An online singing-based breathing and wellbeing programme (ENO Breathe) in people with long COVID breathlessness in the UK: a cohort study

Keir E J Philip, Harriet Owles, Stephanie McVey, Tanja Pagnuco, Katie Bruce, Beth Warnock, Anya Chomacki, Harry Brunjes, Jenny Mollica, Adam Lound, Suzi Zumpe, Amiad M Abrahams, Vijay Padmanaban, Thomas H Hardy, Adam Lewis, Ajit Lalvani, Sarah L Elkin, Nicholas S Hopkinson

Summary

Background Post-COVID-19 condition (also known as long COVID) breathlessness is a common, complex, and frequently debilitating problem for which few evidence-based interventions exist. A previous randomised trial found that participation in an online 6-week breathing and wellbeing programme (ENO Breathe), using singing techniques, was associated with improvements in health-related quality of life (HRQOL) and breathlessness. We aimed to assess the impact of this intervention outside a trial setting.

Methods In this cohort study, participants were referred from 51 UK-based National Health Service (NHS) long COVID clinics, where they had been diagnosed with breathlessness due to long COVID. The eligibility criteria of ENO Breathe were age 18 years or older, having long COVID with associated breathlessness, diagnosis and referral from a specialist collaborating NHS long COVID clinic, and access and ability to engage with the online programme. We compared baseline and post-intervention data to assess the effect of the ENO Breathe programme on HRQOL assessed using the RAND-36 Mental and Physical Health Composite (MHC and PHC) primary outcome, with an estimated minimally clinically important difference of 3; breathlessness (assessed using Dyspnoea-12 scores and visual analogue scales [VAS] for breathlessness at rest, walking, using stairs, and running); anxiety (assessed using the Generalised Anxiety Disorder-7 questionnaire [GAD-7]); and respiratory symptoms (assessed using the COPD Assessment Test [CAT]).

Findings 1413 programme participants were included in this analysis (mean age 49 years [SD 11·9], BMI 28 kg/m^2 [7·2]). 1130 (80%) participants were female, 273 (19%) were male, and ten (1%) did not disclose their gender. 1165 (82%) participants were White, 87 (6%) were Asian, 47 (3%) were Black, 48 (3%) were of mixed or multiple ethnic backgrounds, 31 (2%) reported their ethnicity or race as other (ie, not one of the categories specified), and 35 (2%) did not disclose their ethnicity or race. Participants reported having long COVID symptoms for a median of 415 days (IQR 246–601) at the time of registration with the programme. 1188 (84%) of 1413 participants provided follow-up data on completion of the programme. Completing ENO Breathe was associated with improvements in HRQOL (median difference in RAND-36 MHC 2·98, IQR –1·53 to 8·42; and median difference in PHC 1·69, –1·32 to 5·01), breathlessness (mean difference in Dyspnoea-12 –4·29, 95% CI –4·64 to –3·94; VAS breathlessness scores walking median difference –5, IQR –18 to 6; stairs median difference –10, –25 to 3; and running median difference –3, –19 to 0), anxiety (median GAD-7 score difference –1, IQR –4 to 1), and respiratory symptom impact (mean CAT score difference –2·50, –2·81 to –2·19; all p<0·0001). The VAS breathlessness score at rest did not significantly change (median difference 0, IQR –10 to 13; p=0·24). The response to the ENO Breathe intervention did not differ by age, gender, ethnicity, or pre-existing asthma. There were no reported clinically significant adverse events.

Interpretation The ENO Breathe programme can improve HRQOL, breathlessness, anxiety, and respiratory symptoms in people with long COVID and breathlessness. ENO Breathe could be tested in other major causes of breathlessness and might help inform the development and delivery of other related interventions.

Funding Imperial College London.

Lancet Digit Health 2026

Published Online
https://doi.org/10.1016/j.landig.2026.100988

National Heart and Lung Institute, Imperial College London, London, UK (K E J Philip PhD, H Owles PhD, Prof A Lalvani DM, S L Elkin MD, Prof N S Hopkinson PhD); **NIHR Imperial Biomedical Research Centre, Imperial College London, London, UK** (K E J Philip, Prof N S Hopkinson); **Respiratory Medicine, Imperial College Healthcare NHS Trust, London, UK** (H Owles, V Padmanaban MPT, S L Elkin); **Learning and Participation (Engage), English National Opera, London, UK** (S McVey BA, T Pagnuco MA, K Bruce MA, B Warnock BA, A Chomacki BA, H Brunjes MBBS, J Mollica MA, S Zumpe BMus, T H Hardy BMus); **Patient Experience Research Centre, Imperial College London, London, UK** (A Lound MSc); **Clinical Health Psychology, Imperial College Healthcare NHS Trust, London, UK** (A M Abrahams MA); **School of Health Sciences, University of Southampton, Southampton, UK** (A Lewis PhD); **NIHR Health Protection Research Unit in Respiratory Infections, Imperial College London, London, UK** (Prof A Lalvani)

Correspondence to:
Dr Keir Philip, National Heart and Lung Institute, Imperial College London, London SW3 6LY, UK
k.philip@imperial.ac.uk

