014;**9**:315–30.





STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation | |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Pilot in study title. |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Yes |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Yes Introduction para 1-3, pg3-4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Yes Introduction para 4, pg 4. No hypotheses, this was a feasibility study. |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Methods, para 1, pg 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Methods, para 1, pg 5 and under 'Singing Group Intervention' pg 6. Specific dates are in first line of Results, pg 7 |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants | Methods, para 1, pg 5 |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case | No matched control group |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | Methods, 'data collection', pg 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | Methods, 'Data collection', pg 5 |

| | | | |
|---|---|---|---|
| Bias | 9 | Describe any efforts to address potential sources of bias | Objective lung function tests measured by scientist blinded to previous results. Self reported questionnaires |
| Study size | 10 | Explain how the study size was arrived at | Convenience sample, twice the size of previous studies. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | Methods, 'Analysis', pg 6 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Methods, 'Analysis', pg 6 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | N/A |
| | | (*c*) Explain how missing data were addressed | N/A |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed<br>*Case-control study*—If applicable, explain how matching of cases and controls was addressed<br>*Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy | Results, para 1, pg 7 and Figure 1 Study overview |
| | | (*e*) Describe any sensitivity analyses | N/A |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Results, para 1, pg 7 and Study overview Figure 1 |
| | | (b) Give reasons for non-participation at each stage | Results, para 1 and figure 1 |
| | | (c) Consider use of a flow diagram | Figure 1 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Results, para 2, pg 7 and Table 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table 1 |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) | Result, para 1,pg 7 |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time | Results, para 3, pg 9 and Table 2 and Figure 2 |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure | |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if | Admission days adjusted. Other |

| | | | |
|---|---|---|---|
| | | applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | results unadjusted. Table 2 |
| | | (*b*) Report category boundaries when continuous variables were categorized | N/A |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | N/A feasibility study |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Discussion para1 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Discussion para 3, pg 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Discussion para 4 and 5, pg 12-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Discussion para 6, pg 13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Funding statement pg 14 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

| | |
|---|---|
| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2016-014151.R1 |
| Article Type: | Research |
| Date Submitted by the Author: | 18-Oct-2016 |
| Complete List of Authors: | McNaughton, Amanda; Medical Research Institute of New Zealand, Respiratory Medicine; Wellington Hospital, Respiratory Medicine<br>Weatherall, Mark; University of Otago Wellington,<br>Williams, Mathew; Medical Research Institute of New Zealand,<br>McNaughton, Harry; Medical Research Institute of New Zealand<br>Aldington, Sarah; Wellington Hospital, Capital and Coast District Health Board, Emergency Medicine<br>Williams, Gayle; Capital and Coast District Health Board, Community Health Services<br>Beasley, Richard; Medical Research Institute of New Zealand, |
| Primary Subject Heading: | Respiratory medicine |
| Secondary Subject Heading: | Patient-centred medicine |
| Keywords: | Chronic Obstructive Pulmonary Disease, Pulmonary Rehabilitation, Singing |
| | |

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

Amanda McNaughton[1,2], Mark Weatherall[3], Mathew Williams[1], Harry McNaughton[1], Sarah Aldington[1,4], Gayle Williams[5], Richard Beasley[1,2]

[1] Medical Research Institute of New Zealand, Wellington, New Zealand

[2] Department of Respiratory Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[3] Department of Medicine, University of Otago, Wellington, New Zealand

[4] Department of Emergency Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[5] Department of Community Health, Capital and Coast District Health Board, Wellington, New Zealand

Corresponding author:

Amanda McNaughton

Medical Research Institute of New Zealand,

Wellington Hospital

Private Bag 7902

Wellington 6021 New Zealand

0064 27 838 6925

amanda.mcnaughton@ccdhb.org.nz

## ABSTRACT

**Objective** Singing group participation may benefit patients with chronic obstructive pulmonary disease (COPD). Previous studies are limited by small numbers of participants and short duration of generally, hospital-based singing group intervention. This study examines the feasibility of long-term participation in a community singing group for patients with COPD who had completed pulmonary rehabilitation (PR).

**Methods** This was a non-experimental cohort study. Patients with COPD who had completed PR were recruited to a new community-based singing group which met weekly for over one year. Measurements at baseline, four months and one year comprised comprehensive pulmonary function tests including lung volumes, six minute walk tests (6MWT), Clinical COPD Questionnaire (CCQ), Hospital Anxiety and Depression Scale (HADS), and hospital admission days for acute exacerbation of COPD (AECOPD) for one year before and after the first singing group session.

**Findings** There were 28 participants with chronic lung disease recruited initially. Five withdrew in the first month. Twenty-one participants meeting GOLD criteria for COPD completed four-month, and 18 completed one-year assessments. The mean attendance was 85%. The 6MWT at one year improved by 65 (95% CI 35 to 99) m compared to baseline P<0.001. There was a reduction in residual volume after four months of 130 (95% CI 3 to 250) ml, P=0.046, and a reduction in the HADS Anxiety Score after one year of 0.9 (95% CI 0.1 to 1.8) points, P=0.038. Mean (SD) hospital admission days for AECOPD were 3.6 (7.9) before, and 2.7 (7.3) after joining the singing group, p=0.40 for the difference.

**Conclusions** Our findings support the feasibility of long-term participation in a community singing group for breathless adults with COPD who have completed PR and provide evidence of improved exercise capacity and a reduction in anxiety.

**Strengths and limitations of this study:**

- Broad inclusion criteria and community setting of the singing group supports generalisability of the findings.
- High retention rates with one-year follow-up support the feasibility of this intervention.
- This is the first report of serial lung volume measurements in COPD patients attending a singing group over one year.
- This is a relatively small cohort study.

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD), characterised by persistent airflow limitation that is usually progressive, is an increasingly common syndrome.[1] Common symptoms include progressive breathlessness, cough and sputum production as well as anxiety and depression.[2,3] The chronic breathlessness in COPD is physically limiting and socially isolating, adding further to depression and anxiety.[4] Current pharmacological options have limited benefits and significant adverse effects driving the need for cost-effective, non-pharmacological, person-centred, community-based interventions.[5–8] Pulmonary Rehabilitation (PR) is one of the most effective therapies for COPD, improving quality of life, exercise tolerance, and breathlessness.[9] An important research question is how the benefits of PR can be sustained and augmented.[10]

There is a growing interest in the therapeutic potential of singing for COPD. Singing involves inspiratory expansion (using the diaphragm, external intercostal, and accessory muscles), active exhalation (incremental recruitment of abdominal and internal intercostal muscles) and optimal posture.[11] Singing, therefore, has the potential to improve breathing control and posture, and theoretically to reduce residual volume (RV), which is a manifestation of lung hyperinflation. Improvement in psychological wellbeing has been reported in healthy subjects and people with a variety of chronic conditions participating in singing groups.[12–14]

Two randomised controlled trials of singing group interventions in COPD report improvements in quality of life and reduction in anxiety, although not in lung function.[15,16], One study examining the effects of adding therapeutic singing to PR programme showed no benefit in quality of life or exercise tolerance,[17] whilst two studies have reported improvement in maximal expiratory pressure.[18,19] The limitations of these studies include small sample sizes and short duration, hospital-based intervention.[15–19] A non-experimental feasibility study of singing group intervention for people with COPD in the United Kingdom recruited 106 people into 6 singing groups, and followed the group for ten months. [20] In that report it was unclear if the participants had participated in PR before the singing intervention. That study reported a 34% attrition rate and small statistically significant differences in St

Georges Respiratory Questionnaire as well as spirometry parameters measured by a portable spirometry device. We wished to explore whether singing group participation as an intervention, is acceptable and sustainable for a longer time period with adequate retention rates, to a broad group of COPD patients who had completed PR and whether the benefits can be achieved in a community setting taking a low-cost, pragmatic approach that might be easily reproducible in other centres comprising amateur singing group facilitator leading free weekly sessions in a community hall. We are interested in the potential of singing group participation for patients with COPD as a means to sustain the benefits of PR. The effects of singing group participation on hyperinflation and lung function in COPD patients remain unclear and we wished to measure both spirometry and lung volumes over a significant time period in singing group participants, looking for any effect on residual volume as well as airflow.

The purpose of this cohort study was to assess the feasibility of community singing group participation for one year, for breathless patients with COPD who have completed PR. We report here the quantitative results of the study, the qualitative results are reported separately.[21]

## METHODS

This was a prospective cohort study. Patients with COPD or another chronic lung disease, who had completed an eight-week, hospital-based PR programme, and were attending a weekly maintenance community PR exercise class, were invited by the PR nurse to join a new community-based singing group for the purposes of this study. The group was based in Wellington, New Zealand. In our institution, patients are enrolled in PR programmes if they have chronic lung disease and a Modified Medical Research Council dyspnoea scale of at least grade 2. We report on those participants with physician-diagnosed COPD based on GOLD criteria.[22] There were no further recruitment restrictions based on age, severity of disease, cognition, singing ability, or co-morbidities. The study was approved by the Wellington Hospital Research Governance Group, and all patients gave written informed consent. The trial was registered at www.anzctr.org.au, registry number ACTRN12615000736549.

### Data collection

Patient demographics, pulmonary function tests, six-minute walk test (6MWT), Hospital Anxiety and Depression Scale (HADS)[23] and the Clinical COPD Questionnaire (CCQ)[24] were measured at baseline, four months and one year after enrolment. Spirometry and lung volumes including forced expiratory volume in 1s (FEV1), forced vital capacity (FVC), total lung capacity (TLC), residual volume (RV), functional residual capacity (FRC) and inspiratory capacity (IC) were measured according to ATS/ERS standards (body volume constant plethysmography Masterlab, Erich-Jaeger, Wurzburg, Germany) using the reference values of the European Community for Coal and Steel (ECCS).[25] Short-acting bronchodilator therapy was withheld for four hours prior to testing, and patients were tested when clinically stable, and not within two weeks of an exacerbation. Six-minute walk test (6MWT) was performed according to international guidelines [26] except that only one test was performed at each measurement point, rather than the recommended two. All participants had performed at least one, and mostly two, 6MWT previously as part of their PR programme.

The respiratory scientist performing the pulmonary function tests was masked to the results of previous assessments. Questionnaires were self-completed. Each patient's electronic health record was

searched for admissions where the primary discharge code was an acute exacerbation of COPD. Hospital admission data for acute exacerbation of COPD were recorded for the 12 months before enrolment and 12 months starting from the date of enrolment. PR programme information, the date, sessions attended, and 6MWT results at entry and completion, were obtained from the PR nurse who runs the programme.

**Singing group intervention**

The singing group (Sing Your Lungs Out) met for one hour, weekly, in an urban community hall, continuously throughout the study period. An amateur singing group facilitator (SGF) led the group and a PR nurse attended all sessions. Each rehearsal comprised a five minute warm up session, 35 minutes singing, a five minute warm down and 15 minutes social morning-tea time. It was run free of charge to patients. The SGF and the group chose the singing repertoire together, including a wide mix of genres (eg pop, musicals, traditional Māori songs, folk songs, rounds) with attention to the group's voice range and capacity for phrase lengths. The SGF also discussed breathing for singing techniques as the year progressed and as the group gained confidence. No music reading ability was required. We made recordings of songs to allow practice at home although this was optional. Collaboration with a local boys' high school developed from student piano accompaniment to working with the senior boys' chorale including some joint performances. Over the year, the participants delivered six public performances, supported by the senior chorale from the local school on four occasions. Singing group members continued to attend maintenance exercise classes as well as singing group.

**Analysis**

Continuous variables were compared using a mixed linear model for most variables with an unstructured variance-covariance correlation structure. Hospital admission days were right skew and

were compared with a paired Wilcoxon test and Hodges-Lehmann estimator of the difference. Although individual comparisons are presented with 95% confidence intervals a large number of statistical tests have been carried out and this will inflate the Type I error rate. SAS version 9.4 was used.

## RESULTS

Twenty-eight participants with chronic lung disease were enrolled in the singing group in five months: October 2014 to February 2015. The mean (SD) time from completion of past PR was 1.2 (1.2) years. Response to past PR by the change in 6MWT was available for 14 participants and for these participants the distance had improved from a mean (SD) of 316 (126) m to 356 (148) m. Five participants withdrew within one month of enrolment as they did not wish to continue (n=4) or were recruited into another study (n=1). At baseline assessment, twenty-one participants had COPD as defined by GOLD criteria[22] but two participants had normal FEV1/FVC ratio on spirometry with a clinical diagnosis of interstitial lung disease. They continued to attend singing group but were excluded from this analysis. The 21 participants with COPD attended the singing group for at least one year and had measurements at enrolment and after four months. Eighteen participants were reassessed after 12 months: one had undergone lung transplant and two had such frequent exacerbations that stable follow-up testing was not possible. Figure 1 shows the study overview.

The participants with COPD had a wide range of disease severity and comorbidities. Mean (SD) FEV1% at baseline was 60.3 (21.1), median 57.1, range 14.6-110. The majority (66%) of participants had moderate COPD by GOLD criteria but 20% had severe or very severe COPD, similar to the proportions of COPD severity in the NZ community.[27] Six patients (29%) had an FEV1 at baseline of less than one litre. Common comorbidities were bronchiectasis, congestive cardiac failure, diabetes, and obesity. Six of 21 (29%) were Māori, consistent with the higher prevalence of COPD in Māori in New Zealand who constitute only 6% of the total population over 50 years.[28] The mean (SD) attendance rate for the 12 months was 85% (12.1). Table 1 shows characteristics of the study population at baseline.

Table 1 Characteristics of the study population

| | | | |
|---|---|---|---|
| | N=21 | | |
| Age (years) mean (SD) [range] | 68.8 (9.8) [51 to 91] | | |
| Sex | N/21 (%) | | |
| Men | 8 (38) | | |
| Women | 13 (62) | | |
| Ethnicity | | | |
| European | 14 (67) | | |
| Maori | 6 (29) | | |
| Asian | 1 (5) | | |
| Smoking history | | | |
| Current smoker | 1 (5) | | |
| Ex-smoker | 18 (86) | | |
| Never smoker | 2 (10) | | |
| COPD severity (FEV1% predicted) | | | |
| ≥80% (mild) | 3 (14) | | |
| 50-79% (moderate) | 14 (66) | | |
| 30-49% (severe) | 2 (10) | | |
| <30% (very severe) | 2 (10) | | |
| COPD mortality risk[a] | | | |
| BODE score: 0-2<br>3-4<br>5-6<br>7-10 | 4 (19)<br>8 (38)<br>6 (29)<br>3 (14) | | |
| Continuous long term domiciliary oxygen therapy | 2 (10) | | |
| Comorbidities[b] | | | |
| Bronchiectasis | 3 (14) | | |
| Heart failure | 6 (29) | | |
| Diabetes | 7 (33) | | |
| Anxiety on treatment | 5 (24) | | |
| Atrial fibrillation | 8 (38) | | |
| Ischaemic Heart Disease | 5 (24) | | |
| | | | |
| **Clinical characteristics** | Mean (SD) | Median (IQR) | Min to max |
| FEV1 (L) | 1.3(0.5) | 1.3 (0.9 to 1.6) | 0.6 to 2.6 |
| FEV1 (% predicted) | 60.3 (21.1) | 57.1 (50 to 72.4) | 14.6 to 110.3 |
| FVC (L) | 2.85 (0.9) | 2.75 (2.2 to 3.0) | 1.8 to 4.9 |
| FVC (%predicted) | 103.5 (26.9) | 102.5 (85.3 to 126.7) | 53.4 to160.4 |
| FEV1/FVC | 0.47 (0.14) | 0.47 (0.36 to 0.56) | 0.22 to 0.68 |
| TLC (L) | 6.38 (1.99) | 5.68 (5.2 to 7.0) | 3.57 to 11.3 |
| RV (L) | 3.39 (1.52) | 3.06 (2.6 to 3.4) | 1.67 to 8.52 |
| SpO2 at rest (%) | 95.4 (2.3) | 96 (93 to 97) | 89 to 99 |
| 6MWT (m) | 300 (110) | 290 (212 to 349) | 132 to 508 |
| BMI (kg/m$^2$) | 29.1 (7.6) | 28.0 (23.9 to 32.5) | 20.1 to 53.0 |
| Questionnaires | | | |
| CCQ | 2.11 (0.83) | 1.9 (1.7 to 2.8) | 0.4 to 3.3 |
| HADS anxiety | 5.8 (2.8) | 6 (4 to 7) | 1 to 11 |
| HADS depression | 4.1 (2.3) | 3 (3 to 6) | 1 to 10 |
| HADS total | 9.9 (4.6) | 9 (7 to 12) | 2 to 21 |

**a:**BODE score- The body-mass index, airflow obstruction, dyspnoea and exercise capacity index in COPD [29] **b** Some participants had multiple comorbidities.

