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Research Article

Breathing-Based Meditation for Improving COPD Burden: A Mixed Single-Case and Qualitative Approach

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Abstract

Chronic obstructive pulmonary disease (COPD) impacts the physiological and psycho-emotional aspects of life. COPD-related secondary sequelae also synergistically interact with each other. For example, dyspnea affects the severity of breath, body functions, and the mind (e.g., anxiety, panic, fear). Such negative psycho-emotional states can further negatively impact the breath and the body (e.g., increased dyspnea). Given the breadth of the impact of COPD on multiple facets of health and well-being, it is essential to investigate comprehensive approaches to managing COPD, simultaneously addressing the mind, body, and breath. Sudarshan Kriya Yoga (SKY), a breathwork meditation program, has previously yielded a wide range of physiological and psycho-emotional benefits but has not been explored in individuals with COPD. Using single-case multiple-baseline and qualitative phenomenology methodologies, this study investigated 1) the relation between dyspnea and SKY and 2) the feasibility and general perceived effectiveness of SKY among individuals with COPD. Nine individuals with varying severities of COPD participated. Data collection included ratings of perceived dyspnea (work of breathing, shortness of breath, dyspnea-related distress, dyspnea-related anxiety) and semi-structured in-depth interviews. Results suggest that SKY is feasible and acceptable for individuals with COPD. Additionally, the results demonstrate proof of concept that SKY can help alleviate aspects of the COPD disease burden related to the mind, body, and breath as well as reduce the cyclical effect of the disease sequelae. Larger-scale trials are warranted, but this study is the first to support SKY as a viable complementary and integrative health approach for individuals with COPD.

Keywords
Complementary and alternative medicine; COPD; dyspnea; lived experience; psychophysiology; meditation; SKY Breath Meditation; quality of life

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a preventable, treatable, yet life-threatening disease, characterized by chronic obstructive airflow in the lungs. It is the third leading cause of death in the United States and is projected to continue as a leading global cause of death and disability by 2030 [1]. The comorbidities of COPD (e.g., anxiety, depression) contribute to increased mortality and morbidities, including COPD exacerbations, hospital admissions/re-admissions, increased healthcare expenses, and reduced quality of life [2-4]. The medical costs of COPD in the United States were projected to reach $49 billion in 2020 [5].

The most common COPD-related symptom is chronic and progressive dyspnea [6]. Dyspnea is poorly managed and often under-recognized and under-treated [7, 8]. In the case of chronic lung disease, it is a predictor for hospitalization [9] and mortality [10]. In general, unplanned hospital visits and up to 25% of accident and emergency admissions result from dyspnea [11]. Further, this subjective experience impedes activities of daily living and reduces quality of life [7]. Dyspnea yields a vicious dyspnea-anxiety-dyspnea cycle among individuals with COPD [12-16]. The cascading psycho-physiological impacts of COPD extend broadly across the mind, body, and breath, compromising overall health and quality of life [17].

Past literature has investigated the utilization of traditional as well as complementary and alternative medicine (CAM) to improve psycho-physiological well-being in COPD. For example, research has supported the use of pulmonary rehabilitation (PR) [18] and cognitive behavior therapy (CBT) [19]. Yet, individuals with COPD often discontinue PR [20], and the long-term benefits of PR and CBT are still unknown [16]. Previous literature on CAM has shown varying results with breathing techniques, yoga, and meditation for individuals with COPD [21-24]. The inconsistent outcomes may be a result, in part, of the frequent fusion of different components or multiple approaches within a single intervention. As such, it would be beneficial to explore a more standardized comprehensive program that simultaneously targets the impact of the disease on the mind, body, and breath.

One such program is Sudarshan Kriya Yoga (SKY) Breath Meditation, an evidence-based breathwork meditation program [25, 26]. It is a nine-hour program, delivered across three days according to a standard manual. The program is facilitated by teachers with over 1000 hours of teacher training in breathwork meditation. Over 100 independent studies have been conducted on SKY across different populations and age groups. Overall, research on SKY suggests improved psycho-physiological well-being. For example, enhanced respiratory measures (e.g., respiratory rate, forced vital capacity, FVC; forced expiratory volume in one second, FEV1; peak expiratory flow rate, PEFR; breath holding time) have been reported in individuals without pulmonary disease (e.g., [27-30]). SKY has also been reported to help reduce anxiety and depression in participants with major depressive disorder who demonstrated inadequate response to anti-depressants [31]. In two recent studies, SKY was compared to the Foundations of Emotional Intelligence, Mindfulness-Based Stress Reduction, and Wisdom on Wellness programs [32, 33], and SKY exhibited the greatest positive impacts across multiple psycho-physiological domains (e.g., sleep, depression, stress, mindfulness, positive affect, social connectedness, life satisfaction).

The psycho-physiological benefits of SKY previously observed across other populations may also be translatable to individuals with COPD, appropriately targeting the cyclical impacts of the disease. Prior research has not explored SKY with COPD. Therefore, the objective of the current study was to examine the utility of SKY in individuals with COPD. Using a mixed methods design of single-case and qualitative methodologies, we investigated the overall effectiveness of SKY, specifically 1) the functional relation between SKY and dyspnea perceptions (i.e., work of breathing, shortness of breathing, dyspnea-related distress, and dyspnea-related anxiety) and 2) the feasibility and general perceived effectiveness of SKY for individuals with COPD. Based on the previous literature [27-30, 34], we anticipated that the magnitude of negative dyspnea-related perceptions would decrease after SKY.