Introduction

Post-COVID-19 condition (also known as long COVID) remains a major public health issue for which few evidence-based treatment options exist. In the UK, an estimated 2 million people (3·3% of the population) were living with long COVID as of 2024.[1] Breathlessness is a common long COVID symptom, with complex biopsychosocial components and frequently debilitating impacts.[2] Singing-based interventions can improve various aspects of health for people with and without breathlessness.[3] Digitally delivered

Research in context

Evidence before this study

Post-COVID-19 condition (also known as long COVID) is a common and frequently disabling condition for which there are few evidence-based interventions. An individualised holistic approach to treatment is advocated. Singing-based interventions are increasingly used for breathlessness in various medical conditions. We searched PubMed using the search terms "post-COVID-19 syndrome", "long COVID", and "singing", from database inception to Dec 28, 2024, with no restrictions on language. We identified one randomised clinical trial (by our group) and one pilot study of interventions using singing-based interventions for people with ongoing symptoms following COVID-19. No studies were identified assessing singing-based approaches for long COVID outside a trial setting.

Added value of this study

We describe outcomes of the ENO Breathe programme for people with long COVID and related breathlessness. This is the largest study of a digitally delivered arts-in-health intervention for people with breathlessness to date, and adds to a growing body of research in this area. These results come from a large cohort of people with long COVID and breathlessness, outside a clinical trial setting, participating in an intervention integrated into clinical care provision. The results show that participants had statistically and clinically significant improvements in quality of life, breathlessness, and respiratory symptoms. ENO Breathe is potentially an important addition for a group of patients for whom evidence-based interventions remain scarce.

Implications of all the available evidence

These findings, and those of the previous randomised trial of ENO Breathe, suggest that digitally delivered mind–body and music-based approaches can be integrated into clinical services. Participation in this intervention was associated with a range of clinically important improvements that could support recovery for people with long COVID and breathlessness.

interventions for long COVID are of interest due to their potential to overcome certain participation barriers, including geographical location and disease-related mobility limitations. A 2022 randomised trial of 150 participants found that participation in a 6-week online breathing and wellbeing programme (ENO Breathe), which uses singing techniques, was associated with improvements in health-related quality of life (HRQOL) and breathlessness compared with usual care in people with long COVID.[4] The effect of this intervention outside a trial setting has not been assessed.

We aimed to assess the change in clinically relevant outcome measures experienced by a large number of ENO Breathe participants, with intervention delivery integrated into clinical provision. Additionally, we sought to identify factors associated with a positive response and programme engagement.

Methods

Participants

Participants were referred from 51 UK-based National Health Service (NHS) long COVID clinics, where they had been diagnosed with breathlessness due to long COVID and received individually tailored multidisciplinary clinical assessment and management, based on the knowledge and guidelines available at the time. Those deemed suitable by their clinical team, following assessment and investigation, could be referred to the ENO Breathe programme. People could not self-refer or access the programme through any other route than that described. Given the required referral process, no further diagnostic investigations were completed by the research team. The programme's eligibility criteria were age 18 years or older, having long COVID with associated breathlessness, diagnosis and referral from a specialist collaborating NHS long COVID clinic, and access and ability to engage with the online programme. At first contact with the intervention team, participants were excluded if they were considered too unwell to participate by themselves or by the English National Opera's (ENO's) clinical collaborating team from Imperial College Healthcare NHS Trust (ICHT; London, UK), for reasons including excessive fatigue, comorbidities, or upper airway issues. Gender and race and ethnicity data were self-reported using the categories female, male, or other or prefer not to answer and White British or White other, Asian or Asian British, Black or Black British, mixed or multiple ethnic background, other, or prefer not to say, respectively.

Ethics approval was granted by the NHS Health Research Authority, Stanmore Research Ethics Committee (19/LO/0418). Participants gave written informed consent to their anonymised responses being used for programme evaluation and research use.

Intervention

ENO Breathe is an online breathing and wellbeing programme developed by ENO's Engage (outreach and education) team, in collaboration with people living with long COVID, and with clinical support from the ICHT Respiratory Medicine Team. ENO Engage focuses on learning and participation, including community workshops and programmes. ENO Engage's previous arts-in-health projects have included people with dementia and mental health challenges. The ENO Breathe programme, described in detail elsewhere,[4] uses singing techniques and lullabies from around the world, and aims to improve wellbeing and breathlessness in people with long COVID. This approach differs from other singing-based approaches for people with respiratory conditions in various ways. First, the programme was developed specifically for, and with, people with long COVID, rather than for other conditions.

The programme was designed to be completely online from the beginning, rather than adapted from an in-person programme. Additionally, ENO Breathe focuses particularly on breathlessness and related anxiety, although anxiety is not required for participation. Finally, the programme is comparatively low intensity, whereas approaches such as Singing for Lung Health can be more physiologically demanding.[5] Participants have an initial one-to-one discussion with an ENO vocal specialist and ENO group coordinator, with clinical support from a respiratory physician if necessary, to confirm suitability from both provider and participant perspectives, assess symptoms, and answer participant questions. Six once-weekly, 1-h long, live online group workshop sessions follow, with up to 20 participants per group. These sessions are led by an ENO vocal specialist (professional opera singers trained to deliver the sessions). Participants also receive a welcome pack with an ENO mug and herbal tea to facilitate intimacy and connection, as might be done in a face-to-face session. Additionally, participants are provided with online resources to support their learning, including guided videos, playlists, audio tracks, and written resources for asynchronous use in their own time. Participants also receive regular support email communication from the ENO Breathe team.