FEV1- forced expiratory volume in one second, FVC- forced vital capacity, TLC- total lung capacity RV- residual volume, SpO2-oxygen saturation measured by a pulse oximeter, 6MWT- six-minute walk test, BMI- body mass index, CCQ- clinical COPD questionnaire, HADS- hospital anxiety and depression score.

There was strong evidence for an increase in 6MWT after four months, with a mean increase of 28 (95%CI 5 to 52) m, p = 0.019, increasing further to 65 (95%CI 35 to 99) m, p <0.001 at one year. HADS Anxiety scores were lower at one year with a mean change from baseline of -0.9 (95%CI -1.8 to -0.1) p = 0.038. Lung function tests showed a reduction in RV, mean decrease 130 (95%CI -250 to -3) ml, p =0.046 and total lung capacity, mean decrease 150 (95%CI -290 to -20) ml, p = 0.023 after four months, but no significant differences at 12 months compared to baseline. The questionnaire and clinical measurements, and their changes are shown in Table 2.

196 Table 2: Changes from baseline in lung function, questionnaires and hospital admission days.

| | Mean (SD) | | | Difference from baseline (95% CI) | |
|---|---|---|---|---|---|
| **Variable** | **Baseline N=21** | **Four months N=21** | **One year N=18** | **Four months** | **One year** |
| FEV1 (L) | 1.32 (0.5) | 1.34 (0.5) | 1.44 (0.5) | 0.02 (-0.01 to 0.06) P=0.21 | 0.04 (-0.05 to 0.12) P=0.44 |
| FEV1% | 60.3 (21.1) | 61.9 (22.3) | 64.5 (20.2) | 1.6 (-0.1 to 3.4) P=0.065 | 2.4 (-1.4 to 6.1) P=0.21 |
| FVC (L) | 2.85 (0.9) | 2.81 (0.92) | 2.91 (0.97) | -0.04 (-0.15 to 0.06) P=0.38 | -0.04 (-0.17 to 0.09) P=0.50 |
| FVC% | 103.5 (26.9) | 103.1 (30.4) | 107.0 (24.8) | -0.5 (-4.5 to 3.6) P=0.81 | -0.02 (-4.5 to 4.4) P=0.99 |
| FEV1/FVC | 0.47 (0.14) | 0.48 (0.13) | 0.50 (0.12) | 0.01 (-0.004 to 0.03) P=0.13 | 0.02 (-0.002 to 0.03) P=0.08 |
| TLC (L) | 6.38 (1.99) | 6.22 (1.86) | 6.23 (1.7) | -0.15 (-0.29 to -0.02) P=0.023 | -0.04 (-0.21 to 0.13) P=0.61 |
| TLC% | 117.8 (20.9) | 115.2 (20.2) | 116.4 (20.8) | -2.6 (-4.8 to -0.4) P=0.021 | -0.7 (-3.7 to 2.3) P=0.61 |
| RV (L) | 3.39 (1.52) | 3.27 (1.44) | 3.22 (1.18) | -0.13 (-0.25 to -0.003) P=0.046 | 0.06 (-0.16 to 0.27) P=0.58 |
| RV% | 156.1 (59.9) | 150.2 (57.1) | 145.7 (44.1) | -5.9 (-11.5 to -0.3) P=0.04 | 1.3 (-7.8 to 10.3) P=0.77 |
| IC (L) | 2.29 (0.86) | 2.35 (0.83) | 2.33 (0.87) | 0.06 (-0.03 to 0.15) P=0.18 | -0.07 (-0.18 to 0.04) P=0.21 |
| IC% | 107.2 (27.2) | 110.1 (25.7) | 108.6 (24.3) | 3.0 (-1.8 to 7.7) P=0.21 | -2.9 (-9.3 to 3.5) P=0.35 |
| IC/TLC | 0.37 (0.09) | 0.39 (0.09) | 0.38 (0.09) | 0.02 (0.001 to 0.03) P=0.037 | -0.01 (-0.03 to 0.01) P=0.36 |
| RV/TLC | 0.52 (0.09) | 0.52 (0.09) | 0.52 (0.09) | -0.01 (-0.02 to 0.01) P=0.45 | 0.01 (-0.01 to 0.03) P=0.35 |
| 6MWT (m) | 300 (110) | 328 (118) | 377 (104) | 28 (5 to 52) P=0.019 | 65 (35 to 99) P<0.001 |
| CCQ | 2.11 (0.83) | 2.08 (0.86) | 2.31 (1.04) | -0.03 (-0.31 to 0.26) P=0.84 | 0.26 (-0.04 to 0.57) P=0.08 |
| HADS Anxiety | 5.8 (2.8) | 5.81 (3.52) | 4.67 (3.2) | 0 (-1.2 to 1.2) P=0.99 | -0.9 (-1.8 to -0.1) P=0.038 |
| HADS Depression | 4.1 (2.3) | 3.19 (2.56) | 4.0 (3.91) | -0.9 (-2.1 to 0.2) P=0.11 | 0.1 (-1.3 to 1.6) P=0.85 |

| | | | | | |
|---|---|---|---|---|---|
| HADS Total | 9.9 (4.6) | 9.0 (5.7) | 8.7 (6.4) | -0.9 (-3.0 to 1.2) P=0.37 | -0.8 (-2.6 to 1.0) P=0.35 |
| | | | | | |
| | | **12 months prior to enrolment** | **12 months after enrolment** | **HL estimator (95% CI)** | |
| **Hospital admission days for AECOPD N=20* Mean (SD)** | | 3.6 (7.9) | 2.7 (7.3) | -1.0 (-8.5 to 3.0) P=0.40 | |

FEV1, Forced expiratory volume in 1 s; FVC, forced vital capacity; TLC, total lung capacity; RV, residual volume; FRC, functional residual capacity; IC, inspiratory capacity. Spirometric reference values from European Community for Coal and Steel (ECCS). Short-acting bronchodilator therapy withheld for four hours before testing, patients were tested when clinically stable, and not within two weeks of an exacerbation. Six-minute walk test (6MWT) performed according to international guidelines.[24] AECOPD, Acute exacerbation of COPD. * Excluding one patient who had lung transplant between 4 months and 1-year follow-up assessments.

## DISCUSSION

In this study participation in a weekly community-based singing group for one year is associated with increased exercise capacity, reduced anxiety, and improved lung function in patients with COPD who have completed PR. The high attendance rate over one year, (mean 85%), supports the acceptability and feasibility of this intervention. Factors favouring generalisability of these findings are the broad inclusion criteria, COPD patients recruited from typical public hospital pulmonary rehabilitation service and singing group intervention requiring no special training.

We were surprised by the high long-term attendance rate, mean 85%, for this cohort of patients with significant respiratory disease and comorbidities, including two participants with very severe COPD, one of whom had a lung transplant four months after joining the singing group. The qualitative data from this project, reported separately, showed that most participants had not been previously interested in singing and considered the singing group a fun social activity more than a musical endeavour.[21] The reduction in HADS anxiety scores confirms previous research [15] but this is the first report of statistically and clinically significant improvements in 6MWT and lung volumes, albeit that the latter were modest and short-term, with this type of intervention.. The mean reduction in HADS anxiety score of 0.9 units at one year, did not exceed the minimal clinically important difference (MCID) of 1.32.[30] The mean increase in 6MWT of 65m at one year was greater than the MCID of 30m.[31]

This is the first report of serial RV measurement in COPD patients attending a singing group over one year. The small reduction in RV after four months supports the findings of a previous small COPD study although in that study lung volumes were measured immediately after singing.[19] Although the reduction in hospital admission days for AECOPD was not statistically significant, the point estimate was almost one day less per participant in the year attending singing group, compared to the year before starting (excluding the patient who has a lung transplant during the year). If this is a genuine reduction then, at a daily hospital bed day rate of approximately $NZ800 (GBP460), this represents a saving of $14080 for this group of 20 patients. The actual cost of running the singing group for 12 months was approximately $NZ4000. Therefore this low-cost intervention could potentially be cost effective.

Strengths of this study are the broad inclusion criteria, high retention rates with one-year follow-up, comprehensive pulmonary function tests, and pragmatic community context. Previously reported studies of singing intervention for COPD have generally been of short duration, mostly 6-10 weeks.[15,16,18,19] In contrast to studies using professional singing teachers and physiotherapists, we used amateur singing group facilitators, with musical experience and strong group facilitation skills. Our findings confirm those of Morrison and colleagues who showed medium-term (ten months) feasibility for community singing groups for people with COPD in the UK but with a significantly higher attrition rate than we achieved. A significant component of our study was that participants had both completed a PR programme and were enrolled in a weekly maintenance exercise programme. These are likely to be people more motivated to manage their own health and who had already demonstrated an ability to attend weekly sessions. Thus these results can't be readily generalised to a population of people with COPD who have declined or not been offered PR. We believe there may be a role for SG participation for people with COPD who decline PR and have started a controlled study testing this hypothesis (www.anzctr.org.au registry number ACTRN12616000584437). Limitations of our study include that the 6MWT was only performed once at each visit, but participants had all done at least one 6MWT as part of their recent PR programmes so any learning effect is likely to have been minimised.[32] Singing

group members continued to attend maintenance exercise classes which could explain some of the improvement in exercise capacity. However, on average, the participants had been attending exercise classes for approximately one year prior to singing group enrolment and mean 6MWT distance at commencement of singing group was lower than the 6MWT distance at the end of the PR programme for the 14 participants with complete data from the preceding PR programme. The presence of a PR nurse at the singing sessions may have been important. Her role was in 'meeting and greeting' participants, general encouragement to attend, supervising refreshments and organising transport for performances. There was no formal or informal exercise advice provided. In the interviews that formed the qualitative component of this project [21], a key theme was being cared for in a safe environment and the PR nurse presence contributed to this. All participants received usual medical care so therapeutic changes may have affected some, but not all, of the participants. This is a relatively small cohort study without a control group so both type I and type II errors are possible. This analysis also includes a large number of hypothesis tests which inflate the type 1 error rate.

Our findings are relevant to the question of sustaining the benefits of pulmonary rehabilitation.. A possible mechanism for singing group effectiveness is the promotion of physical activity which is considered to be a critical component of PR.[33] Our qualitative data showed that for many patients, attending the weekly singing group was a most enjoyable highlight of their week and worth the extra physical activity it took to get there.[21] Our finding of a reduction in RV after four months, but not 12 months, may reflect type I error rate inflation, and so be due to the play of chance. However, if this is a real result it could reflect a positive effect of singing on respiratory muscles and expiratory airways pressure that is subsequently overtaken by the natural history of the decline in lung function in COPD. In contrast to other studies[15–18] our singing group intervention focussed on fun group singing with no specific breathing exercises. The impact of breathing exercises alone or in addition to singing remains uncertain.[34] Our group met weekly with singing duration of 35 minutes, and no explicit practice at home. It is possible that there is a dose-response relationship, with increased benefit with more frequent singing group classes and singing practice at home. With the very high attendance rate we

were not able to attempt an analysis for a dose-response relationship between attendance and outcomes. From our experience, longer classes would not be well tolerated by COPD patients.

Our qualitative analysis showed singing group participation was associated with an increased sense of social connection, purpose and meaningful participation which may explain the reduction in anxiety.[21] Although there seems to be an association between anxiety in COPD patients, their health status, and the frequency of AECOPD and hospitalisation, it is complex.[35] However, the reduction in anxiety and increased exercise capacity observed in this study points to the potential for reducing readmissions and supports the use of exercise capacity and readmission for AECOPD, as primary outcome measures for a future randomised controlled trial (RCT).

We believe our results are generalisable because of our broad inclusion criteria, recruitment from a typical hospital PR programme and the use of amateurs for singing group facilitation. We have made available on-line our “10 practical top tips” document for setting up and running a community singing group for people living with COPD (see online supplement). We have been able to sustain this intervention long term, free to patients, as it was set up and financed by a charitable trust. The singing group is still going strong after twenty-two months with high attendance including almost all of the founding members, avoiding the ethical issue of withdrawing the intervention at study completion.

## CONCLUSIONS

Our findings support the feasibility of long-term participation in a community singing group for breathless adults with COPD and provide evidence of improvement in exercise capacity and reduction in anxiety. These results can inform sample size and selection of outcome measures for a future RCT.

**Figure legend:**

Figure 1: Study overview

COPD = chronic obstructive pulmonary disease, PR= pulmonary rehabilitation, AECOPD = acute exacerbation of COPD, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity, GOLD = Global Initiative for Chronic Obstructive Lung Disease

**Acknowledgements** We are grateful to Ruth Collingham and Jackie McAuliffe for running the *Sing Your Lungs Out* Singing Group and to all the patients for their participation.

**Contributors** AM conceived the idea of the study, designed the protocol, wrote the first and final drafts of the manuscript, was the senior investigator, and will act as guarantor**.** SA, HM, MWi, GW, MWe, RB helped design and plan the study and helped write the first and final drafts of the manuscript. GW, AM recruited patients to the study. MWi, AM collected data. MWe was responsible for the analysis.

**Funding** This study was supported by the Medical Research Institute of New Zealand. Sing Your Lungs Out is run by the COPD Choir Trust, a volunteer-run registered charity, which received grants in 2015 from the Wellington City Council and Infinity Foundation Community Trust.

**Competing interests** None

**Ethics approval** This study was approved by the Wellington Hospital Research Governance Group on 23 September 2014

**Data sharing** No additional data are available

## REFERENCES

1 Mannino DM, Buist AS. Global burden of COPD: risk factors, prevalence, and future trends. *Lancet* 2007;**370**:765–73. doi:10.1016/S0140-6736(07)61380-4

2 Rennard SI, Vestbo J. Natural histories of chronic obstructive pulmonary disease. *Proc Am Thorac Soc* 2008;**5**:878–83. doi:10.1513/pats.200804-035QC

3 Yohannes AM, Alexopoulos GS. Depression and anxiety in patients with COPD. *Eur Respir Rev* 2014;**23**:345–9. doi:10.1183/09059180.00007813

4 Martinez Rivera C, Costan Galicia J, Alcázar Navarrete B, *et al.* Factors Associated with Depression in COPD: A Multicenter Study. *Lung* 2016;**194**:335–43. doi:10.1007/s00408-016-9862-7

5 Kew KM, Dias S, Cates CJ. Long-acting inhaled therapy (beta-agonists, anticholinergics and steroids) for COPD: a network meta-analysis. In: Kew KM, ed. *Cochrane Database of Systematic Reviews*. Chichester, UK: : John Wiley & Sons, Ltd 2014.

doi:10.1002/14651858.CD010844.pub2

6 NICE. Chronic obstructive pulmonary disease in over 16s: diagnosis and management | Guidance and guidelines | NICE. 2010.https://www.nice.org.uk/guidance/CG101 (accessed 21 Aug2016).