2. Methods

2.1 Participants

Participants between 30 and 75 years of age were recruited a priori via word-of-mouth, flyers, social media, and ResearchMatch (a nonprofit program that connects researchers and individuals interested in research studies). Since the study was conducted virtually, participants were welcomed from anywhere in the United States. Inclusion criteria included: fluency in English, functional cognitive-linguistic skills, and a physician's diagnosis of COPD. Individuals with uncontrolled hypertension, neurological disorder, tracheostomy tubes, nasogastric feeding tubes, active pulmonary infections, exacerbated COPD, COPD requiring oxygen support during the day, cardiac ischemia, major psychiatric disorders (e.g., schizophrenia, schizoaffective, bipolar), seizure disorders, current/recent pregnancy, recent major surgery, or congestive heart failure were excluded. COPD severity was not a part of the inclusion or exclusion criteria to examine the viability of SKY across a range of individuals with COPD. Participants were required to have stable internet access and a device to connect to the videoconferencing platform used for the intervention. All participants were instructed to continue their usual medical routines.

A total of 9 individuals participated. About half of the participants were male (5/9; 55.56%), and all were White, non-Hispanic. Participants' ages ranged from 57 to 74 years (M = 65.56; SD = 6.09). A majority either currently or previously smoked (7/9; 77.78%). Their COPD severity ranged from mild (n = 2) to very severe (n = 1). Complete demographic information is available in Table 1; participants' most recent pulmonary function test results from their respective clinics are presented in Table 2. Participants' COPD severity was determined stepwise [35] and confirmed with a local pulmonologist.

Table 1 Participant Demographic Information.

Participant	SKY Group	State	Age (Years)	Gender	Race/Ethnicity	Additional Medical Diagnoses	Smoking History	Prior Exercise Behavior
1	1	Ohio	70	Male	White/Non-Hispanic	Hypertension, status post 2/3 of right lung lobectomy secondary to cancer	Current smoker	No
2	1	New Jersey	74	Male	White/Non-Hispanic	Peripheral artery disease with history of stent placements, enlarged prostate, post-traumatic stress disorder, rectal dysfunction	Quit smoking	No
3	1	Ohio	71	Male	White/Non-Hispanic	Skin cancer, hypertension, glaucoma, neuropathy of feet, tinnitus, neck/back issues	Quit smoking	Yes, when weather allows
4	2	Oregon	61	Female	White/Non-Hispanic	Heart murmur, hypercholesterolemia, skin cancer	Current smoker	Yes
5	2	Oregon	68	Female	White/Non-Hispanic	Celiac, melanomas, irritable bowel syndrome, osteoarthritis, esophageal dysphagia	History of second-hand smoke	Yes
6	2	Ohio	59	Female	White/Non-Hispanic	Recurrent major depression	Quit smoking	Yes
7	2	Illinois	69	Male	White/Non-Hispanic	Prostate cancer, history of pulmonary embolism, shoulder and leg operations	Quit smoking	Yes, at pulmonary rehabilitation
8	3	Texas	57	Female	White/Non-Hispanic	None	Quit smoking	Yes
9	3	Florida	61	Male	White/Non-Hispanic	Sinus infections, vocal cord damage from house fire	No, history of being in house fire	Yes

Table 2 Participants' Pulmonary Function Status.

Participant	FVC (%Ref)	FEV1 (%Ref)	FEV1/FVC (%)	Pulmonary Function Reference	Severity Based on American Thoracic Society Grades [35]
1	NA	NA	NA	NA	NA
2	105	64	44	NHANES III - Caucasian	Moderate
3	74	53	53	NHANES - Caucasian	Moderately severe
4	81	45	46	Knudson	Severe
5	90	89	65	Eigen/Bieler	Mild
6	NA	NA	NA	NA	NA
7	93	78	62	NHANES III - Caucasian	Mild
8	54	22	32	NHANES III	Very severe
9	60	47	59	NHANES - Caucasian	Severe

Note. %Ref = percentage of reference value; FEV_1 = forced expiratory volume in one second;
FVC = forced vital capacity; NA = not available; NHANES = National Health and Nutrition Examination Survey.

2.2 Study Design

This study utilized a mixed-methods design involving single-case multiple-baseline and qualitative phenomenological methodologies. The combination allowed for a broader comprehensive understanding of the feasibility and potential utility and benefits of SKY for individuals with COPD, including a triangulation of data from multiple sources to increase the validity and reliability of the findings. All the intervention sessions and single-case data collection time points were completed in the same month to control for potential effects of the season.

Single-case methodology is utilized to document functional relations between independent and dependent variables. It is a rigorous experimental approach that involves repeated measures of direct participant observation, allowing each participant to establish their own experimental control [36]. Further, single-case methodology is ideal for demonstrating the effects of a new intervention in real-life settings before attempting the intervention on a larger scale [36-38]. Since SKY has not been studied with individuals with COPD, single-case methodology was employed to explore if there is a functional relation between the implementation of SKY and improved dyspnea perceptions.

Qualitative methodology helps better understand a phenomenon within certain interest groups [39]. Through the qualitative phenomenological method, model and theory are developed based on participants' voices while exploring intervention outcomes and shaping the overall narrative of the experience in the intervention, rather than the analysis guided by pre-existing researcher hypotheses [40-43]. This study design aims to capture complete and accurate descriptions of particular human experiences and emotions [42]. Since SKY's acceptability, feasibility, and potential utility among individuals with COPD have not been explored, qualitative phenomenology was used to obtain a more complete description of participants' experiences with SKY and insight into the essential subjective components of intervention effectiveness.