People with lived experience of long COVID co-developed the intervention and are part of the ENO Breathe Advisory board, which helped to define the focus and scope of this research.

Outcomes

The primary outcome of interest was HRQOL, assessed using the RAND-36 Mental and Physical Health Composite (MHC and PHC) scores, which has an estimated minimally clinically important difference (MCID) of 3.[6] These scores are one of the most widely used measures of HRQOL, including in people with long COVID.[7] Breathlessness was assessed using the Dyspnoea-12 questionnaire, which has been used in previous long COVID studies and clinical practice[8] (MCIDs total score 2·8; physical subdomain 1·8; affective subdomain 1·1).[9] Breathlessness was also assessed using visual analogue scales (VAS), which have precedent for use in long COVID research,[4] using the question "rate the following levels of your breathlessness over the past 2 weeks: [1] at rest, [2] walking around the house, [3] climbing stairs, and [4] running", from 0 meaning no breathlessness to 100 meaning the most breathlessness possible (MCID 10).[10] Anxiety was assessed using the Generalised Anxiety Disorder-7 questionnaire (GAD-7; MCID 4),[11] also previously used in long COVID research.[12] Respiratory symptom impact was assessed using the COPD Assessment Test (CAT; MCID 2),[13] which has been used in long COVID research.[14]

The ENO Breathe team proactively asked participants about any adverse events or experiences and encouraged them to report anything of potential interest. Due to concerns about potential post-exertional symptom exacerbation or fatigue, change in the RAND-36 question regarding energy and fatigue was assessed specifically.

Data collection

Data were collected before starting the first session and again in the week following the last live session using online self-completion forms between Oct 29, 2020, and Oct 10, 2022.

Statistical analysis

Data are presented as mean and SD or median and IQR, as appropriate. Paired *t*-tests and Wilcoxon signed-rank tests were used, as appropriate, to compare pre-intervention and post-intervention outcome measures, with mean difference and 95% CI or median difference and IQR provided as an estimate of effect size.

To investigate if certain characteristics were associated with clinically important changes in measures and engagement with the programme, we used univariate logistic regression models to identify baseline clinical, demographic, and outcome measures associated with at least MCID improvements and full participation. Data were analysed using STATA (version 14). STROBE reporting guidelines were used. A sample size calculation was not completed before analysis as all eligible participants were included from the available data.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

1640 people were participating in ENO Breathe during the data collection period. 213 were excluded as data were missing on key demographics (age, gender, and ethnicity or race) or key outcome measures at baseline. We also excluded participants who reported having long COVID for less than 90 days, in keeping with current long COVID clinical guidelines at the time of the analysis presented here.[15] No data from participants in the previous randomised trial of this intervention[4] were included in the current study, as the focus of this study is on participants outside a trial setting. 1413 programme participants were included in this analysis (mean age 49 years [SD 11·9], BMI 28 kg/m^2 [7·2]). 1130 (80%) participants were female, 273 (19%) were male, and ten (1%) did not disclose their gender. 1165 (82%) participants were White, 87 (6%) were Asian, 47 (3%) were Black, 48 (3%) were of mixed or multiple ethnic backgrounds, 31 (2%) reported their ethnicity or race as other (ie, not one of the categories specified), and 35 (2%) did not disclose their ethnicity or race. Participants reported having long COVID symptoms for a median of 415 days (IQR 246–601; range 90–964) at the time of registration with the programme (table 1).

1188 (84%) of 1413 participants provided follow-up data on completion of the programme. A small number of

See Online for appendix

	Participants (n=1413)
Age, years	49 (11·9)
Gender	
Female	1130 (80%)
Male	273 (19%)
Other or prefer not to answer	10 (1%)
Ethnicity or race	
White British or White other	1165 (82%)
Asian or Asian British	87 (6%)
Black or Black British	47 (3%)
Mixed or multiple ethnic background	48 (3%)
Other	31 (2%)
Prefer not to say	35 (2%)
English first language	1262/1384 (91%)
BMI, kg/m^2*	28·2 (7·0)
Symptom duration at baseline, days	415 (246–601)
Comorbidities	
Asthma	355 (25%)
Chronic obstructive pulmonary disease	9 (1%)
Heart disease	30 (2%)
Hypertension	180 (13%)
Diabetes	77 (5%)

Data are mean (SD), n (%), n/N (%), or median (IQR). *n=1379.

Table 1: **Participant characteristics**

participants did not provide complete follow-up data (table 2). Compliance with the intervention was high, with participants attending a median of six (IQR 5 to 6) of a possible six live online sessions. There were no reported clinically significant adverse events and the RAND-36 question relating to energy and fatigue showed an improvement from a baseline score of 20 (IQR 10 to 35) to 25 (10 to 40) at follow-up (median difference 5 [–5 to 15]; p<0·0001).