7 Agusti A. The path to personalised medicine in COPD. *Thorax* 2014;**69**:857–64. doi:10.1136/thoraxjnl-2014-205507

8 Ernst P, Saad N, Suissa S. Inhaled corticosteroids in COPD: the clinical evidence. *Eur Respir J* 2014;:525–37. doi:10.1183/09031936.00128914

9 McCarthy B, Casey D, Devane D, *et al.* Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2015;**2**:CD003793. doi:10.1002/14651858.CD003793.pub3

10 Celli BR, Decramer M, Wedzicha J, *et al.* An official American Thoracic Society/European Respiratory Society statement: research questions in COPD. *Eur Respir J* 2015;**45**:879–905. doi:10.1183/09031936.00009015

11 Watson A. Breathing in Singing. In: Welch G, Howard D, Nix J, eds. *The Oxford Handbook of Singing*. Oxford University Press 2014. doi:10.1093/oxfordhb/9780199660773.013.10

12 Clift S, Hancox G, Morrison I, *et al.* Choral singing and psychological wellbeing: Quantitative and qualitative findings from English choirs in a cross-national survey. *J Appl Arts Heal* 2010;**1**:19–34.

13 Clark I, Harding K. Psychosocial outcomes of active singing interventions for therapeutic purposes: a systematic review of the literature. *Nord J Music Ther* 2012;**21**:80–98. doi:10.1080/08098131.2010.545136

14 Reagon C, Gale N, Enright S, *et al.* A mixed-method systematic review to investigate the effect of group singing on health related quality of life. *Complement Ther Med* 2016;**27**:1–11. doi:10.1016/j.ctim.2016.03.017

15 Lord VM, Cave P, Hume VJ, *et al.* Singing teaching as a therapy for chronic respiratory disease--a randomised controlled trial and qualitative evaluation. *BMC Pulm Med* 2010;**10**:41. doi:10.1186/1471-2466-10-41

16 Lord VM, Hume VJ, Kelly JL, *et al.* Singing classes for chronic obstructive pulmonary disease: a randomized controlled trial. *BMC Pulm Med* 2012;**12**:69. doi:10.1186/1471-2466-12-69

17 Goodridge D, Nicol JJ, Horvey KJ, *et al.* Therapeutic Singing as an Adjunct for Pulmonary Rehabilitation Participants With COPD: Outcomes of a Feasibility Study. *Music Med* 2013;**5**:169–76. doi:10.1177/1943862113493012

18 Bonilha AG, Onofre F, Vieira ML, *et al.* Effects of singing classes on pulmonary function and quality of life of COPD patients. *Int J COPD* 2009;**4**:1–8. doi:10.2147/COPD.S4077

19 Pacheco C, Costa A, Amado J, *et al.* Singing in chronic obstructive pulmonary disease patients: A pilot study in Portugal. *Rev Port Pneumol* 2014;**20**:225–8. doi:10.1016/j.rppneu.2014.02.009

20 Morrison I, Clift SM, Page S et al. A UK feasibility study on the value of singing for people

with Chronic Obstructive Pulmonary Disease (COPD). UNESCO Observatory Multi-Disciplinary Journal in the Arts 2013:3;1-19

21 McNaughton A, Aldington S, Williams G, *et al.* Sing Your Lungs Out: A qualitative study of a community singing group for people with Chronic Obstructive Pulmonary Disease (COPD). *BMJ Open* 2016;**6**:e012521 doi:10.1136/bmjopen-2016-012521

22 Global Strategy for Diagnosis, Management, and Prevention of COPD - 2016 - Global Initiative for Chronic Obstructive Lung Disease - GOLD. http://goldcopd.org/global-strategy-diagnosis-management-prevention-copd-2016/

23 Bjelland I, Dahl A, Haug T, *et al.* The validity of the Hospital Anxiety and Depression Scale: an updated literature review. *J Psychosom Res* 2002;52:69-77

24 van der Molen T, Willemse BWM, Schokker S, *et al.* Development, validity and responsiveness of the Clinical COPD Questionnaire. *Health Qual Life Outcomes* 2003;**1**:13.

25 Clausen JL, Coates AL, Quanjer PH. Measurement of lung volumes in humans: review and recommendations from an ATS/ERS workshop. *Eur Respir J* 1997;10:1205–6

26 ATS Statement: Guidelines for the Six-Minute Walk Test. *Am Thorac Soc Am J Respir Crit Care Med* 2002;**166**:111–7. doi:10.1164/rccm.166/1/111

27 Shirtcliffe P, Weatherall M, Marsh S, *et al*. COPD prevalence in a random population survey: a matter of definition. *Eur Respir J* 2007;30:232–9

28 Ministry of Health New Zealand. District health board Maori health plans profiles and needs assessments. 2015.http://www.health.govt.nz/publication/dhb-maori-health-profiles

29 Celli BR, Cote CG, Marin JM, *et al.* The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *NEJM* 2004;350:1005–12. doi:10.1056/NEJMoa021322

30 Puhan MA, Frey M, Büchi S, *et al.* The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease. *Health Qual Life Outcomes* 2008;**6**:46. doi:10.1186/1477-7525-6-46

31 Holland AE, Nici L. The Return of the Minimum Clinically Important Difference for 6-Minute-Walk Distance in Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med* 2013;**187**:335–6. doi:10.1164/rccm.201212-2191ED

32 Holland AE, Spruit MA, Troosters T, *et al.* An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J* 2014;**44**:1428–46. doi:10.1183/09031936.00150314

33 Spruit MA, Pitta F, McAuley E, *et al.* Pulmonary Rehabilitation and Physical Activity in Patients with Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med* 2015;**192**:924–33. doi:10.1164/rccm.201505-0929CI

34 Holland AE, Hill CJ, Jones AY, *et al.* Breathing exercises for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* Published Online First: 2012. doi:10.1002/14651858.CD008250.pub2

35 Pooler A, Beech R. Examining the relationship between anxiety and depression and exacerbations of COPD which result in hospital admission: a systematic review. *Int J*

412 *Chron Obs Pulmon Dis* 2014;**9**:315–30.

413

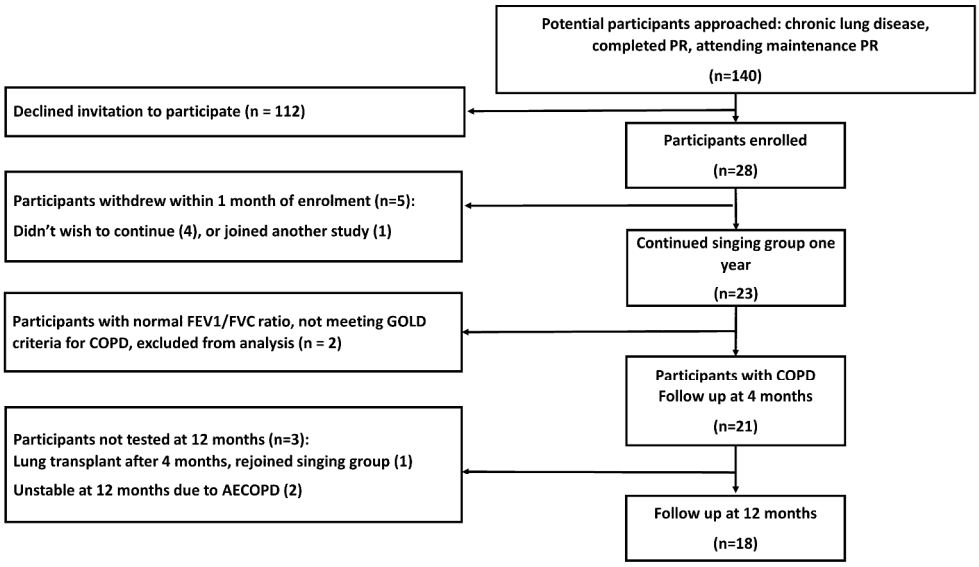



Figure 1: Study overview.
COPD = chronic obstructive pulmonary disease, PR= pulmonary rehabilitation, AECOPD = acute exacerbation of COPD, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity, GOLD = Global Initiative for Chronic Obstructive Lung Disease

Figure 1 shows the study overv
338x190mm (300 x 300 DPI)

# Setting up a singing group like Sing Your Lungs Out

We provide links below to two short videos of this singing group and a "10 practical top tips" document for setting up a community singing group for people living with COPD which we hope will inform, motivate and encourage others to set up singing groups.

https://www.dropbox.com/sc/boc5sr7hkcbi6tz/AAAlbUQqOWyvDeJGTnoXVcg-a?preview=NO_Graphics_02.mp4

https://www.youtube.com/watch?v=fduau0jV09o

http://www.mrinz.ac.nz/pdfs/How_to_set_up_SYLO.pdf

STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation | |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Pilot in study title. |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Yes |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Yes Introduction para 1-3, pg3-4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Yes Introduction para 4, pg 4. No hypotheses, this was a feasibility study. |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Methods, para 1, pg 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Methods, para 1, pg 5 and under 'Singing Group Intervention' pg 6. Specific dates are in first line of Results, pg 7 |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br>*Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls<br>*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants | Methods, para 1, pg 5 |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed<br>*Case-control study*—For matched studies, give matching criteria and the number of controls per case | No matched control group |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | Methods, 'data collection', pg 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | Methods, 'Data collection', pg 5 |

| | | | |
|---|---|---|---|
| Bias | 9 | Describe any efforts to address potential sources of bias | Objective lung function tests measured by scientist blinded to previous results. Self reported questionnaires |
| Study size | 10 | Explain how the study size was arrived at | Convenience sample, twice the size of previous studies. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | Methods, 'Analysis', pg 6 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Methods, 'Analysis', pg 6 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | N/A |
| | | (*c*) Explain how missing data were addressed | N/A |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy | Results, para 1, pg 7 and Figure 1 Study overview |
| | | (*e*) Describe any sensitivity analyses | N/A |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Results, para 1, pg 7 and Study overview Figure 1 |
| | | (b) Give reasons for non-participation at each stage | Results, para 1 and figure 1 |
| | | (c) Consider use of a flow diagram | Figure 1 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Results, para 2, pg 7 and Table 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table 1 |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) | Result, para 1,pg 7 |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time | Results, para 3, pg 9 and Table 2 and Figure 2 |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure | |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if | Admission days adjusted. Other |

| | | | |
|---|---|---|---|
| | | applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | results unadjusted. Table 2 |
| | | (*b*) Report category boundaries when continuous variables were categorized | N/A |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | N/A feasibility study |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Discussion para1 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Discussion para 3, pg 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Discussion para 4 and 5, pg 12-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Discussion para 6, pg 13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Funding statement pg 14 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

| | |
|---|---|
| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2016-014151.R2 |
| Article Type: | Research |
| Date Submitted by the Author: | 09-Nov-2016 |
| Complete List of Authors: | McNaughton, Amanda; Medical Research Institute of New Zealand, Respiratory Medicine; Wellington Hospital, Respiratory Medicine<br>Weatherall, Mark; University of Otago Wellington,<br>Williams, Mathew; Medical Research Institute of New Zealand,<br>McNaughton, Harry; Medical Research Institute of New Zealand<br>Aldington, Sarah; Wellington Hospital, Capital and Coast District Health Board, Emergency Medicine<br>Williams, Gayle; Capital and Coast District Health Board, Community Health Services<br>Beasley, Richard; Medical Research Institute of New Zealand, |
| Primary Subject Heading: | Respiratory medicine |
| Secondary Subject Heading: | Patient-centred medicine |
| Keywords: | Chronic Obstructive Pulmonary Disease, Pulmonary Rehabilitation, Singing |
| | |

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

Amanda McNaughton[1,2], Mark Weatherall[3], Mathew Williams[1], Harry McNaughton[1], Sarah Aldington[1,4], Gayle Williams[5], Richard Beasley[1,2]

[1] Medical Research Institute of New Zealand, Wellington, New Zealand

[2] Department of Respiratory Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[3] Department of Medicine, University of Otago, Wellington, New Zealand

[4] Department of Emergency Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[5] Department of Community Health, Capital and Coast District Health Board, Wellington, New Zealand

Corresponding author:

Amanda McNaughton

Medical Research Institute of New Zealand,

Wellington Hospital

Private Bag 7902

Wellington 6021 New Zealand

0064 27 838 6925

amanda.mcnaughton@ccdhb.org.nz

## ABSTRACT

**Objective** Singing group participation may benefit patients with chronic obstructive pulmonary disease (COPD). Previous studies are limited by small numbers of participants and short duration of generally, hospital-based singing group intervention. This study examines the feasibility of long-term participation in a community singing group for patients with COPD who had completed pulmonary rehabilitation (PR).

**Methods** This was a feasibility cohort study. Patients with COPD who had completed PR and were enrolled in a weekly community exercise group, were recruited to a new community-based singing group which met weekly for over one year. Measurements at baseline, four months and one year comprised comprehensive pulmonary function tests including lung volumes, six minute walk tests (6MWT), Clinical COPD Questionnaire (CCQ), Hospital Anxiety and Depression Scale (HADS), and hospital admission days for acute exacerbation of COPD (AECOPD) for one year before and after the first singing group session.

**Findings** There were 28 participants with chronic lung disease recruited from 140 people approached. Five withdrew in the first month. Twenty-one participants meeting GOLD criteria for COPD completed four-month, and 18 completed one-year assessments. The mean attendance was 85%. For the pre-specified primary outcome measure, total HADS score, difference between baseline and 12 months was -0.9, 95% CI -3.0 to 1.2, p = 0.37. Of the secondary measures, a significant reduction was observed for HADS Anxiety Score after one year of -0.9 (95% CI -1.8 to -0.1) points, P=0.038 and an increase in the 6MWT at one year, of 65 (95% CI 35 to 99) m compared to baseline P<0.001.

**Conclusions** Our findings support the feasibility of long-term participation in a community singing group for breathless adults with COPD who have completed PR and are enrolled in a

weekly community exercise group and provide evidence of improved exercise capacity and a reduction in anxiety.

**Strengths and limitations of this study:**

- High attendance and retention rates over one-year follow-up support the feasibility of this intervention.
- Recruitment from a typical hospital PR programme and low cost community setting of the singing group supports the practicality and reproducibility of the intervention
- This is the first report of serial lung volume measurements in COPD patients attending a singing group over one year.
- This is a relatively small cohort study.