2.3 Procedure and Analysis

This research was conducted with approval from the participating university's Institutional Review Board (Protocol Number: 10202019.028) and the Art of Living Research Committee. Table 3 outlines the procedures and data collection process across all study time points, which is described in further detail below.

Table 3 Procedure and Data Collection Schedule.

Time	Task
Time 0 (≥5 days pre-SKY)	a. Screen participants b. Consent c. Assign to groups d. Begin data-collection for single case e. Collect questionnaires
Time 1 (5 days pre-SKY)	a. Teach advanced victory breath
Intervention	SKY

Time 2 (after SKY)	a. Interview b. End data-collection for single case c. Collect questionnaires
Time 3 (10 weeks post-SKY)	a. Interview

Participants residing in the same time zones (i.e., Pacific, Central, and Eastern) within the United States were assigned to the same intervention group. These groups were then randomized to determine the order of the receipt of intervention, with the start of intervention staggered across the three groups. Two individuals could not make it to their randomized group intervention timing; therefore, they were assigned to the next intervention group.

2.3.1 Intervention

The SKY Breath Meditation Program is an evidence-based breathwork meditation program taught through the Art of Living Foundation [25, 26]. SKY Breath Meditation Program is a nine-hour group program highlighting Sudarshan Kriya Yoga and complemented by the resilience and positive psychology strategies. The program takes place across three days (three hours each day). It consists of an advanced form of victory breathing (ujjayi), bellow's breath (bhastrika), "Om," and Sudarshan Kriya. Victory breath is done via light constrictions of the laryngeal muscles. Arm positions, breath holds, and ratio of inhalation to exhalation are employed in the advanced form of victory breath. Bellow's breath is done via rapid inhalation and forceful exhalation. "Om" is said thrice. Sudarshan Kriya uses cyclical and rhythmic breathing patterns of various lengths and frequencies [25]. Participants in the current study were instructed to complete the breathwork more gently at first to reduce airway irritation [26]. The training is further complemented by a home SKY practice, which consists of a shortened version of SKY, taking approximately 25 minutes daily.

A certified SKY instructor, blinded to the study hypotheses, facilitated the program per the SKY manual. Intervention fidelity was assessed through several mechanisms. First, for each participant, the SKY instructor documented whether she taught each component (i.e., self-rating) and whether the participants could demonstrate each component on each training day correctly. Second, a trained data collector, blinded to the study hypotheses, observed the sessions live and completed a fidelity checklist, rating whether the instructor covered all components and whether the participants demonstrated the components accurately. This collector was present throughout the intervention (i.e., fidelity frequency of 100%). The researcher also kept an attendance log for the entirety of the research program.

All three groups of intervention were completed via videoconferencing. Five days before the start of the intervention (Time 1 in Table 3), participants learned a component of SKY (i.e., advanced victory breath). This initial training aimed to help participants acclimate to controlled and trained breathwork. Participants were instructed to practice the advanced victory breath daily until the start of SKY. They then engaged in the three-day group intervention. After the three-day intervention, participants were asked to complete the home SKY practice daily for the next ten weeks. Additionally, participants were encouraged to attend 75% of the follow-up sessions, where SKY was completed in a group setting. The weekly ~60-minute follow-up sessions continued for approximately ten weeks. A follow-up attendance log was also kept.

2.4 Data Collection

2.4.1 Single Case

A single-case, multiple baseline design across participants was utilized. The SKY intervention was held separately for the three groups of participants, and the order in which each group received the intervention was determined via randomization. Baseline data collection for the outcomes of interest (described below) began simultaneously for all participants across all groups (Time 0 in Table 3). At least five baseline data points were collected before the first group of participants received the SKY intervention. Once a baseline had been established for the first group (i.e., at least five stable baseline data points or worsening responses), SKY was implemented. Via a staggered multiple baseline design, the second group of participants remained in baseline and did not receive SKY until the first group's intervention data points demonstrated improvement in their responses. Once the second group received SKY, the same protocol of staggered implementation was applied to the third group.

Before the baseline data collection, a Modified Borg scale [44] was emailed to each participant to rate four dyspnea perceptions (outcomes of interest): work of breathing, WOB; shortness of breathing, SOB; dyspnea-related distress, DS; and dyspnea-related anxiety, DA. The primary author and the research team called the participants at an agreed-upon time daily to record the participants' ratings of perceived dyspnea. This process was continued throughout the baseline and intervention phases and ended six days after the end of the intervention for the third group (Time 2 in Table 3). During each call, participants were asked to respond to the following questions based on how they were feeling right then, at that moment in time: "How hard are you working to breathe; that is, how much effort is it taking you to breathe?" (WOB); "How short of breath are you; that is, how intense or severe is your shortness of breath?" (SOB); "How distressing is your shortness of breath to you; that is, how bothersome or upsetting is your shortness of breath to you?" (DD); and "How anxious about your shortness of breath are you; that is, how nervous or apprehensive about your shortness of breath are you?" (DA) [45]. Using the Modified Borg Scale, participants individually rated the four dyspnea perceptions (see Table 4).

Table 4 Modified Borg Scale.

0	Nothing at all (just noticeable)
0.5	Very very slight
1	Very slight
2	Slight
3	Moderate
4	Somewhat severe
5	Severe
6	
7	Very severe
8	
9	Very very severe (almost maximal)
10	Maximal

2.4.2 Qualitative

The primary author (TL) interviewed each participant individually between five and thirteen days after the completion of SKY (Time 2 in Table 3). The interviewer presented brief and open-ended questions to understand the participants' perceptions of their acceptability, feasibility, and experiences of SKY. The semi-structured interview guide was constructed a priori. The interviewer did not know 8/9 of the participants before the study. According to both the interviewer and the data coders during the analysis process, the interview with the familiar participant followed a procedure consistent with the other interviews, and no differences were noted. Additionally, bracketing was used to minimize research bias and to allow the participants' narratives and experiences to surface from their perspectives [42].