Completing ENO Breathe was associated with improvements in HRQOL (median difference in RAND-36 MHC 2·98, IQR –1·53 to 8·42; and median difference in PHC 1·69, –1·32 to 5·01), breathlessness (mean difference in Dyspnoea-12 –4·29, 95% CI –4·64 to –3·94; VAS breathlessness scores walking median difference –5, IQR –18 to 6; stairs median difference –10, –25 to 3; and running median difference –3, –19 to 0), anxiety (median GAD-7 score difference –1, IQR –4 to 1), and respiratory symptom impact (mean CAT score difference –2·50, –2·81 to –2·19; all p<0·0001). The VAS breathlessness at rest did not significantly change (median difference 0, IQR –10 to 13; p=0·24; table 2). The proportion of participants with a change in each outcome measure equal to or above the MCID is shown in the figure.

Age, gender, BMI, symptom duration at baseline, baseline VAS dyspnoea scores, and comorbid asthma or hypertension were not associated with an above MCID change in RAND-36 MHC or PHC scores. People with a high symptom burden at baseline were more likely to have an above MCID improvement in MHC score, as were people who attended all six live sessions, compared with those who did not (appendix p 1). High symptom burden was indicated by baseline low MHC, high CAT score, and high GAD-7; high Dyspnoea-12 score (primarily the affective component) was associated with an above MCID change in RAND-36 MHC.

Similarly, people with high symptom burden at baseline, and those who attended all six live sessions, were more likely to have an above MCID improvement in PHC score (appendix p 2). High symptom burden was indicated by baseline low MHC and PHC scores; high GAD-7; and high Dyspnoea-12 score (both affective and physical components), all associated with an above MCID change in RAND-36 PHC.

Low MHC score, high BMI, high CAT score, high GAD-7 score, high Dyspnoea-12 score (both affective and physical components), high scores on all VAS for dyspnoea, and attending all live sessions were associated with above MCID improvements in Dyspnoea-12 total score (appendix p 3). Similarly, worse baseline health indicated by low MHC and PHC and high CAT, GAD-7, Dyspnoea-12, and VAS dyspnoea scores was associated with above MCID changes in GAD-7 score (appendix p 4).

For people with asthma (n=355), no association was found between an above MCID change in RAND-36 MHC score (odds ratio 1·02, 95% CI 0·78–1·33; p=0·88), RAND-36 PHC score (1·11, 0·84–1·45; p=0·47), Dyspnoea-12 score (0·90, 0·68–1·17; p=0·42), or GAD-7 score (1·03, 0·76–1·38; p=0·87). Similarly, there was no association between having hypertension (n=180) and an above MCID change in RAND-36 MHC score (0·97, 0·70–1·36; p=0·87), RAND-36 PHC score (0·71, 0·50–1·02; p=0·064), or Dyspnoea-12 score (1·07, 0·76–1·51; p=0·71). Having hypertension was associated with increased odds of an above MCID improvement in GAD-7 score (1·45, 1·01–2·08; p=0·043); however, the number of people with hypertension was small, with a large 95% CI. Numbers of people reporting other medical diagnoses were too small for meaningful comparison.

Attendance at all six of the live sessions was associated with older age, lower BMI, and lower VAS dyspnoea scores at rest, walking, and on stairs. Having English as a first language was also associated with attending all six live sessions; however, only 122 (9%) respondents to this question stated that English was not their first language (appendix p 5).

Baseline data from people who provided follow-up data were similar to those who did not provide follow-up data. The only differences between groups were that people were more likely to provide follow-up data if they were older, female, and had better scores for VAS dyspnoea at rest and the affective component of the Dyspnoea-12 score (appendix p 6).

Discussion

In people recruited from long COVID clinics in the UK, taking part in the ENO Breathe programme led to clinically

	Baseline (median [IQR] or mean [SD])	Follow-up (median [IQR] or mean [SD])	Median difference (IQR) or mean difference (95% CI)	p value	Showed minimal clinically important difference	Number of observations
RAND-36 Mental Health Composite	32·49 (26·08 to 39·83)	36·62 (29·81 to 43·71)	2·98 (–1·53 to 8·42)*	<0·0001	591 (50·0%)	1183
RAND-36 Physical Health Composite	31·40 (27·05 to 36·87)	33·16 (28·56 to 39·55)	1·69 (–1·32 to 5·01)*	<0·0001	459 (38·8%)	1183
COPD Assessment Test (respiratory symptoms)	19·48 (6·40)	16·98 (6·90)	–2·50 (–2·81 to –2·19)†	<0·0001	677 (57·0%)	1187
Generalised Anxiety Disorder-7 questionnaire (anxiety)	7 (3 to 11)	5 (2 to 8)	–1 (–4 to 1)*	<0·0001	316 (26·6%)	1187
Dyspnoea-12 (total score)	15·44 (7·44)	11·14 (7·18)	–4·29 (–4·64 to –3·94)†	<0·0001	722 (60·8%)	1187
Dyspnoea-12 (physical component)	10·03 (4·18)	7·53 (4·18)	–2·50 (–2·71 to –2·30)†	<0·0001	722 (60·8%)	1187
Dyspnoea-12 (affective component)	5 (2 to 8)	2 (1 to 6)	–1 (–4 to 0)*	<0·0001	565 (47·6%)	1187
VAS dyspnoea at rest	20 (5 to 35)	20 (5 to 40)	0 (–10 to 13)*	0·24	337 (28·4%)	1188
VAS dyspnoea walking	35 (20 to 50)	29 (12 to 50)	–5 (–18 to 6)*	<0·0001	502 (42·3%)	1188
VAS dyspnoea stairs	60 (40 to 80)	50 (27 to 69)	–10 (–25 to 3)*	<0·0001	598 (50·3%)	1188
VAS dyspnoea running	90·5 (78·0 to 100·0)	82 (63 to 99)	–3 (–19 to 0)*	<0·0001	459 (38·6%)	1188