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD), characterised by persistent airflow limitation that is usually progressive, is an increasingly common syndrome.[1] Common symptoms include progressive breathlessness, cough and sputum production as well as anxiety and depression.[2,3] The chronic breathlessness in COPD is physically limiting and socially isolating, adding further to depression and anxiety.[4] Current pharmacological options have limited benefits and significant adverse effects driving the need for cost-effective, non-pharmacological, person-centred, community-based interventions.[5–8] Pulmonary Rehabilitation (PR) is one of the most effective therapies for COPD, improving quality of life, exercise tolerance, and breathlessness.[9] An important research question is how the benefits of PR can be sustained and augmented.[10]

There is a growing interest in the therapeutic potential of singing for COPD. Singing involves inspiratory expansion (using the diaphragm, external intercostal, and accessory muscles), active exhalation (incremental recruitment of abdominal and internal intercostal muscles) and optimal posture.[11] Singing, therefore, has the potential to improve breathing control and posture, and theoretically to reduce residual volume (RV), which is a manifestation of lung hyperinflation. Improvement in psychological wellbeing has been reported in healthy subjects and people with a variety of chronic conditions participating in singing groups.[12–14]

Two randomised controlled trials of singing group interventions in COPD report improvements in quality of life and reduction in anxiety, although not in lung function.[15,16], One study examining the effects of adding therapeutic singing to PR programme showed no benefit in quality of life or exercise tolerance,[17] whilst two studies have reported improvement in maximal expiratory pressure.[18,19] The limitations of these studies include small sample sizes and short duration.[15–19] A non-experimental feasibility study of singing group intervention for people with COPD in the United Kingdom recruited 106 people into 6 singing groups, and followed the group for ten months. [20] In that report it was unclear if the participants had participated in PR before the singing intervention. That study reported a 34% attrition rate and small statistically significant differences in St Georges Respiratory

Questionnaire as well as spirometry parameters measured by a portable spirometry device. We wished to explore whether singing group participation as an intervention, is acceptable and sustainable for a longer time period with adequate retention rates, to a broad group of COPD patients who had completed PR and whether the benefits can be achieved in a community setting taking a low-cost, pragmatic approach that might be easily reproducible in other centres. We are interested in the potential of singing group participation for patients with COPD as a means to sustain the benefits of PR. We are also interested in identifying measures sensitive to change during the intervention period and the feasibility of this measurement. The effects of singing group participation on hyperinflation and lung function in COPD patients remain unclear and we wished to measure both spirometry and lung volumes over a significant time period in singing group participants, looking for any effect on residual volume as well as airflow.

The purpose of this cohort study was to assess the feasibility of community singing group participation for one year, for breathless patients with COPD who had completed PR. We report here the quantitative results of the study, the qualitative results are reported separately.[21]

## METHODS

This was a prospective feasibility study. Patients with COPD or another chronic lung disease, who had completed an eight-week, hospital-based PR programme, and were enrolled in a weekly community exercise class, were invited by the PR nurse to join a new community-based singing group for the purposes of this study. The group was based in Wellington, New Zealand. In our institution, patients are enrolled in PR programmes if they have chronic lung disease and a Modified Medical Research Council dyspnoea scale of at least grade 2. All patients completing a PR programme are encouraged to enrol in a weekly community exercise class. We report on those participants with physician-diagnosed COPD based on GOLD criteria.[22] There were no further recruitment restrictions based on age, severity of disease, cognition, singing ability, or co-morbidities. The study was approved by the Wellington Hospital Research Governance Group, and all patients gave written informed consent. The trial was registered at www.anzctr.org.au, registry number ACTRN12615000736549.

### Data collection

Patient demographics, pulmonary function tests, six-minute walk test (6MWT), Hospital Anxiety and Depression Scale (HADS)[23] and the Clinical COPD Questionnaire (CCQ)[24] were measured at baseline, four months and one year after enrolment. Spirometry and lung volumes including forced expiratory volume in 1s (FEV1), forced vital capacity (FVC), total lung capacity (TLC), residual volume (RV), functional residual capacity (FRC) and inspiratory capacity (IC) were measured according to ATS/ERS standards (body volume constant plethysmography Masterlab, Erich-Jaeger, Wurzburg, Germany) using the reference values of the European Community for Coal and Steel (ECCS).[25] Short-acting bronchodilator therapy was withheld for four hours prior to testing, and patients were tested when clinically stable, and not within two weeks of an exacerbation. Six-minute walk test (6MWT) was performed according to international guidelines [26] except that only one test was performed at each measurement point, rather than the recommended two. All participants had performed at least one, and mostly two, 6MWT previously as part of their PR programme.

The respiratory scientist performing the pulmonary function tests was masked to the results of previous assessments. Questionnaires were self-completed. Each patient's electronic health record was searched for diagnosis, comorbidities and admissions where the primary discharge code was an acute exacerbation of COPD. Hospital admission data for acute exacerbation of COPD were recorded for the 12 months before enrolment and 12 months starting from the date of enrolment. PR programme information, the date, sessions attended, and 6MWT results at entry and completion, were obtained from the PR nurse who runs the programme.

**Singing group intervention**

The singing group (Sing Your Lungs Out) met for one hour, weekly, in an urban community hall, continuously throughout the study period. An amateur singing group facilitator (SGF) led the group and a PR nurse attended all sessions. Each rehearsal comprised a five minute warm up session, 35 minutes singing, a five minute warm down and 15 minutes social morning-tea time. It was run free of charge to patients. The SGF and the group chose the singing repertoire together, including a wide mix of genres (eg pop, musicals, traditional Māori songs, folk songs, rounds) with attention to the group's voice range and capacity for phrase lengths. The SGF also discussed breathing for singing techniques as the year progressed and as the group gained confidence. No music reading ability was required. We made recordings of songs to allow practice at home although this was optional. Collaboration with a local boys' high school developed from student piano accompaniment to working with the senior boys' chorale including some joint performances. Over the year, the participants delivered six public performances, supported by the senior chorale from the local school on four occasions. Singing group members remained enrolled in the community exercise classes, as well as singing group.

**Analysis**

Continuous variables were compared using a mixed linear model for most variables with an unstructured variance-covariance correlation structure. Hospital admission days were right skew and were compared with a paired Wilcoxon test and Hodges-Lehmann estimator of the difference. Although individual comparisons are presented with 95% confidence intervals a large number of statistical tests have been carried out and this will inflate the Type I error rate. SAS version 9.4 was used.

## RESULTS

Out of 140 people with chronic lung disease approached, 28 participants (20%) were enrolled in the singing group in five months: October 2014 to February 2015. The mean (SD) time from completion of past PR was 1.2 (1.2) years. Response to past PR by the change in 6MWT was available for 14 participants and for these participants the distance had improved from a mean (SD) of 316 (126) m to 356 (148) m. Five participants withdrew within one month of enrolment as they did not wish to continue (n=4) or were recruited into another study (n=1). At baseline assessment, twenty-one participants had COPD as defined by GOLD criteria[22] but two participants had normal FEV1/FVC ratio on spirometry with a clinical diagnosis of interstitial lung disease. They continued to attend singing group but were excluded from this analysis. The 21 participants with COPD attended the singing group for at least one year and had measurements at enrolment and after four months. Eighteen participants were reassessed after 12 months: one had undergone lung transplant and two had such frequent exacerbations that stable follow-up testing was not possible. Figure 1 shows the study overview.

The participants with COPD had a wide range of disease severity and comorbidities. Mean (SD) FEV1% at baseline was 60.3 (21.1), median 57.1, range 14.6-110. The majority (66%) of participants had moderate COPD by GOLD criteria but 20% had severe or very severe COPD, similar to the proportions of COPD severity in the NZ community.[27] Six patients (29%) had an FEV1 at baseline of less than one litre. Common comorbidities were bronchiectasis, congestive cardiac failure, diabetes, and obesity. Six of 21 (29%) were Māori, consistent with the higher prevalence of COPD in Māori in New Zealand who constitute only 6% of the total population over 50 years.[28] The mean (SD) attendance rate for the 12 months was 85% (12.1). Table 1 shows characteristics of the study population at baseline.

Table 1 Characteristics of the study population

| | | | |
|---|---|---|---|
| | N=21 | | |
| Age (years) mean (SD) [range] | 68.8 (9.8) [51 to 91] | | |
| Sex | N/21 (%) | | |
| Men | 8 (38) | | |
| Women | 13 (62) | | |
| Ethnicity | | | |
| European | 14 (67) | | |
| Maori | 6 (29) | | |
| Asian | 1 (5) | | |
| Smoking history | | | |
| Current smoker | 1 (5) | | |
| Ex-smoker | 18 (86) | | |
| Never smoker | 2 (10) | | |
| COPD severity (FEV1% predicted) | | | |
| ≥80% (mild) | 3 (14) | | |
| 50-79% (moderate) | 14 (66) | | |
| 30-49% (severe) | 2 (10) | | |
| <30% (very severe) | 2 (10) | | |
| COPD mortality risk[a] | | | |
| BODE score: 0-2<br>3-4<br>5-6<br>7-10 | 4 (19)<br>8 (38)<br>6 (29)<br>3 (14) | | |
| Continuous long term domiciliary oxygen therapy | 2 (10) | | |
| Comorbidities[b] | | | |
| Bronchiectasis | 3 (14) | | |
| Heart failure | 6 (29) | | |
| Diabetes | 7 (33) | | |
| Anxiety on treatment | 5 (24) | | |
| Atrial fibrillation | 8 (38) | | |
| Ischaemic Heart Disease | 5 (24) | | |
| | | | |
| **Clinical characteristics** | Mean (SD) | Median (IQR) | Min to max |
| FEV1 (L) | 1.3(0.5) | 1.3 (0.9 to 1.6) | 0.6 to 2.6 |
| FEV1 (% predicted) | 60.3 (21.1) | 57.1 (50 to 72.4) | 14.6 to 110.3 |
| FVC (L) | 2.85 (0.9) | 2.75 (2.2 to 3.0) | 1.8 to 4.9 |
| FVC (%predicted) | 103.5 (26.9) | 102.5 (85.3 to 126.7) | 53.4 to160.4 |
| FEV1/FVC | 0.47 (0.14) | 0.47 (0.36 to 0.56) | 0.22 to 0.68 |
| TLC (L) | 6.38 (1.99) | 5.68 (5.2 to 7.0) | 3.57 to 11.3 |
| RV (L) | 3.39 (1.52) | 3.06 (2.6 to 3.4) | 1.67 to 8.52 |
| SpO2 at rest (%) | 95.4 (2.3) | 96 (93 to 97) | 89 to 99 |
| 6MWT (m) | 300 (110) | 290 (212 to 349) | 132 to 508 |
| BMI (kg/m$^2$) | 29.1 (7.6) | 28.0 (23.9 to 32.5) | 20.1 to 53.0 |
| Questionnaires | | | |
| CCQ | 2.11 (0.83) | 1.9 (1.7 to 2.8) | 0.4 to 3.3 |
| HADS anxiety | 5.8 (2.8) | 6 (4 to 7) | 1 to 11 |
| HADS depression | 4.1 (2.3) | 3 (3 to 6) | 1 to 10 |
| HADS total | 9.9 (4.6) | 9 (7 to 12) | 2 to 21 |

**a:**BODE score- The body-mass index, airflow obstruction, dyspnoea and exercise capacity index in COPD [29] **b** Some participants had multiple comorbidities.

FEV1- forced expiratory volume in one second, FVC- forced vital capacity, TLC- total lung capacity RV- residual volume, SpO2-oxygen saturation measured by a pulse oximeter, 6MWT- six-minute walk test, BMI- body mass index, CCQ- clinical COPD questionnaire, HADS- hospital anxiety and depression score.

There was strong evidence for an increase in 6MWT after four months, with a mean increase of 28 (95%CI 5 to 52) m, p = 0.019, increasing further to 65 (95%CI 35 to 99) m, p <0.001 at one year. HADS Anxiety scores were lower at one year with a mean change from baseline of -0.9 (95%CI -1.8 to -0.1) p = 0.038. Lung function tests showed a reduction in RV, mean decrease 130 (95%CI -250 to -3) ml, p =0.046 and total lung capacity, mean decrease 150 (95%CI -290 to -20) ml, p = 0.023 after four months, but no significant differences at 12 months compared to baseline. The questionnaire and clinical measurements, and their changes are shown in Table 2.

199 Table 2: Changes from baseline in lung function, questionnaires and hospital admission days.

| | Mean (SD) | | | Difference from baseline (95% CI) | |
|---|---|---|---|---|---|
| **Variable** | **Baseline N=21** | **Four months N=21** | **One year N=18** | **Four months** | **One year** |
| FEV1 (L) | 1.32 (0.5) | 1.34 (0.5) | 1.44 (0.5) | 0.02 (-0.01 to 0.06) P=0.21 | 0.04 (-0.05 to 0.12) P=0.44 |
| FEV1% | 60.3 (21.1) | 61.9 (22.3) | 64.5 (20.2) | 1.6 (-0.1 to 3.4) P=0.065 | 2.4 (-1.4 to 6.1) P=0.21 |
| FVC (L) | 2.85 (0.9) | 2.81 (0.92) | 2.91 (0.97) | -0.04 (-0.15 to 0.06) P=0.38 | -0.04 (-0.17 to 0.09) P=0.50 |
| FVC% | 103.5 (26.9) | 103.1 (30.4) | 107.0 (24.8) | -0.5 (-4.5 to 3.6) P=0.81 | -0.02 (-4.5 to 4.4) P=0.99 |
| FEV1/FVC | 0.47 (0.14) | 0.48 (0.13) | 0.50 (0.12) | 0.01 (-0.004 to 0.03) P=0.13 | 0.02 (-0.002 to 0.03) P=0.08 |
| TLC (L) | 6.38 (1.99) | 6.22 (1.86) | 6.23 (1.7) | -0.15 (-0.29 to -0.02) P=0.023 | -0.04 (-0.21 to 0.13) P=0.61 |
| TLC% | 117.8 (20.9) | 115.2 (20.2) | 116.4 (20.8) | -2.6 (-4.8 to -0.4) P=0.021 | -0.7 (-3.7 to 2.3) P=0.61 |
| RV (L) | 3.39 (1.52) | 3.27 (1.44) | 3.22 (1.18) | -0.13 (-0.25 to -0.003) P=0.046 | 0.06 (-0.16 to 0.27) P=0.58 |
| RV% | 156.1 (59.9) | 150.2 (57.1) | 145.7 (44.1) | -5.9 (-11.5 to -0.3) P=0.04 | 1.3 (-7.8 to 10.3) P=0.77 |
| IC (L) | 2.29 (0.86) | 2.35 (0.83) | 2.33 (0.87) | 0.06 (-0.03 to 0.15) P=0.18 | -0.07 (-0.18 to 0.04) P=0.21 |
| IC% | 107.2 (27.2) | 110.1 (25.7) | 108.6 (24.3) | 3.0 (-1.8 to 7.7) P=0.21 | -2.9 (-9.3 to 3.5) P=0.35 |
| IC/TLC | 0.37 (0.09) | 0.39 (0.09) | 0.38 (0.09) | 0.02 (0.001 to 0.03) P=0.037 | -0.01 (-0.03 to 0.01) P=0.36 |
| RV/TLC | 0.52 (0.09) | 0.52 (0.09) | 0.52 (0.09) | -0.01 (-0.02 to 0.01) P=0.45 | 0.01 (-0.01 to 0.03) P=0.35 |
| 6MWT (m) | 300 (110) | 328 (118) | 377 (104) | 28 (5 to 52) P=0.019 | 65 (35 to 99) P<0.001 |
| CCQ | 2.11 (0.83) | 2.08 (0.86) | 2.31 (1.04) | -0.03 (-0.31 to 0.26) P=0.84 | 0.26 (-0.04 to 0.57) P=0.08 |
| HADS Anxiety | 5.8 (2.8) | 5.81 (3.52) | 4.67 (3.2) | 0 (-1.2 to 1.2) P=0.99 | -0.9 (-1.8 to -0.1) P=0.038 |
| HADS Depression | 4.1 (2.3) | 3.19 (2.56) | 4.0 (3.91) | -0.9 (-2.1 to 0.2) P=0.11 | 0.1 (-1.3 to 1.6) P=0.85 |

| | | | | | |
|---|---|---|---|---|---|
| HADS Total | 9.9 (4.6) | 9.0 (5.7) | 8.7 (6.4) | -0.9 (-3.0 to 1.2) P=0.37 | -0.8 (-2.6 to 1.0) P=0.35 |
| | | | | | |
| | | **12 months prior to enrolment** | **12 months after enrolment** | **HL estimator (95% CI)** | |
| **Hospital admission days for AECOPD N=20* Mean (SD)** | | 3.6 (7.9) | 2.7 (7.3) | -1.0 (-8.5 to 3.0) P=0.40 | |

FEV1, Forced expiratory volume in 1 s; FVC, forced vital capacity; TLC, total lung capacity; RV, residual volume; FRC, functional residual capacity; IC, inspiratory capacity. AECOPD, Acute exacerbation of COPD. * Excluding one patient who had lung transplant between 4 months and 1-year follow-up assessments.