The qualitative phenomenological methodology allowed the participants' voices to reveal their experience with the shared phenomenon of participating in SKY [42]. Table 5 shows the guiding questions; follow-up probes were used depending on the participants' responses. The semi-structured interviews took place online via videoconferencing. Each interview lasted about 30-50 minutes. Video and audio recordings were completed. Field notes were also taken during the interviews and served as an additional primary data source.

Table 5 Interview Questions.

Qualitative interview questions - adapted from Linville et al. (2018) [43]
What has been your experience with SKY? What are strengths and weaknesses about it?
What are some of the changes that you have noticed in your daily activities that you think may have something to do with your participation in SKY?
What are some of the changes that you have noticed in your oral intake that you think may have something to do with your participation in SKY?
What are some of the changes that you have noticed in your social life that you think may have something to do with your participation in SKY?
What are some of the changes that you have noticed in your sleep quality that you think may have something to do with your participation in SKY?
What are the best parts of SKY from your perspective? What changes would you recommend to SKY?
Have you noticed any differences in the way you think about your physical activities, oral intake, and social life since your participation in SKY?
What factors might make it difficult for you to take what you have learned in SKY and use it in your day-to-day life?
Have you noticed that sky has affected your emotions? If so, how has SKY impacted your emotions?
Have you noticed that sky has affected your breathings? If so, how has SKY impacted your breathing?
What are some reasons you might or might not recommend SKY to someone else with COPD?

2.5 Data Analysis

2.5.1 Single Case

The single-case design data were analyzed using a traditional visual approach [36]. Visual analysis was completed for each dyspnea perception rating. The level, trend, variability, immediacy effect, overlap, and consistency of data within and across phases were observed. Two quantitative analyses further augmented data visualization to explore the intervention's effect size between the baseline and the SKY phases. First, the Tau-U statistic was calculated to generate an effect size of the intervention. Tau-U, a reliable estimate of effect size, integrates nonoverlap between the baseline and the intervention phases while controlling for monotonic trend within the data [46]. The Tau-U analyses were completed using a publicly available calculator at https://jepusto.shinyapps.io/SCD-effect-sizes/. The interpretation of the Tau-U scores used the following values: 0.65 or lower: weak or small effect; 0.66 to 0.92: medium to high effect; and 0.93 to 1: large or strong effect [46]. Second, log response ratios (LRR) were utilized to describe the magnitude of the functional relations between the behavioral measures by quantifying functional relations of proportionate change between phases in the level of the outcome [47]. The LRR, a general metric of an effect size index, compares two mean levels. The direction of improvement is indicated as LRR-d for decrease (in the measures of WOB, SOB, DD, and DA). The confidence level was set at 0.95. The percentage change metric helps conceptualize the effect size of treatment impacts. The LRR calculations were completed using the calculator available at https://jepusto.shinyapps.io/SCD-effect-sizes.

2.5.2 Qualitative

The following data analysis methods for the current study were adopted from Groenewald and Linville and colleagues [42, 43]. First, interview transcripts generated in the videoconferencing software were manually checked and cleaned by the research team. If any parts of the transcript did not make sense semantically during the subsequent coding process, the transcript was cross-checked again with the recording. These verbatim transcripts served as a primary data source along with the field notes described above. Data analysis began with the transcripts and notes being read closely to identify the participants' statements of meaning related to their experience with SKY by the primary author and three additional coders.

The four-person research team completed the coding process with caution, not to impose interpretation, or outside meaning, on the participants' words, particularly in the first stages of coding, so that the overall essence of each transcript could be retained. Each transcript was ultimately independently coded by two individuals. Common categories across interviews and individual coding variations were recorded, leading to the thematic building (vertical analysis process). The findings were based on the final themes and the sub-themes that emerged and were refined across the coding process. Questions regarding the coding process were addressed at weekly meetings and reconciliation of the discrepancies in data coding across coders.

The trustworthiness of the findings was ensured through multiple steps in addition to the strategies mentioned earlier [48]. First, a research collaborator outside the primary team acted as an external auditor throughout the research. Second, the research team attended data analysis training and debriefing sessions frequently. This ensured research effectiveness and that the emerging themes and categories remained truthful to the data. Third, bracketing was employed to limit personal preconceptions from biasing the data analysis.

3. Results

3.1 Acceptability and Feasibility of SKY Among Individuals with COPD

Before exploring intervention effectiveness, the viability of SKY as an intervention for individuals with COPD based on acceptability and feasibility was examined. All participants attended all three days of the SKY intervention and experienced no adverse effects. There was excellent agreement between the SKY instructor's self-rating and the trained data collector's ratings that each component of SKY was covered in training and that each participant accurately demonstrated every component of SKY across the training sessions. Based on the qualitative data, SKY also appeared acceptable to the participants with COPD, and its implementation was feasible even in severe COPD. First, participants expressed an overall positive experience with the SKY intervention, describing it as "a good good program" (Participant 2), "very interesting and helpful" (Participant 1), and that they could "appreciate all the benefit I'm getting" (Participant 4). Participant 7 felt "like I've accomplished something" with multiple participants indicating how much they enjoyed the program: "I do feel better, and I enjoy it" (Participant 3); "I really enjoyed it. I enjoyed the whole experience" (Participant 8); "You know it's not that strenuous of an exercise that it's gonna hurt you physically, you know, and which- which I like" (Participant 2). Participants commented on how the SKY techniques were not only helpful but also interesting and easy to learn. One participant shared that the depth of the program was worthwhile.