P values are from paired *t* tests or Wilcoxon-Rank Test as appropriate. VAS=visual analogue scale. *Data are median difference (IQR). †Data are mean difference (95% CI).

Table 2: **Baseline and post-intervention outcome measures (complete case)**

important improvements in HRQOL, respiratory symptoms, and breathlessness. These results provide support in a large, prospective cohort of the effects observed in a previous small randomised controlled trial of this intervention,[4] when the programme is integrated into clinical care provision. The intervention was well tolerated, with high engagement and completion rates. No serious adverse events were reported, and fatigue scores improved. Improvements seen were independent of age, gender, ethnicity, or the presence or absence of other respiratory diagnoses.

This study builds on a previous randomised trial[4] and supports the ongoing delivery of the ENO Breathe intervention. The findings are similar to those of related studies. For example, a mixed-methods, single-arm, pilot study of another singing and breathing intervention for long COVID called SingStrong found that the intervention was positively received and pre-post assessments indicated possible improvements in breathlessness, usual activities, cognition, and wellbeing, although the study was not statistically powered for these outcome measures.[16] Although still small, the evidence base for interventions for people living with long COVID has grown. Research suggests that pulmonary rehabilitation, both in person and online, can be effective at improving exercise capacity and fatigue in appropriately selected individuals with long COVID, such as those who do not have high levels of post-exertional malaise.[17] Telemedicine interventions focusing on various aspects of long COVID have also shown promise; however, an absence of large well conducted studies is frequently highlighted as a major limitation in this area, further emphasising the importance of the current study and the previous randomised trial on this intervention.[4] Current evidence-based guidelines emphasise pulmonary rehabilitation, symptom self-management, social prescribing, pacing, and support groups as strategies to manage long COVID.[15] Guidelines recommend holistic assessment of individuals from which personalised management strategies can be developed.[15] The findings of the current study suggest this intervention could be integrated alongside existing strategies, as it has been to date, contributing to an expanding range of management options for people with long COVID.

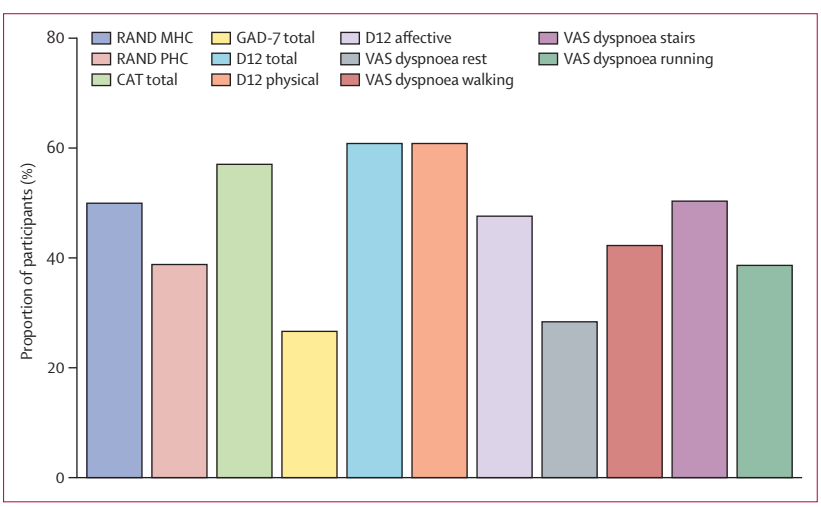

Figure: **The proportion of participants with an improvement in each variable that was equal to or larger than the minimal clinically important difference for that variable**
CAT=COPD assessment test. D12=Dyspnoea-12 questionnaire. GAD-7=generalised anxiety disorder-7 questionnaire. MHC=mental health composite. PHC=physical health composite. VAS=visual analogue scale.

Our findings also align with research on singing-based interventions for people with breathlessness due to other conditions. A randomised trial of online Singing for Lung Health in COPD showed small, but potentially important, improvements in HRQOL.[18] A randomised trial of pulmonary rehabilitation with face-to-face Singing for Lung Health compared with pulmonary rehabilitation with standard physical exercise training found non-inferior impacts on 6-min walking distance, with no significant between-group differences in quality of life, anxiety, depression, or lung function. These studies build on smaller and non-randomised studies suggesting positive

effects on quality of life, respiratory symptoms, and functioning in daily life.[19]

Various mechanisms potentially contribute to the outcome measure improvements observed, which were indicated in qualitative components of the previous randomised trial of this intervention. Physical effects reported included improving breathing patterns and breathing mechanics,[4] which might relate to breathing pattern abnormalities, common in long COVID breathlessness. The qualitative findings also indicated that psychological effects such as improving mood and reducing negative thoughts about breathlessness are likely to be important, as are social and creative health aspects of participation,[4] with similar effects reported after singing-based interventions for other conditions.[3] Such multifaceted biopsychosocial effects align with previous work proposing potential mechanisms of action in the use of singing-based approaches for people with respiratory conditions.[20] Related conceptual frameworks of breathlessness such as the Breathing, Thinking, Functioning model[21] and a multi-dimensional model of dysfunctional breathing[22] have facilitated practical application of biopsychosocial approaches in the development and delivery of various interventions for breathlessness.