## DISCUSSION

This study has shown that recruitment and retention of patients with COPD to a community singing group (SG) is feasible. The high attendance rate over one year, mean 85%, supports the acceptability and feasibility of this intervention. In this study, participation in a weekly community-based singing group for one year is associated with increased exercise capacity and reduced anxiety in patients with COPD who have completed PR and are attending a community exercise group.

We were surprised by the high long-term attendance rate, for this cohort of patients with significant respiratory disease and comorbidities, including two participants with very severe COPD, one of whom had a lung transplant four months after joining the singing group. The qualitative data from this project, reported separately, showed that most participants had not been previously interested in singing and considered the singing group a fun social activity more than a musical endeavour.[21] The reduction in HADS anxiety scores confirms previous research [15] but this is the first report of statistically and clinically significant improvement in 6MWT with this type of intervention. The mean reduction in HADS anxiety score of 0.9 units at one year did not exceed the minimal clinically important difference (MCID) of 1.32.[30] The mean increase in 6MWT of 65m at one year was greater than the MCID of 30m.[31] This is the first report of serial RV measurement in COPD patients attending a singing group over one year. The small (130ml) statistically significant reduction in RV after four months but not 12 months may reflect type I error rate inflation, and so be due to the play of chance. A

previous small COPD study showed a median fall in RV of 270ml in four patients after 10 weeks of singing classes.[19] On the other hand, Bonilha and colleagues did not find any significant change in RV in 15 participants after 24 weeks of singing classes.[18] They did report a small but statistically significant difference in RV two minutes after a short singing session in subjects from the singing group (where RV reduced) and a control group (where RV increased) but no difference between the groups at 30 minutes.[18] Although the reduction in hospital admission days for AECOPD per year was not statistically significant, the point estimate was almost one day less per participant in the year attending singing group, compared to the year before starting (excluding the patient who had a lung transplant during the year). The actual cost of running the singing group for 12 months was approximately $NZ4,000 (GBP 2,363). Any significant reduction in hospital bed days, even one day per patient per year, as a result of the intervention would likely make this low cost intervention cost effective.

Strengths of this study are the one year duration, high retention rates, comprehensive pulmonary function tests and low-cost community setting. Previously reported studies of singing intervention for COPD have generally been of short duration, mostly 6-10 weeks.[15,16,18,19] In contrast to studies using professional singing teachers and physiotherapists, we used amateur singing group facilitators, with musical experience and strong group facilitation skills. Our findings confirm those of Morrison and colleagues who showed medium-term (ten months) feasibility for community singing groups for people with COPD in the UK but they had a significantly higher attrition rate.[20] A significant component of our study was that participants had both completed a PR programme and were enrolled in a weekly maintenance exercise programme. These are likely to be people more motivated to manage their own health and who had already demonstrated an ability to attend weekly sessions. It is possible that some of the benefit in reduced hospital admissions could be explained by recent completion of PR.[32] These results can't be readily generalised to a population of people with COPD who have declined or not been offered PR. We believe there may be a role for SG participation for people with COPD who decline PR and have started a controlled study testing this hypothesis (www.anzctr.org.au registry number ACTRN12616000584437). Limitations of our study include that the

6MWT was only performed once at each visit, but participants had all done at least one 6MWT as part of their recent PR programmes so any learning effect is likely to have been minimised.[33] Singing group members remained enrolled in maintenance exercise classes after PR, as recommended by international guidelines [32]. There is conflicting evidence as to whether maintenance exercise classes preserve the benefits on exercise capacity of PR, but no evidence that maintenance exercise classes improve exercise capacity in people who have completed PR [32]. On average, our participants had been attending exercise classes for approximately one year prior to singing group enrolment and mean 6MWT distance at commencement of singing group was substantially lower than the 6MWT distance at the end of the PR programme for the 14 participants with complete data from the preceding PR programme. This suggests a low likelihood that the substantial improvement in 6MWT distance during 12 months of SG participation could be explained by exercise class attendance alone. The presence of a PR nurse at the singing sessions may have been important. Her role was in 'meeting and greeting' participants, general encouragement to attend, supervising refreshments and organising transport for performances. There was no formal or informal exercise advice provided. In the interviews that formed the qualitative component of this project [21], a key theme was being cared for in a safe environment and the PR nurse presence contributed to this. All participants received usual medical care so therapeutic changes may have affected some, but not all, of the participants. This is a relatively small cohort study without a control group so both type I and type II errors are possible. This analysis also includes a large number of hypothesis tests which inflate the type 1 error rate.

Our findings are relevant to the question of sustaining the benefits of pulmonary rehabilitation. A possible mechanism for singing group effectiveness is the promotion of physical activity which is considered to be a critical component of PR.[34] Our qualitative data showed that for many patients, attending the weekly singing group was a most enjoyable highlight of their week and worth the extra physical activity it took to get there.[21]. In contrast to other studies[15–18] our singing group intervention focussed on fun group singing with no specific breathing exercises. The impact of breathing exercises alone or in addition to singing remains uncertain.[35] Our group met weekly with

singing duration of 35 minutes, and no explicit practice at home. It is possible that there is a dose-response relationship, with increased benefit with more frequent singing group classes and singing practice at home. With the very high attendance rate we were not able to attempt an analysis for a dose-response relationship between attendance and outcomes.

Our qualitative analysis showed singing group participation was associated with an increased sense of social connection, purpose and meaningful participation which may explain the reduction in anxiety.[21] Although there seems to be an association between anxiety in COPD patients, their health status, and the frequency of AECOPD and hospitalisation, it is complex.[36] However, the reduction in anxiety and increased exercise capacity observed in this study points to the potential for reducing readmissions and supports the use of exercise capacity and readmission for AECOPD, as primary outcome measures for a future randomised controlled trial (RCT).

We believe our results could be replicated by others given recruitment from a typical hospital PR programme and the practical, low cost approach to running the singing group, including community venue and the use of amateurs for singing group facilitation. We have made available on-line our “10 practical top tips” document for setting up and running a community singing group for people living with COPD (see online supplement). We have been able to sustain this intervention long term, free to patients, as it was set up and financed by a charitable trust. The singing group is still going strong after twenty-four months with high attendance including almost all of the founding members, avoiding the ethical issue of withdrawing the intervention at study completion.

## CONCLUSIONS

Our findings support the feasibility of long-term participation in a community singing group for breathless adults with COPD who have completed PR and are enrolled in a weekly community exercise group and provide evidence of improvement in exercise capacity and reduction in anxiety. These results can inform sample size and selection of outcome measures for a future RCT.

**Figure legend:**

Figure 1: Study overview

COPD = chronic obstructive pulmonary disease, PR= pulmonary rehabilitation, AECOPD = acute exacerbation of COPD, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity, GOLD = Global Initiative for Chronic Obstructive Lung Disease

**Acknowledgements** We are grateful to Ruth Collingham and Jackie McAuliffe for running the *Sing Your Lungs Out* Singing Group and to all the patients for their participation.

**Contributors** AM conceived the idea of the study, designed the protocol, wrote the first and final drafts of the manuscript, was the senior investigator, and will act as guarantor**.** SA, HM, MWi, GW, MWe, RB helped design and plan the study and helped write the first and final drafts of the manuscript. GW, AM recruited patients to the study. MWi, AM collected data. MWe was responsible for the analysis.

**Funding** This study was supported by the Medical Research Institute of New Zealand. Sing Your Lungs Out is run by the COPD Choir Trust, a volunteer-run registered charity, which received grants in 2015 from the Wellington City Council and Infinity Foundation Community Trust.

**Competing interests** None

**Ethics approval** This study was approved by the Wellington Hospital Research Governance Group on 23 September 2014

**Data sharing** No additional data are available

**REFERENCES**

1 Mannino DM, Buist AS. Global burden of COPD: risk factors, prevalence, and future trends. *Lancet* 2007;**370**:765–73. doi:10.1016/S0140-6736(07)61380-4

2 Rennard SI, Vestbo J. Natural histories of chronic obstructive pulmonary disease. *Proc Am Thorac Soc* 2008;**5**:878–83. doi:10.1513/pats.200804-035QC

3 Yohannes AM, Alexopoulos GS. Depression and anxiety in patients with COPD. *Eur Respir Rev* 2014;**23**:345–9. doi:10.1183/09059180.00007813

4 Martinez Rivera C, Costan Galicia J, Alcázar Navarrete B, *et al.* Factors Associated with

Depression in COPD: A Multicenter Study. *Lung* 2016;**194**:335–43. doi:10.1007/s00408-016-9862-7

5 Kew KM, Dias S, Cates CJ. Long-acting inhaled therapy (beta-agonists, anticholinergics and steroids) for COPD: a network meta-analysis. In: Kew KM, ed. *Cochrane Database of Systematic Reviews*. Chichester, UK: : John Wiley & Sons, Ltd 2014. doi:10.1002/14651858.CD010844.pub2

6 NICE. Chronic obstructive pulmonary disease in over 16s: diagnosis and management | Guidance and guidelines | NICE. 2010.https://www.nice.org.uk/guidance/CG101 (accessed 21 Aug2016).

7 Agusti A. The path to personalised medicine in COPD. *Thorax* 2014;**69**:857–64. doi:10.1136/thoraxjnl-2014-205507

8 Ernst P, Saad N, Suissa S. Inhaled corticosteroids in COPD: the clinical evidence. *Eur Respir J* 2014;:525–37. doi:10.1183/09031936.00128914

9 McCarthy B, Casey D, Devane D, *et al.* Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2015;**2**:CD003793. doi:10.1002/14651858.CD003793.pub3

10 Celli BR, Decramer M, Wedzicha J, *et al.* An official American Thoracic Society/European Respiratory Society statement: research questions in COPD. *Eur Respir J* 2015;**45**:879–905. doi:10.1183/09031936.00009015

11 Watson A. Breathing in Singing. In: Welch G, Howard D, Nix J, eds. *The Oxford Handbook of Singing*. Oxford University Press 2014. doi:10.1093/oxfordhb/9780199660773.013.10

12 Clift S, Hancox G, Morrison I, *et al.* Choral singing and psychological wellbeing: Quantitative and qualitative findings from English choirs in a cross-national survey. *J Appl Arts Heal* 2010;**1**:19–34.

13 Clark I, Harding K. Psychosocial outcomes of active singing interventions for therapeutic purposes: a systematic review of the literature. *Nord J Music Ther* 2012;**21**:80–98. doi:10.1080/08098131.2010.545136

14 Reagon C, Gale N, Enright S, *et al.* A mixed-method systematic review to investigate the effect of group singing on health related quality of life. *Complement Ther Med* 2016;**27**:1–11. doi:10.1016/j.ctim.2016.03.017

15 Lord VM, Cave P, Hume VJ, *et al.* Singing teaching as a therapy for chronic respiratory disease--a randomised controlled trial and qualitative evaluation. *BMC Pulm Med* 2010;**10**:41. doi:10.1186/1471-2466-10-41

16 Lord VM, Hume VJ, Kelly JL, *et al.* Singing classes for chronic obstructive pulmonary disease: a randomized controlled trial. *BMC Pulm Med* 2012;**12**:69. doi:10.1186/1471-2466-12-69

17 Goodridge D, Nicol JJ, Horvey KJ, *et al.* Therapeutic Singing as an Adjunct for Pulmonary Rehabilitation Participants With COPD: Outcomes of a Feasibility Study. *Music Med* 2013;**5**:169–76. doi:10.1177/1943862113493012

18 Bonilha AG, Onofre F, Vieira ML, *et al.* Effects of singing classes on pulmonary function and quality of life of COPD patients. *Int J COPD* 2009;**4**:1–8. doi:10.2147/COPD.S4077

19 Pacheco C, Costa A, Amado J, *et al.* Singing in chronic obstructive pulmonary disease patients: A pilot study in Portugal. *Rev Port Pneumol* 2014;**20**:225–8. doi:10.1016/j.rppneu.2014.02.009

20 Morrison I, Clift SM, Page S et al. A UK feasibility study on the value of singing for people with Chronic Obstructive Pulmonary Disease (COPD). UNESCO Observatory Multi-Disciplinary Journal in the Arts 2013:3;1-19

21 McNaughton A, Aldington S, Williams G, *et al.* Sing Your Lungs Out: A qualitative study of a community singing group for people with Chronic Obstructive Pulmonary Disease (COPD). *BMJ Open* 2016;**6**:e012521 doi:10.1136/bmjopen-2016-012521

22 Global Strategy for Diagnosis, Management, and Prevention of COPD - 2016 - Global Initiative for Chronic Obstructive Lung Disease - GOLD. http://goldcopd.org/global-strategy-diagnosis-management-prevention-copd-2016/

23 Bjelland I, Dahl A, Haug T, *et al.* The validity of the Hospital Anxiety and Depression Scale: an updated literature review. *J Psychosom Res* 2002;52:69-77

24 van der Molen T, Willemse BWM, Schokker S, *et al.* Development, validity and responsiveness of the Clinical COPD Questionnaire. *Health Qual Life Outcomes* 2003;**1**:13.

25 Clausen JL, Coates AL, Quanjer PH. Measurement of lung volumes in humans: review and recommendations from an ATS/ERS workshop. *Eur Respir J* 1997;10:1205–6

26 ATS Statement: Guidelines for the Six-Minute Walk Test. *Am Thorac Soc Am J Respir Crit Care Med* 2002;**166**:111–7. doi:10.1164/rccm.166/1/111

27 Shirtcliffe P, Weatherall M, Marsh S, *et al*. COPD prevalence in a random population survey: a matter of definition. *Eur Respir J* 2007;30:232–9

28 Ministry of Health New Zealand. District health board Maori health plans profiles and needs assessments. 2015.http://www.health.govt.nz/publication/dhb-maori-health-profiles

29 Celli BR, Cote CG, Marin JM, *et al.* The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *NEJM* 2004;350:1005–12. doi:10.1056/NEJMoa021322

30 Puhan MA, Frey M, Büchi S, *et al.* The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease. *Health Qual Life Outcomes* 2008;**6**:46. doi:10.1186/1477-7525-6-46

31 Holland AE, Nici L. The Return of the Minimum Clinically Important Difference for 6-Minute-Walk Distance in Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 2013;187:335–6. doi:10.1164/rccm.201212-2191ED

32 Bolton CE, Bevan-Smith EF, Blakey JD, et al. British Thoracic Society guideline on pulmonary rehabilitation in adults. *Thorax* 2013;68:ii1–ii30.