Finally, regardless of disease severity, all participants reported that based on their personal experiences with SKY, they would recommend such a program to their peers with COPD. In particular, participants felt they would recommend SKY because it was beneficial and something they could participate in, regardless of physical ability. Overall, the participants shared that SKY brought a new perspective on life, markedly contributing to its value. See the Appendix for detailed illustrative examples of the participants' quotes.

3.2 Effectiveness of SKY Among Individuals with COPD

3.2.1 Single Case: Functional Relation Between SKY and Improved COPD Burden

To examine the potential effectiveness of SKY for individuals with COPD, we explored whether a functional relation exists between SKY and dyspnea perceptions (i.e., work of breathing, WOB; shortness of breath, SOB; dyspnea-related distress, DD; and dyspnea-related anxiety, DA). Below, data visualizations, Tau-U, and LRR statistical analyses are discussed.

Figure 1 graphically displays participants' ratings of WOB on the Modified Borg Scale. At the individual level, most participants, except for Participants 5 and 7, demonstrated variability in level (i.e., the magnitude of the data) and trend (i.e., direction) across the baseline phase. There appeared to be a change in variability of rated WOB post-SKY for Participants 1, 2, and 4, with visual analysis revealing that these participants demonstrated a greater degree of stability post-SKY. When comparing the baseline data with the data gathered during the SKY and the post-intervention phases, Participant 1 demonstrated a shift in level in the post-intervention phase, with the data indicating a stable level and trend. While showing a single spike in the post-intervention phase, he quickly returned to his post-intervention stability. Participant 3 demonstrated a decreased trend towards the end of SKY with a reduction in perceived WOB. For Participant 6, there was less extreme variability in perceived WOB during the post-intervention phase compared to the baseline. Overall, the influence of SKY on WOB differed across all participants, and each participant's WOB rating differed across the study time points.

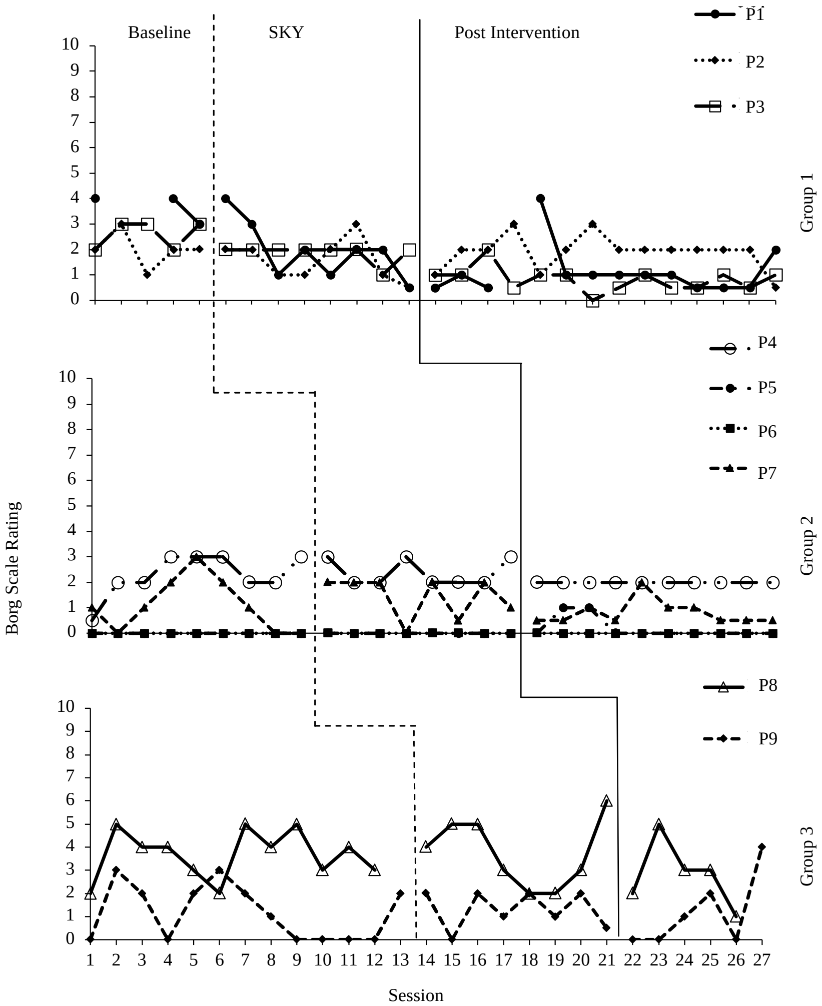

Figure 1 Perspective of work of breathing severity.

The results of the statistical analyses for WOB are summarized in Table 6. The majority of participants demonstrated a small Tau-U effect size. A medium-to-high effect size was calculated for Participant 1 (0.83) and Participant 3 (0.87). Participant 7 had a Tau-U of zero, mirrored in the data visualization, where his perceptual ratings were consistently zero. Based on the LRR, six of the participants (i.e., 1, 2, 3, 4, 6, and 8) demonstrated varying degrees of improvement for perceived WOB (i.e., reduced WOB), ranging from 5.5% (SE = 0.13) to 61.28% (SE = 0.19); the other three participants (i.e., 5, 7, 9) showed no change. The greatest improvement was observed for Participant 1, followed by Participant 3. The treatment effect on WOB for Participant 1 was estimated as -0.95, 95% CI: [-1.33, -0.57], corresponding to a decrease in WOB of 61.28%, 95% CI: [-73.52%, -43.38%]. Similar to the findings from the data visualization, several participants showed a high degree of variability across their ratings. In particular, Participants 6 and 9 had relatively high standard errors (SE = 0.35 and 0.38 respectively), corresponding to the variable level and trend observed on the data visualization.