Practical and logistical factors should be considered in relation to the generalisability of this intervention. Participants in this study were all assessed in specialist NHS COVID-19 clinics before referral, reducing the risk of missing out on other specific therapies or identification of other causes of their symptoms. Currently, ENO Breathe continues to receive a high number of referrals, with multiple new groups starting each month. However, over time the incidence of new cases of long COVID and the provision of specialist long COVID services is likely to change, with many previous long COVID clinics no longer existing or being merged with other conditions or services. These changes might necessitate adaptations to the provision and integration of ENO Breathe, or similar interventions, into wider care pathways.

Online delivery is likely to affect the experience and effects of participation. Previous research suggests that online singing interventions facilitate attendance compared with when physical presence is required, but the psychosocial benefits related to social connection might be reduced.[23] Infection control considerations are also important, with potentially justified concerns regarding aerosolised transmission of infections, which are particularly relevant for group singing.[24,25]

Greater improvements were observed in those who were most symptomatic at baseline and attended all six live sessions, which were also factors associated with an increased probability of a clinically important improvement in HRQOL (MHC and PHC) and breathlessness (Dyspnoea-12). These findings are similar to those of a randomised trial comparing ENO Breathe with usual care, which consisted of clinical management as directed by a long COVID clinic and any other clinical services.[4] There was also an indication that people with higher levels of breathlessness (VAS dyspnoea scores for rest, walking, and stairs, but not running) were less likely to complete all six of the live sessions. Overall, these findings suggest that more symptomatic people might be less likely to complete all sessions but improve more than less symptomatic people if they do fully participate. Importantly, these results do not indicate a particular long COVID phenotype that should either be targeted by, or excluded from, this intervention.

Certain limitations should be considered. This is a short-term study, with outcomes assessed at around 7 weeks from baseline. Longer-term outcomes would be of interest and should be included in future research. Data on health-care use and other factors relevant to economic analysis were not collected but would be useful to help assess the cost effectiveness of the programme. This study was not randomised; however, by focusing on participants undergoing the intervention integrated into clinical care, outside a clinical trial setting, our findings complement the results of a previous randomised trial on this intervention.[4] Given the nature of the intervention and the study methods, masking of participants was not possible. As such, more objective measures of impact or clinical assessment, such as physical activity assessment, would be of interest in future studies.[26] Additionally, the questionnaires used have not been formally validated in people with long COVID, and there were no validated outcome measures specifically for long COVID when data were collected due to the novelty of the condition. However, the measures have been used in multiple other conditions with shared symptoms and in other long COVID research. Of note, the VAS dyspnoea scores relate to responses to the question "rate the following levels of your breathlessness over the past 2 weeks: [1] at rest, [2] walking around the house, [3] climbing stairs, and [4] running". It is possible, or even likely, that some participants would not have climbed stairs or run during that period; therefore, these outcome measures should be interpreted with a degree of caution.

Another consideration relates to interpreting the number of participants meeting the MCID for an outcome. MCIDs are population-derived thresholds and there could be variation on an individual level. For example, the meaningfulness of an MCID change for an individual with a low baseline score might be different from an individual with a high baseline score for a specific variable. Similarly, a change of exactly the MCID is probably experienced differently from a change of multiple times the MCID, although in some of the analyses these changes have been grouped together as being equal to or greater than the MCID, hence potential oversimplification. However, presenting the data in this way provides an intuitive and clinically interpretable metric of the effect of health-care interventions and has been recommended in US Food and Drug Adminstration[27] and European Commission[28] guidance.

The absence of a control group in this study is an important limitation to consider. Appreciating considerable variation and heterogeneous, often non-linear, trajectories, data suggest that people with long COVID generally show a trend towards improvement in symptoms over time.[29] Therefore, a degree of caution is required when interpreting effect sizes in this study. However, the findings of our analysis align closely with that of a randomised trial on the same intervention,[4] indicating that a substantial contribution to improvements in symptoms is attributable to the intervention. Qualitative data from the randomised trial show that participants believe their participation has an important impact on their health.[4] Additionally, if the improvements reported were due to the natural history of the condition, we might also expect the duration of symptoms to be related to improvements, but such an association was not found. The absence of a sample size calculation should also be considered and a degree of caution applied; however, we believe the size of the total sample is sufficient for the analyses presented.

The finding that worse baseline scores were related to above MCID improvements could represent regression to the mean. However, this finding could indicate that the most symptomatic participants had the most to gain. Considered alongside the previous randomised trial results and qualitative work, it is possible that both explanations could be contributing to our findings.