33 Holland AE, Spruit MA, Troosters T, *et al.* An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J* 2014;**44**:1428–46. doi:10.1183/09031936.00150314

34 Spruit MA, Pitta F, McAuley E, *et al.* Pulmonary Rehabilitation and Physical Activity in Patients with Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med*

2015;**192**:924–33. doi:10.1164/rccm.201505-0929CI

35 Holland AE, Hill CJ, Jones AY, *et al.* Breathing exercises for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* Published Online First: 2012. doi:10.1002/14651858.CD008250.pub2

36 Pooler A, Beech R. Examining the relationship between anxiety and depression and exacerbations of COPD which result in hospital admission: a systematic review. *Int J Chron Obs Pulmon Dis* 2014;**9**:315–30.

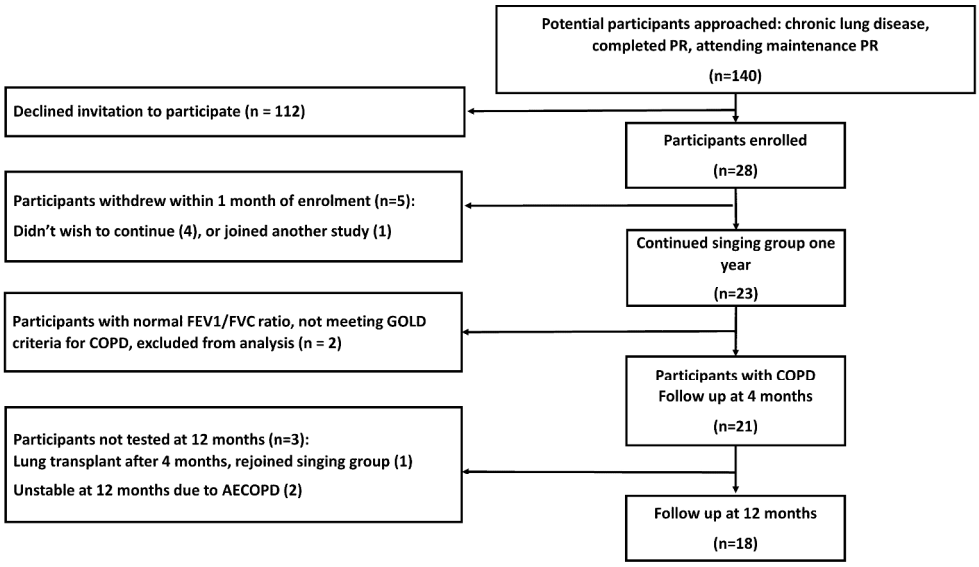



Figure 1: Study overview.
COPD = chronic obstructive pulmonary disease, PR= pulmonary rehabilitation, AECOPD = acute exacerbation of COPD, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity, GOLD = Global Initiative for Chronic Obstructive Lung Disease

Figure 1 shows the study overv
338x190mm (300 x 300 DPI)

# Setting up a singing group like Sing Your Lungs Out

We provide links below to two short videos of this singing group and a "10 practical top tips" document for setting up a community singing group for people living with COPD which we hope will inform, motivate and encourage others to set up singing groups.

https://www.dropbox.com/sc/boc5sr7hkcbi6tz/AAAlbUQqOWyvDeJGTnoXVcg-a?preview=NO_Graphics_02.mp4

https://www.youtube.com/watch?v=fduau0jV09o

http://www.mrinz.ac.nz/pdfs/How_to_set_up_SYLO.pdf

STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation | |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Pilot in study title. |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Yes |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Yes Introduction para 1-3, pg3-4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Yes Introduction para 4, pg 4. No hypotheses, this was a feasibility study. |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Methods, para 1, pg 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Methods, para 1, pg 5 and under 'Singing Group Intervention' pg 6. Specific dates are in first line of Results, pg 7 |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br>*Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls<br>*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants | Methods, para 1, pg 5 |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed<br>*Case-control study*—For matched studies, give matching criteria and the number of controls per case | No matched control group |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | Methods, 'data collection', pg 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | Methods, 'Data collection', pg 5 |

| | | | |
|---|---|---|---|
| Bias | 9 | Describe any efforts to address potential sources of bias | Objective lung function tests measured by scientist blinded to previous results. Self reported questionnaires |
| Study size | 10 | Explain how the study size was arrived at | Convenience sample, twice the size of previous studies. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | Methods, 'Analysis', pg 6 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Methods, 'Analysis', pg 6 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | N/A |
| | | (*c*) Explain how missing data were addressed | N/A |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy | Results, para 1, pg 7 and Figure 1 Study overview |
| | | (*e*) Describe any sensitivity analyses | N/A |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Results, para 1, pg 7 and Study overview Figure 1 |
| | | (b) Give reasons for non-participation at each stage | Results, para 1 and figure 1 |
| | | (c) Consider use of a flow diagram | Figure 1 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Results, para 2, pg 7 and Table 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table 1 |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) | Result, para 1,pg 7 |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time | Results, para 3, pg 9 and Table 2 and Figure 2 |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure | |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if | Admission days adjusted. Other |

| | | | |
|---|---|---|---|
| | | applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | results unadjusted. Table 2 |
| | | (*b*) Report category boundaries when continuous variables were categorized | N/A |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | N/A feasibility study |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Discussion para1 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Discussion para 3, pg 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Discussion para 4 and 5, pg 12-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Discussion para 6, pg 13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Funding statement pg 14 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

| | |
|---|---|
| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2016-014151.R3 |
| Article Type: | Research |
| Date Submitted by the Author: | 29-Nov-2016 |
| Complete List of Authors: | McNaughton, Amanda; Medical Research Institute of New Zealand, Respiratory Medicine; Wellington Hospital, Respiratory Medicine<br>Weatherall, Mark; University of Otago Wellington,<br>Williams, Mathew; Medical Research Institute of New Zealand,<br>McNaughton, Harry; Medical Research Institute of New Zealand<br>Aldington, Sarah; Wellington Hospital, Capital and Coast District Health Board, Emergency Medicine<br>Williams, Gayle; Capital and Coast District Health Board, Community Health Services<br>Beasley, Richard; Medical Research Institute of New Zealand, |
| Primary Subject Heading: | Respiratory medicine |
| Secondary Subject Heading: | Patient-centred medicine |
| Keywords: | Chronic Obstructive Pulmonary Disease, Pulmonary Rehabilitation, Singing |
| | |

# Sing Your Lungs Out- A community singing group for chronic obstructive pulmonary disease: a one-year pilot study

Amanda McNaughton[1,2], Mark Weatherall[3], Mathew Williams[1], Harry McNaughton[1], Sarah Aldington[1,4], Gayle Williams[5], Richard Beasley[1,2]

[1] Medical Research Institute of New Zealand, Wellington, New Zealand

[2] Department of Respiratory Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[3] Department of Medicine, University of Otago, Wellington, New Zealand

[4] Department of Emergency Medicine, Capital and Coast District Health Board, Wellington, New Zealand

[5] Department of Community Health, Capital and Coast District Health Board, Wellington, New Zealand

Corresponding author:

Amanda McNaughton

Medical Research Institute of New Zealand,

Wellington Hospital

Private Bag 7902

Wellington 6021 New Zealand

0064 27 838 6925

amanda.mcnaughton@ccdhb.org.nz

## ABSTRACT

**Objective** Singing group participation may benefit patients with chronic obstructive pulmonary disease (COPD). Previous studies are limited by small numbers of participants and short duration of generally, hospital-based singing group intervention. This study examines the feasibility of long-term participation in a community singing group for patients with COPD who had completed pulmonary rehabilitation (PR).

**Methods** This was a feasibility cohort study. Patients with COPD who had completed PR and were enrolled in a weekly community exercise group, were recruited to a new community-based singing group which met weekly for over one year. Measurements at baseline, four months and one year comprised comprehensive pulmonary function tests including lung volumes, six minute walk test (6MWT), Clinical COPD Questionnaire (CCQ), Hospital Anxiety and Depression Scale (HADS), and hospital admission days for acute exacerbation of COPD (AECOPD) for one year before and after the first singing group session.

**Findings** There were 28 participants with chronic lung disease recruited from 140 people approached. Five withdrew in the first month. Twenty-one participants meeting GOLD criteria for COPD completed four-month, and 18 completed one-year assessments. The mean attendance was 85%. For the pre-specified primary outcome measure, total HADS score, difference between baseline and 12 months was -0.9, 95% CI -3.0 to 1.2, p = 0.37. Of the secondary measures, a significant reduction was observed for HADS Anxiety Score after one year of -0.9 (95% CI -1.8 to -0.1) points, P=0.038 and an increase in the 6MWT at one year, of 65 (95% CI 35 to 99) m compared to baseline P<0.001.

**Conclusions** Our findings support the feasibility of long-term participation in a community singing group for adults with COPD who have completed PR and are enrolled in a weekly

community exercise group and provide evidence of improved exercise capacity and a reduction in anxiety.

**Strengths and limitations of this study:**

- High attendance and retention rates over one-year follow-up support the feasibility of this intervention.
- Recruitment from a typical hospital PR programme and low cost community setting of the singing group supports the practicality and reproducibility of the intervention
- This is the first report of serial lung volume measurements in COPD patients attending a singing group over one year.
- This is a relatively small cohort study.

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD), characterised by persistent airflow limitation that is usually progressive, is an increasingly common syndrome.[1] Common symptoms include progressive breathlessness, cough and sputum production as well as anxiety and depression.[2,3] The chronic breathlessness in COPD is physically limiting and socially isolating, adding further to depression and anxiety.[4] Current pharmacological options have limited benefits and significant adverse effects driving the need for cost-effective, non-pharmacological, person-centred, community-based interventions.[5–8] Pulmonary Rehabilitation (PR) is one of the most effective therapies for COPD, improving quality of life, exercise tolerance, and breathlessness.[9] An important research question is how the benefits of PR can be sustained and augmented.[10]

There is a growing interest in the therapeutic potential of singing for COPD. Singing involves inspiratory expansion (using the diaphragm, external intercostal, and accessory muscles), active exhalation (incremental recruitment of abdominal and internal intercostal muscles) and optimal posture.[11] Singing, therefore, has the potential to improve breathing control and posture, and theoretically to reduce residual volume (RV), which is a manifestation of lung hyperinflation. Improvement in psychological wellbeing has been reported in healthy subjects and people with a variety of chronic conditions participating in singing groups.[12–14]

Two randomised controlled trials of singing group interventions in COPD report improvements in quality of life and reduction in anxiety, although not in lung function.[15,16], One study examining the effects of adding therapeutic singing to PR programme showed no benefit in quality of life or exercise tolerance,[17] whilst two studies have reported improvement in maximal expiratory pressure.[18,19] The limitations of these studies include small sample sizes and short duration.[15–19] A non-experimental feasibility study of singing group intervention for people with COPD in the United Kingdom recruited 106 people into 6 singing groups, and followed the group for ten months. [20] In that report it was unclear if the participants had participated in PR before the singing intervention. That study reported a 34% attrition rate and small statistically significant differences in St Georges Respiratory

Questionnaire as well as spirometry parameters measured by a portable spirometry device. We wished to explore whether singing group participation as an intervention, is acceptable and sustainable for a longer time period with adequate retention rates, to a broad group of COPD patients who had completed PR and whether the benefits can be achieved in a community setting taking a low-cost, pragmatic approach that might be easily reproducible in other centres. We are interested in the potential of singing group participation for patients with COPD as a means to sustain the benefits of PR. We are also interested in identifying measures sensitive to change during the intervention period and the feasibility of this measurement. The effects of singing group participation on hyperinflation and lung function in COPD patients remain unclear and we wished to measure both spirometry and lung volumes over a significant time period in singing group participants, looking for any effect on residual volume as well as airflow.

The purpose of this cohort study was to assess the feasibility of community singing group participation for one year, for breathless patients with COPD who had completed PR. We report here the quantitative results of the study, the qualitative results are reported separately.[21]

## METHODS

This was a prospective feasibility study. Patients with COPD or another chronic lung disease, who had completed an eight-week, hospital-based PR programme, and were enrolled in a weekly community exercise class, were invited by the PR nurse to join a new community-based singing group for the purposes of this study. The invitation was to the group as a whole and no individual approach was made. The group was based in Wellington, New Zealand. In our institution, patients are enrolled in PR programmes if they have chronic lung disease and a Modified Medical Research Council dyspnoea scale of at least grade 2. All patients completing a PR programme are encouraged to enrol in a weekly community exercise class. We report on those participants with physician-diagnosed COPD based on GOLD criteria.[22] There were no further recruitment restrictions based on age, severity of disease, cognition, singing ability, or co-morbidities. The study was approved by the Wellington Hospital Research Governance Group, and all patients gave written informed consent. The trial was registered at www.anzctr.org.au, registry number ACTRN12615000736549.

### Data collection

Patient demographics, pulmonary function tests, six-minute walk test (6MWT), Hospital Anxiety and Depression Scale (HADS)[23] and the Clinical COPD Questionnaire (CCQ)[24] were measured at baseline, four months and one year after enrolment. Spirometry and lung volumes including forced expiratory volume in 1s (FEV1), forced vital capacity (FVC), total lung capacity (TLC), residual volume (RV), functional residual capacity (FRC) and inspiratory capacity (IC) were measured according to ATS/ERS standards (body volume constant plethysmography Masterlab, Erich-Jaeger, Wurzburg, Germany) using the reference values of the European Community for Coal and Steel (ECCS).[25] Short-acting bronchodilator therapy was withheld for four hours prior to testing, and patients were tested when clinically stable, and not within two weeks of an exacerbation. Six-minute walk test (6MWT) was performed according to international guidelines [26] except that only one test was performed at each measurement point, rather than the recommended two. All participants had performed at least one, and mostly two, 6MWT previously as part of their PR programme.

The respiratory scientist performing the pulmonary function tests was masked to the results of previous assessments. Questionnaires were self-completed. Each patient's electronic health record was searched for diagnosis, comorbidities and admissions where the primary discharge code was an acute exacerbation of COPD. Hospital admission data for acute exacerbation of COPD were recorded for the 12 months before enrolment and 12 months starting from the date of enrolment. PR programme information, the date, sessions attended, and 6MWT results at entry and completion, were obtained from the PR nurse who runs the programme.

**Singing group intervention**

The singing group (Sing Your Lungs Out) met for one hour, weekly, in an urban community hall, continuously throughout the study period. An amateur singing group facilitator (SGF) led the group and a PR nurse attended all sessions. Each rehearsal comprised a five minute warm up session, 35 minutes singing, a five minute warm down and 15 minutes social morning-tea time. It was run free of charge to patients. The SGF and the group chose the singing repertoire together, including a wide mix of genres (eg pop, musicals, traditional Māori songs, folk songs, rounds) with attention to the group's voice range and capacity for phrase lengths. The SGF also discussed breathing for singing techniques as the year progressed and as the group gained confidence. No music reading ability was required. We made recordings of songs to allow practice at home although this was optional. Collaboration with a local boys' high school developed from student piano accompaniment to working with the senior boys' chorale including some joint performances. Over the year, the participants delivered six public performances, supported by the senior chorale from the local school on four occasions. Singing group members remained enrolled in the community exercise classes, as well as singing group.

**Analysis**

Continuous variables were compared using a mixed linear model for most variables with an unstructured variance-covariance correlation structure. Hospital admission days were right skew and were compared with a paired Wilcoxon test and Hodges-Lehmann estimator of the difference. Although individual comparisons are presented with 95% confidence intervals a large number of statistical tests have been carried out and this will inflate the Type I error rate. SAS version 9.4 was used.