Table 6 Work of Breathing Results.

Participant	Effect Size			Standard Error for LRR-d Estimate	LRR-d 95% Confidence Interval	Percentage Change 95% Confidence Interval
	Tau-U	LRR-d Estimate	Percentage Change			
1	0.83	-0.95	-61.28	0.19	[-1.33, -0.57]	[-73.52, -43.38]
2	0.15	-0.13	-12.12	0.18	[-0.48, 0.23]	[-38.39, 25.34]
3	0.87	-0.77	-53.55	0.15	[-1.06, -0.47]	[-65.45, -37.56]
4	0.26	-0.06	-5.50	0.13	[-0.31, 0.20]	[-26.6, 21.66]
5	-0.11	NA	NA	NA	NA	NA
6	-0.05	-0.06	-6.13	0.35	[-0.75, 0.63]	[-52.93, 87.18]
7	0.00	NA	NA	NA	NA	NA
8	0.13	-0.08	-7.32	0.15	[-0.37, 0.22]	[-30.83, 24.18]
9	-0.15	0.07	7.04	0.38	[-0.68, 0.82]	[-49.42, 126.51]

Note. LRR-d is log response ratio - decrease. NA is not applicable or unable to calculate percentage changes.

Figure 2 graphically displays participants' ratings of perceived SOB on the Modified Borg Scale. At the individual level, Participants 1, 3, 4, and 6 demonstrated a more stable level post-intervention than in the other phases. Participants 3 and 6 demonstrated a change in level post-SKY, and Participants 1 and 4 exhibited more stability after SKY than before. Participant 2 showed decreased variability in SOB rating post-SKY as compared to before. Overall, the influence of SKY on SOB differed across all participants, and each participant's SOB ratings differed across the study time points.

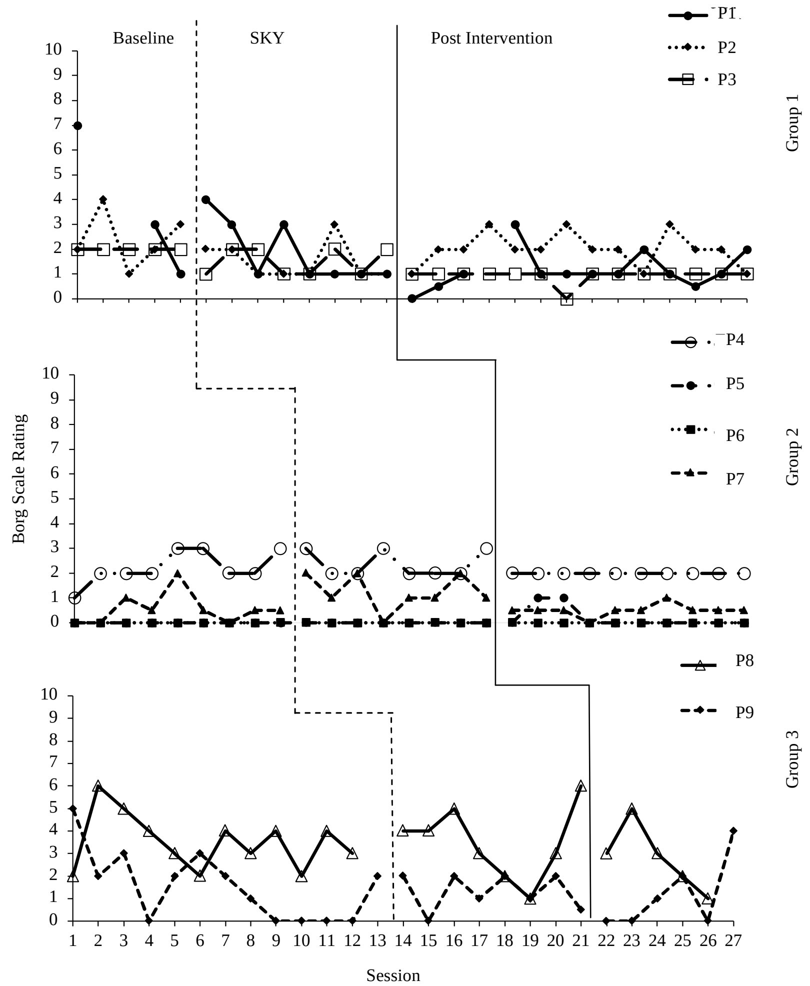

Figure 2 Perspective of shortness of breath severity.

The results of the statistical analyses for SOB are summarized in Table 7. In examining Tau-U, Participant 3 demonstrated a medium-to-high effect (0.82), while the effect size was small for the rest of the participants. Based on the LRR calculations, no improvements were observed for Participants 5 and 7, reflected in their data visualizations, where their perceptions were mainly rated as zero. The remaining seven participants all demonstrated varying degrees of improvement, with percentage changes ranging from 2.9% (SE = 0.11) to 64.88% (SE = 0.51). Participants 1 and 3 exhibited the greatest improvement in SOB. The effect of treatment estimated for Participant 1 was -1.05, 95% CI: [-2.04, -0.06], which corresponded to a decrease in SOB of 64.88%, 95% CI: [-86.96%, -5.41%]. Participants 1 and 6 had the largest standard error, at 0.51 and 0.42, respectively, likely representative of the variable level and trend in perceived SOB across the baseline and SKY phases observed in data visualization.