Further evidence on generalisability is needed. Future research should assess ENO Breathe in contexts outside the UK, given differing social and cultural roles of singing and other arts-based activities.[30] Indeed, related programmes are being developed and delivered in other countries. Additionally, future research could investigate the use of this intervention in other causes of breathlessness.

In conclusion, our results support that in a large cohort outside a clinical trial setting the ENO Breathe online breathing and wellbeing programme can improve health-related quality of life, breathlessness, anxiety, and respiratory symptoms in people with long COVID and related breathlessness. Such findings support the ongoing delivery of this programme and its integration into guidelines and management strategies. Our results also suggest that the intervention should be tested in other major causes of breathlessness and could help inform the development and delivery of other related interventions.

Contributors

NSH and KEJP designed the study. KEJP and NSH obtained ethics approval and authorisation for the study. HO and SLE provided clinical input during delivery of the intervention. The ENO Breathe programme was devised by the English National Opera in collaboration with Imperial College Healthcare Trust. The scope and content of the programme were designed by SZ, JM, TP, SLE, HO, VP, and ALo. TP, AC, BW, SM, and KB coordinated delivery of ENO Breathe and data collection. KEJP analysed the data and wrote the first draft of the manuscript. KEJP and NSH have directly accessed and verified the underlying data reported in the manuscript. All authors contributed to the study design, study conduct, interpretation, revising the manuscript, and agreed on the final version. No authors were precluded from accessing data in the study, and all authors accept final responsibility for the decision to submit for publication.

Declaration of interests

KEJP was supported by the Imperial College National Heart and Lung Institute Clinical Lecturer scheme. KEJP has received honoraria from Chiesi for non-promotional lectures and from GSK for conference attendance. ALe receives a £250 per annum honorarium for being the Association of Chartered Physiotherapists in Respiratory Care Research Champion. ALa is a trustee and non-executive director of the English National Opera (ENO). NSH is chair of Action on Smoking and Health (UK) and medical director at Asthma and Lung UK. JM holds the following positions: The Clod Ensemble (chair—unpaid), National Opera Studio (trustee—unpaid position), and The Lord-Lieutenant of Greater London's Council on Culture and Heritage (member—unpaid position). SM, TP, KB, BW, AC, HB, JM, SZ, and THH work for ENO, who developed and deliver ENO Breathe; however, the programme is delivered free of charge to participants. All other authors declare no competing interests.

Data sharing

Data will not be made publicly available as ethics approval for sharing data has not been granted.

Acknowledgments

KEJP was supported by the Imperial College National Heart and Lung Institute Clinical Lecturer Scheme. KEJP would like to acknowledge the National Institute for Health and Care Research (NIHR) Biomedical Research Centre based at Imperial College Healthcare NHS Trust and Imperial College London for their support. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the UK Department of Health. The ENO Breathe programme is generously supported by the English National Opera's patrons, donors, and several trusts and foundations. We thank the participants for their time and effort, with particular thanks to participant experts for contributing to the steering group meetings and providing participant feedback and perspectives on the qualitative aspects of the research. We also thank Laura Moth, Phillip Crisp, Georgina Russell, Boon Lim, Michelle Maguire, Helena Klinge, Abi Simpson, Emily Smith, Amy Powell, Lea Cornthwaite, and Edmund Jeffery for their expertise, advice, and support in the creation, development, and delivery of the programme.

References

1 Office for National Statistics. Self-reported coronavirus (COVID-19) infections and associated symptoms, England and Scotland: November 2023 to March 2024. April 25, 2024. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/articles/selfreportedcoronaviruscovid19infectionsandassociatedsymptomsenglandandscotland/november2023tomarch2024 (accessed Feb 1, 2025).

2 Buttery S, Philip KEJ, Williams P, et al. Patient symptoms and experience following COVID-19: results from a UK-wide survey. *BMJ Open Respir Res* 2021; **8:** e001075.

3 Fancourt D, Finn S. What is the evidence on the role of the arts in improving health and well-being? A scoping review. Copenhagen: WHO Regional Office for Europe, 2019.

4 Philip KEJ, Owles H, McVey S, et al. An online breathing and wellbeing programme (ENO Breathe) for people with persistent symptoms following COVID-19: a parallel-group, single-blind, randomised controlled trial. *Lancet Respir Med* 2022; **10:** 851–62.

5 Philip KE, Lewis A, Buttery SC, et al. Physiological demands of singing for lung health compared with treadmill walking. *BMJ Open Respir Res* 2021; **8:** e000959.

6 Frendl DM, Ware JE Jr. Patient-reported functional health and well-being outcomes with drug therapy: a systematic review of randomized trials using the SF-36 health survey. *Med Care* 2014; **52:** 439–45.

7 Líška D, Liptaková E, Babičová A, Batalik L, Baňárová PS, Dobrodenková S. What is the quality of life in patients with long COVID compared to a healthy control group? *Front Public Health* 2022; **10:** 975992.

8 Hylton H, Long A, Francis C, et al. Real-world use of the Breathing Pattern Assessment Tool in assessment of breathlessness post-COVID-19. *Clin Med (Lond)* 2022; **22:** 376–79.