## RESULTS

Out of 140 people with chronic lung disease approached, 28 participants (20%) were enrolled in the singing group in five months: October 2014 to February 2015. The mean (SD) time from completion of past PR was 1.2 (1.2) years. Response to past PR by the change in 6MWT was available for 14 participants and for these participants the distance had improved from a mean (SD) of 316 (126) m to 356 (148) m. Five participants withdrew within one month of enrolment as they did not wish to continue (n=4) or were recruited into another study (n=1). At baseline assessment, twenty-one participants had COPD as defined by GOLD criteria[22] but two participants had normal FEV1/FVC ratio on spirometry with a clinical diagnosis of interstitial lung disease. They continued to attend singing group but were excluded from this analysis. The 21 participants with COPD attended the singing group for at least one year and had measurements at enrolment and after four months. Eighteen participants were reassessed after 12 months: one had undergone lung transplant and two had such frequent exacerbations that stable follow-up testing was not possible. Figure 1 shows the study overview.

The participants with COPD had a wide range of disease severity and comorbidities. Mean (SD) FEV1% at baseline was 60.3 (21.1), median 57.1, range 14.6-110. The majority (66%) of participants had moderate COPD by GOLD criteria but 20% had severe or very severe COPD, similar to the proportions of COPD severity in the NZ community.[27] Six patients (29%) had an FEV1 at baseline of less than one litre. Common comorbidities were bronchiectasis, congestive cardiac failure, diabetes, and obesity. Six of 21 (29%) were Māori, consistent with the higher prevalence of COPD in Māori in New Zealand who constitute only 6% of the total population over 50 years.[28] The mean (SD) attendance rate for the 12 months was 85% (12.1). Table 1 shows characteristics of the study population at baseline.

Table 1 Characteristics of the study population

| | | | |
|---|---|---|---|
| | N=21 | | |
| Age (years) mean (SD) [range] | 68.8 (9.8) [51 to 91] | | |
| Sex | N/21 (%) | | |
| Men | 8 (38) | | |
| Women | 13 (62) | | |
| Ethnicity | | | |
| European | 14 (67) | | |
| Maori | 6 (29) | | |
| Asian | 1 (5) | | |
| Smoking history | | | |
| Current smoker | 1 (5) | | |
| Ex-smoker | 18 (86) | | |
| Never smoker | 2 (10) | | |
| COPD severity (FEV1% predicted) | | | |
| ≥80% (mild) | 3 (14) | | |
| 50-79% (moderate) | 14 (66) | | |
| 30-49% (severe) | 2 (10) | | |
| <30% (very severe) | 2 (10) | | |
| COPD mortality risk[a] | | | |
| BODE score: 0-2<br>3-4<br>5-6<br>7-10 | 4 (19)<br>8 (38)<br>6 (29)<br>3 (14) | | |
| Continuous long term domiciliary oxygen therapy | 2 (10) | | |
| Comorbidities[b] | | | |
| Bronchiectasis | 3 (14) | | |
| Heart failure | 6 (29) | | |
| Diabetes | 7 (33) | | |
| Anxiety on treatment | 5 (24) | | |
| Atrial fibrillation | 8 (38) | | |
| Ischaemic Heart Disease | 5 (24) | | |
| | | | |
| **Clinical characteristics** | Mean (SD) | Median (IQR) | Min to max |
| FEV1 (L) | 1.3(0.5) | 1.3 (0.9 to 1.6) | 0.6 to 2.6 |
| FEV1 (% predicted) | 60.3 (21.1) | 57.1 (50 to 72.4) | 14.6 to 110.3 |
| FVC (L) | 2.85 (0.9) | 2.75 (2.2 to 3.0) | 1.8 to 4.9 |
| FVC (%predicted) | 103.5 (26.9) | 102.5 (85.3 to 126.7) | 53.4 to160.4 |
| FEV1/FVC | 0.47 (0.14) | 0.47 (0.36 to 0.56) | 0.22 to 0.68 |
| TLC (L) | 6.38 (1.99) | 5.68 (5.2 to 7.0) | 3.57 to 11.3 |
| RV (L) | 3.39 (1.52) | 3.06 (2.6 to 3.4) | 1.67 to 8.52 |
| SpO2 at rest (%) | 95.4 (2.3) | 96 (93 to 97) | 89 to 99 |
| 6MWT (m) | 300 (110) | 290 (212 to 349) | 132 to 508 |
| BMI (kg/m$^2$) | 29.1 (7.6) | 28.0 (23.9 to 32.5) | 20.1 to 53.0 |
| Questionnaires | | | |
| CCQ | 2.11 (0.83) | 1.9 (1.7 to 2.8) | 0.4 to 3.3 |
| HADS anxiety | 5.8 (2.8) | 6 (4 to 7) | 1 to 11 |
| HADS depression | 4.1 (2.3) | 3 (3 to 6) | 1 to 10 |
| HADS total | 9.9 (4.6) | 9 (7 to 12) | 2 to 21 |

**a:**BODE score- The body-mass index, airflow obstruction, dyspnoea and exercise capacity index in COPD [29] **b** Some participants had multiple comorbidities.

FEV1- forced expiratory volume in one second, FVC- forced vital capacity, TLC- total lung capacity RV- residual volume, SpO2-oxygen saturation measured by a pulse oximeter, 6MWT- six-minute walk test, BMI- body mass index, CCQ- clinical COPD questionnaire, HADS- hospital anxiety and depression score.

There was strong evidence for an increase in 6MWT after four months, with a mean increase of 28 (95%CI 5 to 52) m, p = 0.019, increasing further to 65 (95%CI 35 to 99) m, p <0.001 at one year. HADS Anxiety scores were lower at one year with a mean change from baseline of -0.9 (95%CI -1.8 to -0.1) p = 0.038. Lung function tests showed a reduction in RV, mean decrease 130 (95%CI -250 to -3) ml, p =0.046 and total lung capacity, mean decrease 150 (95%CI -290 to -20) ml, p = 0.023 after four months, but no significant differences at 12 months compared to baseline. The questionnaire and clinical measurements, and their changes are shown in Table 2.

200 Table 2: Changes from baseline in lung function, questionnaires and hospital admission days.

| | Mean (SD) | | | Difference from baseline (95% CI) | |
|---|---|---|---|---|---|
| **Variable** | **Baseline N=21** | **Four months N=21** | **One year N=18** | **Four months** | **One year** |
| FEV1 (L) | 1.32 (0.5) | 1.34 (0.5) | 1.44 (0.5) | 0.02 (-0.01 to 0.06) P=0.21 | 0.04 (-0.05 to 0.12) P=0.44 |
| FEV1% | 60.3 (21.1) | 61.9 (22.3) | 64.5 (20.2) | 1.6 (-0.1 to 3.4) P=0.065 | 2.4 (-1.4 to 6.1) P=0.21 |
| FVC (L) | 2.85 (0.9) | 2.81 (0.92) | 2.91 (0.97) | -0.04 (-0.15 to 0.06) P=0.38 | -0.04 (-0.17 to 0.09) P=0.50 |
| FVC% | 103.5 (26.9) | 103.1 (30.4) | 107.0 (24.8) | -0.5 (-4.5 to 3.6) P=0.81 | -0.02 (-4.5 to 4.4) P=0.99 |
| FEV1/FVC | 0.47 (0.14) | 0.48 (0.13) | 0.50 (0.12) | 0.01 (-0.004 to 0.03) P=0.13 | 0.02 (-0.002 to 0.03) P=0.08 |
| TLC (L) | 6.38 (1.99) | 6.22 (1.86) | 6.23 (1.7) | -0.15 (-0.29 to -0.02) P=0.023 | -0.04 (-0.21 to 0.13) P=0.61 |
| TLC% | 117.8 (20.9) | 115.2 (20.2) | 116.4 (20.8) | -2.6 (-4.8 to -0.4) P=0.021 | -0.7 (-3.7 to 2.3) P=0.61 |
| RV (L) | 3.39 (1.52) | 3.27 (1.44) | 3.22 (1.18) | -0.13 (-0.25 to -0.003) P=0.046 | 0.06 (-0.16 to 0.27) P=0.58 |
| RV% | 156.1 (59.9) | 150.2 (57.1) | 145.7 (44.1) | -5.9 (-11.5 to -0.3) P=0.04 | 1.3 (-7.8 to 10.3) P=0.77 |
| IC (L) | 2.29 (0.86) | 2.35 (0.83) | 2.33 (0.87) | 0.06 (-0.03 to 0.15) P=0.18 | -0.07 (-0.18 to 0.04) P=0.21 |
| IC% | 107.2 (27.2) | 110.1 (25.7) | 108.6 (24.3) | 3.0 (-1.8 to 7.7) P=0.21 | -2.9 (-9.3 to 3.5) P=0.35 |
| IC/TLC | 0.37 (0.09) | 0.39 (0.09) | 0.38 (0.09) | 0.02 (0.001 to 0.03) P=0.037 | -0.01 (-0.03 to 0.01) P=0.36 |
| RV/TLC | 0.52 (0.09) | 0.52 (0.09) | 0.52 (0.09) | -0.01 (-0.02 to 0.01) P=0.45 | 0.01 (-0.01 to 0.03) P=0.35 |
| 6MWT (m) | 300 (110) | 328 (118) | 377 (104) | 28 (5 to 52) P=0.019 | 65 (35 to 99) P<0.001 |
| CCQ | 2.11 (0.83) | 2.08 (0.86) | 2.31 (1.04) | -0.03 (-0.31 to 0.26) P=0.84 | 0.26 (-0.04 to 0.57) P=0.08 |
| HADS Anxiety | 5.8 (2.8) | 5.81 (3.52) | 4.67 (3.2) | 0 (-1.2 to 1.2) P=0.99 | -0.9 (-1.8 to -0.1) P=0.04 |
| HADS Depression | 4.1 (2.3) | 3.19 (2.56) | 4.0 (3.91) | -0.9 (-2.1 to 0.2) P=0.11 | 0.1 (-1.3 to 1.6) P=0.85 |

| | | | | | |
|---|---|---|---|---|---|
| HADS Total | 9.9 (4.6) | 9.0 (5.7) | 8.7 (6.4) | -0.9 (-3.0 to 1.2) P=0.37 | -0.8 (-2.6 to 1.0) P=0.35 |
| | | | | | |
| | | **12 months prior to enrolment** | **12 months after enrolment** | **HL estimator (95% CI)** | |
| **Hospital admission days for AECOPD N=20* Mean (SD)** | | 3.6 (7.9) | 2.7 (7.3) | -1.0 (-8.5 to 3.0) P=0.40 | |

FEV1, Forced expiratory volume in 1 s; FVC, forced vital capacity; TLC, total lung capacity; RV, residual volume; IC, inspiratory capacity; 6MWT- six-minute walk test, CCQ- clinical COPD questionnaire, HADS- hospital anxiety and depression score. AECOPD, Acute exacerbation of COPD. * Excluding one patient who had lung transplant between 4 months and 1-year follow-up assessments.

## DISCUSSION

This study has shown that recruitment and retention of patients with COPD to a community singing group (SG) is feasible. Approximately 20% of people attending a maintenance exercise class following PR accepted the invitation to participate in a new singing group. Recruitment could be increased by individual approaches, repeat approaches and feedback by current participants in the singing group which now has a significant profile in the community. The high attendance rate over one year, mean 85%, supports the acceptability and feasibility of this intervention. In this study, participation in a weekly community-based singing group for one year was associated with increased exercise capacity and reduced anxiety in patients with COPD who have completed PR and were attending a community exercise group.

We were surprised by the high long-term attendance rate, for this cohort of patients with significant respiratory disease and comorbidities, including two participants with very severe COPD, one of whom had a lung transplant four months after joining the singing group. The qualitative data from this project, reported separately, showed that most participants had not been previously interested in singing and considered the singing group a fun social activity more than a musical endeavour.[21] The reduction in HADS anxiety scores confirms previous research [15] but this is the first report of statistically and clinically significant improvement in 6MWT with this type of intervention. The mean

reduction in HADS anxiety score of 0.9 units at one year did not exceed the minimal clinically important difference (MCID) of 1.32.[30] The mean increase in 6MWT of 65m at one year was greater than the MCID of 30m.[31] This is the first report of serial RV measurement in COPD patients attending a singing group over one year. The small (130ml) statistically significant reduction in RV after four months but not 12 months may reflect type I error rate inflation, and so be due to the play of chance. A previous small COPD study showed a median fall in RV of 270ml in the four patients able to be tested, out of eight patients originally recruited, after 10 weeks of singing classes.[19] On the other hand, Bonilha and colleagues did not find any significant change in RV in 15 participants after 24 weeks of singing classes.[18] They did report a small but statistically significant difference in RV two minutes after a short singing session in subjects from the singing group (where RV reduced) and a control group (where RV increased) but no difference between the groups at 30 minutes.[18] The reduction in hospital admission days for AECOPD per year was not statistically significant, with a point estimate of approximately one day less per participant in the year attending singing group, compared to the year before starting (excluding the patient who had a lung transplant during the year). The actual cost of running the singing group for 12 months was approximately $NZ4,000 (GBP 2,363). A future study of singing group intervention could include a health economic analysis to assess cost-effectiveness.

Strengths of this study are the one year duration, comprehensive pulmonary function tests and low-cost community setting. Previously reported studies of singing intervention for COPD have generally been of short duration, mostly 6-10 weeks.[15-19] In contrast to studies using professional singing teachers and physiotherapists, we used amateur singing group facilitators, with musical experience and strong group facilitation skills. Limitations of our study include that the 6MWT was only performed once at each visit, but participants had all done at least one 6MWT as part of their recent PR programmes so any learning effect is likely to have been minimised.[32] This is a relatively small cohort study without a control group so both type I and type II errors are possible. This analysis also includes a large number of hypothesis tests which inflate the type 1 error rate.

Our findings confirm those of Morrison and colleagues who showed medium-term (ten months) feasibility for community singing groups for people with COPD in the UK but they had a significantly higher attrition rate.[20] A significant component of our study was that participants had both completed a PR programme and were enrolled in a weekly maintenance exercise programme. These are likely to be people more motivated to manage their own health and who had already demonstrated an ability to attend weekly sessions. It is possible that some of the benefit in reduced hospital admissions could be explained by recent completion of PR.[33] These results can't be readily generalised to a population of people with COPD who have declined or not been offered PR. We believe there may be a role for SG participation for people with COPD who decline PR and have started a controlled study testing this hypothesis (www.anzctr.org.au registry number ACTRN12616000584437). Singing group members remained enrolled in maintenance exercise classes after PR, as recommended by international guidelines.[33] There is conflicting evidence as to whether maintenance exercise classes preserve the benefits on exercise capacity of PR, but no evidence that maintenance exercise classes improve exercise capacity in people who have completed PR.[33] On average, our participants had been attending exercise classes for approximately one year prior to singing group enrolment and mean 6MWT distance at commencement of singing group was substantially lower than the 6MWT distance at the end of the PR programme for the 14 participants with complete data from the preceding PR programme. This suggests a low likelihood that the substantial improvement in 6MWT distance during 12 months of SG participation could be explained by exercise class attendance alone. The presence of a PR nurse at the singing sessions may have been important. Her role was in 'meeting and greeting' participants, general encouragement to attend, supervising refreshments and organising transport for performances. There was no formal or informal exercise advice provided. In the interviews that formed the qualitative component of this project [21], a key theme was being cared for in a safe environment and the PR nurse presence contributed to this. All participants received usual medical care so therapeutic changes may have affected some of the participants.