Table 7 Shortness of Breath Results.

Participant	Effect Size			Standard Error for LRR-d Estimate	LRR-d 95% Confidence Interval	Percentage Change 95% Confidence Interval
	Tau-U	LRR-d Estimate	Percentage Change			
1	0.49	-1.05	-64.88	0.51	[-2.04, -0.06]	[-86.96, -5.41]
2	0.32	-0.30	-25.66	0.23	[-0.75, 0.15]	[-52.56, 16.49]
3	0.82	-0.56	-42.96	0.09	[0.73, -0.39]	[-51.97, -32.26]
4	0.17	-0.03	-2.90	0.11	[-0.24, 0.18]	[-21.48, 20.07]
5	-0.11	NA	NA	NA	NA	NA
6	-0.28	0.35	41.66	0.42	[-0.47, 1.17]	[-37.69, 222.05]
7	0.00	NA	NA	NA	NA	NA
8	0.03	-0.08	-7.37	0.17	[-0.40, 0.25]	[-33.23, 28.5]
9	-0.11	-0.22	-19.48	0.37	[-0.95, 0.52]	[-61.35, 67.67]

Note. LRR-d is log response ratio - decrease. NA is not applicable or unable to calculate percentage changes.

Figure 3 graphically displays participants' ratings of DD on the Modified Borg Scale. Comparing the baseline and intervention phases, Participant 1 demonstrated a more stable level and trend post-SKY. Participant 3 exhibited a stable level post-SKY. Participant 4 demonstrated greater stability post-SKY, and Participant 6 presented a change in level post-SKY. Finally, Participant 9 presented with consecutive days of stable level and trend a few days before the start of intervention towards the end of the data collection period. Overall, the influence of SKY on DD differed across all participants, and each participant's DD rating differed across the study time points.

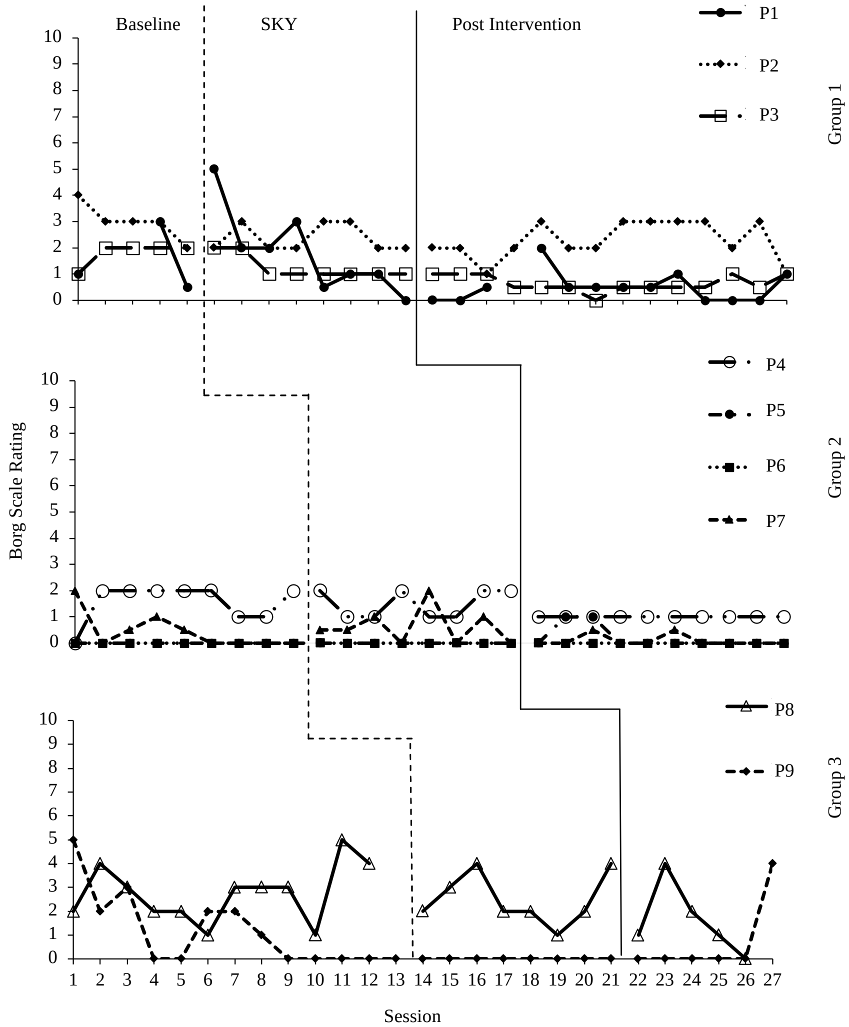

Figure 3 Perspective of dyspnea-related distress severity.

As displayed in Table 8, participants' responses varied based on effect size calculations. Participant 3 showed the greatest treatment effect (0.83; medium-to-high), while most participants demonstrated a small effect. Participant 7 had a Tau-U of zero, mirrored in the data visualization, where his perceptual ratings were consistently zero. Based on the LRR calculations, no improvements were observed for Participants 5 and 7, likely reflecting the majority of their ratings being zero, as observed in the data visualization. The remaining six participants demonstrated varying degrees of improvement, with percentage changes ranging from 21.25% (SE = 0.21) to 61.99% (SE = 1.07). Of those six, the greatest improvement was observed for Participant 9, with the effect of treatment estimated as -0.97, 95% CI: [-3.06, 1.13], which corresponded to a decrease in DD of 61.99%, 95% CI: [-95.32%, 208.96%]. Participant 9 also demonstrated the largest standard error at 1.07, likely reflecting his variable level and trend in the baseline phase and a spike in severity rating observed on the last day of data collection post SKY.