9 Ekström MP, Bornefalk H, Sköld CM, et al. Minimal clinically important differences and feasibility of Dyspnea-12 and the multidimensional dyspnea profile in cardiorespiratory disease. *J Pain Symptom Manage* 2020; **60:** 968–75.

10 Ries AL. Minimally clinically important difference for the UCSD Shortness of Breath Questionnaire, Borg Scale, and Visual Analog Scale. *COPD* 2005; **2:** 105–10.

11 Toussaint A, Hüsing P, Gumz A, et al. Sensitivity to change and minimal clinically important difference of the 7-item Generalized Anxiety Disorder Questionnaire (GAD-7). *J Affect Disord* 2020; **265:** 395–401.

12 Sauer MC, Barlow PB, Comellas AP, Garg A. Anxiety and depression symptoms among patients with long COVID: a retrospective cohort study. *Eur Arch Psychiatry Clin Neurosci* 2024; **274:** 1879–86.

13 Kon SS, Canavan JL, Jones SE, et al. Minimum clinically important difference for the COPD Assessment Test: a prospective analysis. *Lancet Respir Med* 2014; **2:** 195–203.

14 Soril LJJ, Damant RW, Lam GY, et al. The effectiveness of pulmonary rehabilitation for post-COVID symptoms: a rapid review of the literature. *Respir Med* 2022; **195:** 106782.

15 NICE. NICE guideline [NG188] COVID-19 rapid guideline: managing the long-term effects of COVID-19. Version 1.7, updated Jan 25, 2024. https://www.nice.org.uk/guidance/ng188 (accessed Feb 1, 2025).

16 Cahalan RM, Meade C, Mockler S. SingStrong—a singing and breathing retraining intervention for respiratory and other common symptoms of long COVID: a pilot study. *Can J Respir Ther* 2022; **58:** 20–27.

17 Oliveira MR, Hoffman M, Jones AW, Holland AE, Borghi-Silva A. Effect of pulmonary rehabilitation on exercise capacity, dyspnea, fatigue, and peripheral muscle strength in patients with post-COVID-19 syndrome: a systematic review and meta-analysis. *Arch Phys Med Rehabil* 2024; **105:** 1559–70.

18 Philip KEJ, Buttery SC, Bowen S, et al. Singing for Lung Health in COPD: a multicentre randomised controlled trial of online delivery. *BMJ Open Respir Res* 2024; **11:** e002365.

19 Cave P, Lewis A, Fancourt D. Singing for Lung Health. In: Heydon R, Fancourt D, Cohen AJ, eds. The Routledge companion to interdiciplinary studies in singing, volume III: wellbeing. New York, NY: Routledge, 2020.

20 Lewis A, Philip KEJ, Lound A, Cave P, Russell J, Hopkinson NS. The physiology of singing and implications for 'Singing for Lung Health' as a therapy for individuals with chronic obstructive pulmonary disease. *BMJ Open Respir Res* 2021; **8:** e000996.

21 Spathis A, Booth S, Moffat C, et al. The Breathing, Thinking, Functioning clinical model: a proposal to facilitate evidence-based breathlessness management in chronic respiratory disease. *NPJ Prim Care Respir Med* 2017; **27:** 27.

22 Courtney R. A multi-dimensional model of dysfunctional breathing and integrative breathing therapy—commentary on the functions of breathing and its dysfunctions and their relationship to breathing therapy. *J Yoga Phys Ther* 2016; **6:** 6.

23 Philip KE, Lewis A, Jeffery E, et al. Moving singing for lung health online in response to COVID-19: experience from a randomised controlled trial. *BMJ Open Respir Res* 2020; **7:** e000737.

24 Philip KEJ, Lewis A, Buttery SC, et al. Aerosol transmission of SARS-CoV-2: inhalation as well as exhalation matters for COVID-19. *Am J Respir Crit Care Med* 2021; **203:** 1041–42.

25 Archer J, McCarthy LP, Symons HE, et al. Comparing aerosol number and mass exhalation rates from children and adults during breathing, speaking and singing. *Interface Focus* 2022; **12:** 20210078.

26 Buttery SC, Williams PJ, Alghamdi SM, et al. Investigating the prognostic value of digital mobility outcomes in patients with chronic obstructive pulmonary disease: a systematic literature review and meta-analysis. *Eur Respir Rev* 2023; **32:** 230134.

27 US Food and Drug Adminstration. Patient-reported outcome measures: use in medical product development to support labeling claims. December, 2009. https://www.fda.gov/regulatory-information/search-fda-guidance-documents/patient-reported-outcome-measures-use-medical-product-development-support-labeling-claims (accessed Feb 1, 2025).

28 European Commision Directorate-General for Health and Food Safety. Guidance on outcomes for joint clinical assessment. June 13, 2024. https://health.ec.europa.eu/publications/guidance-outcomes-joint-clinical-assessments_en (accessed Feb 1, 2025).

29 Davis HE, Assaf GS, McCorkell L, et al. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. *EClinicalMedicine* 2021; **38:** 101019.

30 Philip KE, Cartwright LL, Westlake D, et al. Music and dance in respiratory disease management in Uganda: a qualitative study of patient and healthcare professional perspectives. *BMJ Open* 2021; **11:** e053189.