Our findings are relevant to the question of sustaining the benefits of pulmonary rehabilitation. A possible mechanism for singing group effectiveness is the promotion of physical activity which is considered to be a critical component of PR.[34] Our qualitative data showed that for many patients, attending the weekly singing group was a most enjoyable highlight of their week and worth the extra physical activity it took to get there.[21]. In contrast to other studies[15–18] our singing group intervention focussed on fun group singing with no specific breathing exercises. The impact of breathing exercises alone or in addition to singing remains uncertain.[35] Our group met weekly with singing duration of 35 minutes, and no explicit practice at home. It is possible that there is a dose-response relationship, with increased benefit with more frequent singing group classes and singing practice at home. With the very high attendance rate we were not able to attempt an analysis for a dose-response relationship between attendance and outcomes.

Our qualitative analysis showed singing group participation was associated with an increased sense of social connection, purpose and meaningful participation which may explain the reduction in anxiety.[21] Although there seems to be an association between anxiety in COPD patients, their health status, and the frequency of AECOPD and hospitalisation, it is complex.[36] However, the reduction in anxiety and increased exercise capacity observed in this study points to the potential for reducing readmissions and supports the use of exercise capacity and readmission for AECOPD, as primary outcome measures for a future randomised controlled trial (RCT).

We believe our results could be replicated by others given recruitment from a typical hospital PR programme and the practical, low cost approach to running the singing group, including community venue and the use of amateurs for singing group facilitation. We have made available on-line our “10 practical top tips” document for setting up and running a community singing group for people living with COPD (see online supplement). We have been able to sustain this intervention long term, free to patients, as it was set up and financed by a charitable trust. The singing group is still going strong after twenty-four months with high attendance including almost all of the founding members, avoiding the ethical issue of withdrawing the intervention at study completion.

## CONCLUSIONS

Our findings support the feasibility of long-term participation in a community singing group for adults with COPD who have completed PR and are enrolled in a weekly community exercise group and provide evidence of improvement in exercise capacity and reduction in anxiety. These results can inform sample size and selection of outcome measures for a future RCT.

**Figure legend:**

Figure 1: Study overview

COPD = chronic obstructive pulmonary disease, PR= pulmonary rehabilitation, AECOPD = acute exacerbation of COPD, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity, GOLD = Global Initiative for Chronic Obstructive Lung Disease

**Acknowledgements** We are grateful to Ruth Collingham and Jackie McAuliffe for running the *Sing Your Lungs Out* Singing Group and to all the patients for their participation.

**Contributors** AM conceived the idea of the study, designed the protocol, wrote the first and final drafts of the manuscript, was the senior investigator, and will act as guarantor**.** SA, HM, MWi, GW, MWe, RB helped design and plan the study and helped write the first and final drafts of the manuscript. GW, AM recruited patients to the study. MWi, AM collected data. MWe was responsible for the analysis.

**Funding** This study was supported by the Medical Research Institute of New Zealand. Sing Your Lungs Out is run by the COPD Choir Trust, a volunteer-run registered charity, which received grants in 2015 from the Wellington City Council and Infinity Foundation Community Trust.

**Competing interests** None

**Ethics approval** This study was approved by the Wellington Hospital Research Governance Group on 23 September 2014

**Data sharing** No additional data are available

## REFERENCES


1 Mannino DM, Buist AS. Global burden of COPD: risk factors, prevalence, and future trends. *Lancet* 2007;**370**:765–73. doi:10.1016/S0140-6736(07)61380-4

2 Rennard SI, Vestbo J. Natural histories of chronic obstructive pulmonary disease. *Proc Am Thorac Soc* 2008;**5**:878–83. doi:10.1513/pats.200804-035QC

3 Yohannes AM, Alexopoulos GS. Depression and anxiety in patients with COPD. *Eur Respir Rev* 2014;**23**:345–9. doi:10.1183/09059180.00007813

4 Martinez Rivera C, Costan Galicia J, Alcázar Navarrete B, *et al.* Factors Associated with Depression in COPD: A Multicenter Study. *Lung* 2016;**194**:335–43. doi:10.1007/s00408-016-9862-7

5 Kew KM, Dias S, Cates CJ. Long-acting inhaled therapy (beta-agonists, anticholinergics and steroids) for COPD: a network meta-analysis. In: Kew KM, ed. *Cochrane Database of Systematic Reviews*. Chichester, UK: : John Wiley & Sons, Ltd 2014. doi:10.1002/14651858.CD010844.pub2

6 NICE. Chronic obstructive pulmonary disease in over 16s: diagnosis and management | Guidance and guidelines | NICE. 2010.https://www.nice.org.uk/guidance/CG101 (accessed 21 Aug2016).

7 Agusti A. The path to personalised medicine in COPD. *Thorax* 2014;**69**:857–64. doi:10.1136/thoraxjnl-2014-205507

8 Ernst P, Saad N, Suissa S. Inhaled corticosteroids in COPD: the clinical evidence. *Eur Respir J* 2014;:525–37. doi:10.1183/09031936.00128914

9 McCarthy B, Casey D, Devane D, *et al.* Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2015;**2**:CD003793. doi:10.1002/14651858.CD003793.pub3

10 Celli BR, Decramer M, Wedzicha J, *et al.* An official American Thoracic Society/European Respiratory Society statement: research questions in COPD. *Eur Respir J* 2015;**45**:879–905. doi:10.1183/09031936.00009015

11 Watson A. Breathing in Singing. In: Welch G, Howard D, Nix J, eds. *The Oxford Handbook of Singing*. Oxford University Press 2014. doi:10.1093/oxfordhb/9780199660773.013.10

12 Clift S, Hancox G, Morrison I, *et al.* Choral singing and psychological wellbeing: Quantitative and qualitative findings from English choirs in a cross-national survey. *J Appl Arts Heal* 2010;**1**:19–34.

13 Clark I, Harding K. Psychosocial outcomes of active singing interventions for therapeutic purposes: a systematic review of the literature. *Nord J Music Ther* 2012;**21**:80–98. doi:10.1080/08098131.2010.545136

14 Reagon C, Gale N, Enright S, *et al.* A mixed-method systematic review to investigate the effect of group singing on health related quality of life. *Complement Ther Med* 2016;**27**:1–11. doi:10.1016/j.ctim.2016.03.017

15 Lord VM, Cave P, Hume VJ, *et al.* Singing teaching as a therapy for chronic respiratory disease--a randomised controlled trial and qualitative evaluation. *BMC Pulm Med* 2010;**10**:41. doi:10.1186/1471-2466-10-41

16 Lord VM, Hume VJ, Kelly JL, *et al.* Singing classes for chronic obstructive pulmonary disease: a randomized controlled trial. *BMC Pulm Med* 2012;**12**:69. doi:10.1186/1471-2466-12-69

17 Goodridge D, Nicol JJ, Horvey KJ, *et al.* Therapeutic Singing as an Adjunct for Pulmonary Rehabilitation Participants With COPD: Outcomes of a Feasibility Study. *Music Med* 2013;**5**:169–76. doi:10.1177/1943862113493012

18 Bonilha AG, Onofre F, Vieira ML, *et al.* Effects of singing classes on pulmonary function and quality of life of COPD patients. *Int J COPD* 2009;**4**:1–8. doi:10.2147/COPD.S4077

19 Pacheco C, Costa A, Amado J, *et al.* Singing in chronic obstructive pulmonary disease patients: A pilot study in Portugal. *Rev Port Pneumol* 2014;**20**:225–8. doi:10.1016/j.rppneu.2014.02.009

20 Morrison I, Clift SM, Page S et al. A UK feasibility study on the value of singing for people with Chronic Obstructive Pulmonary Disease (COPD). UNESCO Observatory Multi-Disciplinary Journal in the Arts 2013:3;1-19

21 McNaughton A, Aldington S, Williams G, *et al.* Sing Your Lungs Out: A qualitative study of a community singing group for people with Chronic Obstructive Pulmonary Disease (COPD). *BMJ Open* 2016;**6**:e012521 doi:10.1136/bmjopen-2016-012521

22 Global Strategy for Diagnosis, Management, and Prevention of COPD - 2016 - Global Initiative for Chronic Obstructive Lung Disease - GOLD. http://goldcopd.org/global-strategy-diagnosis-management-prevention-copd-2016/

23 Bjelland I, Dahl A, Haug T, *et al.* The validity of the Hospital Anxiety and Depression Scale: an updated literature review. *J Psychosom Res* 2002;52:69-77

24 van der Molen T, Willemse BWM, Schokker S, *et al.* Development, validity and responsiveness of the Clinical COPD Questionnaire. *Health Qual Life Outcomes* 2003;**1**:13.

25 Clausen JL, Coates AL, Quanjer PH. Measurement of lung volumes in humans: review and recommendations from an ATS/ERS workshop. *Eur Respir J* 1997;10:1205–6

26 ATS Statement: Guidelines for the Six-Minute Walk Test. *Am Thorac Soc Am J Respir Crit Care Med* 2002;**166**:111–7. doi:10.1164/rccm.166/1/111

27 Shirtcliffe P, Weatherall M, Marsh S, *et al*. COPD prevalence in a random population survey: a matter of definition. *Eur Respir J* 2007;30:232–9

28 Ministry of Health New Zealand. District health board Maori health plans profiles and needs assessments. 2015.http://www.health.govt.nz/publication/dhb-maori-health-profiles

29 Celli BR, Cote CG, Marin JM, *et al.* The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *NEJM* 2004;350:1005–12. doi:10.1056/NEJMoa021322

30 Puhan MA, Frey M, Büchi S, *et al.* The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease.

*Health Qual Life Outcomes* 2008;**6**:46. doi:10.1186/1477-7525-6-46

31 Holland AE, Nici L. The Return of the Minimum Clinically Important Difference for 6-Minute-Walk Distance in Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 2013;187:335–6. doi:10.1164/rccm.201212-2191ED

32 Holland AE, Spruit MA, Troosters T, *et al.* An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J* 2014;**44**:1428–46. doi:10.1183/09031936.00150314

33 Bolton CE, Bevan-Smith EF, Blakey JD, et al. British Thoracic Society guideline on pulmonary rehabilitation in adults. *Thorax* 2013;68:ii1–ii30.

34 Spruit MA, Pitta F, McAuley E, *et al.* Pulmonary Rehabilitation and Physical Activity in Patients with Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med* 2015;**192**:924–33. doi:10.1164/rccm.201505-0929CI

35 Holland AE, Hill CJ, Jones AY, *et al.* Breathing exercises for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* Published Online First: 2012. doi:10.1002/14651858.CD008250.pub2

36 Pooler A, Beech R. Examining the relationship between anxiety and depression and exacerbations of COPD which result in hospital admission: a systematic review. *Int J Chron Obs Pulmon Dis* 2014;**9**:315–30.

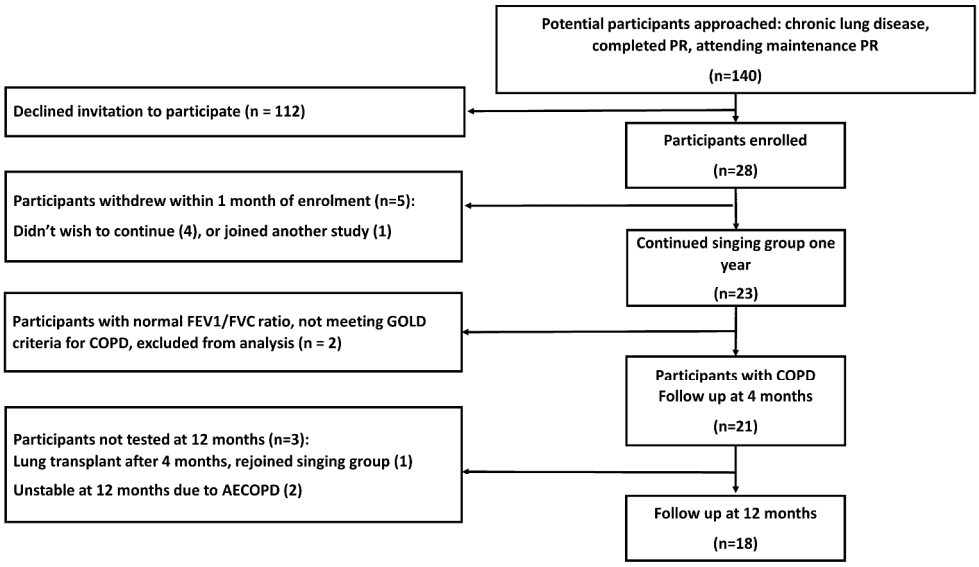



Figure 1: Study overview.
COPD = chronic obstructive pulmonary disease, PR= pulmonary rehabilitation, AECOPD = acute exacerbation of COPD, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity, GOLD = Global Initiative for Chronic Obstructive Lung Disease

Figure 1 shows the study overv
338x190mm (300 x 300 DPI)

# Setting up a singing group like Sing Your Lungs Out

We provide links below to two short videos of this singing group and a "10 practical top tips" document for setting up a community singing group for people living with COPD which we hope will inform, motivate and encourage others to set up singing groups.

https://www.dropbox.com/sc/boc5sr7hkcbi6tz/AAAlbUQqOWyvDeJGTnoXVcg-a?preview=NO_Graphics_02.mp4

https://www.youtube.com/watch?v=fduau0jV09o

http://www.mrinz.ac.nz/pdfs/How_to_set_up_SYLO.pdf

STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation | |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Pilot in study title. |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Yes |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Yes Introduction para 1-3, pg3-4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | Yes Introduction para 4, pg 4. No hypotheses, this was a feasibility study. |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Methods, para 1, pg 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Methods, para 1, pg 5 and under 'Singing Group Intervention' pg 6. Specific dates are in first line of Results, pg 7 |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br>*Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls<br>*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants | Methods, para 1, pg 5 |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed<br>*Case-control study*—For matched studies, give matching criteria and the number of controls per case | No matched control group |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | Methods, 'data collection', pg 5 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | Methods, 'Data collection', pg 5 |

| | | | |
|---|---|---|---|
| Bias | 9 | Describe any efforts to address potential sources of bias | Objective lung function tests measured by scientist blinded to previous results. Self reported questionnaires |
| Study size | 10 | Explain how the study size was arrived at | Convenience sample, twice the size of previous studies. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | Methods, 'Analysis', pg 6 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | Methods, 'Analysis', pg 6 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | N/A |
| | | (*c*) Explain how missing data were addressed | N/A |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy | Results, para 1, pg 7 and Figure 1 Study overview |
| | | (*e*) Describe any sensitivity analyses | N/A |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Results, para 1, pg 7 and Study overview Figure 1 |
| | | (b) Give reasons for non-participation at each stage | Results, para 1 and figure 1 |
| | | (c) Consider use of a flow diagram | Figure 1 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | Results, para 2, pg 7 and Table 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Table 1 |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) | Result, para 1,pg 7 |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time | Results, para 3, pg 9 and Table 2 and Figure 2 |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure | |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures | |
| Main results | 16 | (*a*) Give unadjusted estimates and, if | Admission days adjusted. Other |

| | | | |
|---|---|---|---|
| | | applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | results unadjusted. Table 2 |
| | | (*b*) Report category boundaries when continuous variables were categorized | N/A |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | N/A feasibility study |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | Discussion para1 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | Discussion para 3, pg 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | Discussion para 4 and 5, pg 12-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | Discussion para 6, pg 13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | Funding statement pg 14 |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.