Table 8 Dyspnea-Related Distress Results.

Participant	Effect Size			Standard Error for LRR-d Estimate	LRR-d 95% Confidence Interval	Percentage Change 95% Confidence Interval
	Tau-U	LRR-d Estimate	Percentage Change			
1	0.33	-0.50	-39.27	0.58	[-1.63, 0.63]	[-80.37, 87.82]
2	0.43	-0.26	-23.02	0.12	[-0.50, -0.02]	[-39.27, -2.41]
3	0.83	-0.73	-52.00	0.16	[-1.05, -0.42]	[-64.93, -34.29]
4	0.36	-0.25	-22.11	0.18	[-0.60, 0.10]	[-44.85, 10.01]
5	-0.11	NA	NA	NA	NA	NA
6	-0.03	-0.35	-29.18	0.64	[-1.60, 0.91]	[-79.77, 147.86]
7	0.00	NA	NA	NA	NA	NA
8	0.33	-0.24	-21.25	0.21	[-0.65, 0.17]	[-47.67, 18.51]
9	0.15	-0.97	-61.99	1.07	[-3.06, 1.13]	[-95.32, 208.96]

Note. LRR-d is log response ratio - decrease. NA is not applicable or unable to calculate percentage change.

Figure 4 graphically displays participants' ratings of DA on the Modified Borg Scale. Most noticeably, Participants 1, 2, 3, and 4 demonstrated multiple days of stable level and trend post-SKY without an apparent change in variability compared to the baseline and SKY phases.

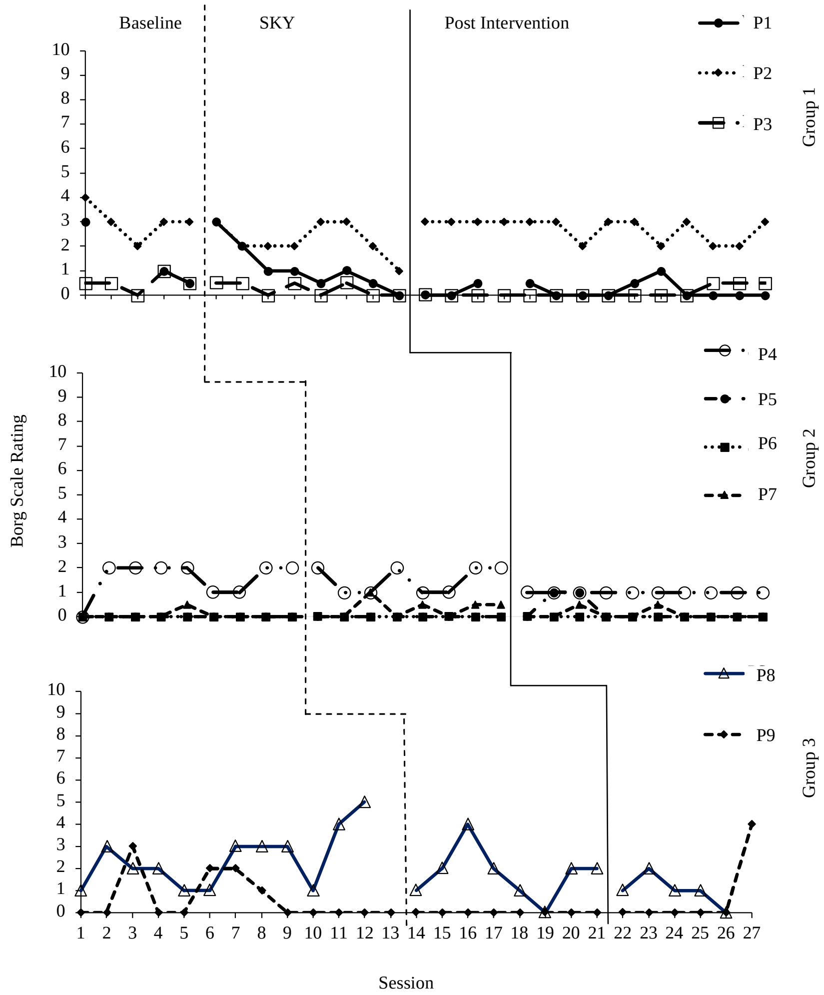

Figure 4 Perspective of dyspnea-related anxiety severity.

Statistics for DA are displayed in Table 9. Based on the Tau-U calculations, six participants (1, 2, 3, 4, 8, and 9) demonstrated a small effect size, and the remaining three (Participants 5, 6, and 7) showed no effect. For example, Participant 7 had a Tau-U of zero, mirrored in the data visualization, where his perceptual ratings were consistently zero. Concerning LRR calculations, no improvements were observed for Participants 5, 6, and 7, consistent with their data visualizations, where perceptual responses hovered around zero. The remaining six participants demonstrated varying degrees of improvement, with percentage changes ranging from 15.52% (SE = 0.12) to 68.15% (SE = 0.45). Participant 1 exhibited the greatest gains. His estimated LRR for DA was -1.09, 95% CI: [-2.26, 0.08], corresponding to a decrease in DA of 66.35%, 95% CI: [-89.53%, 7.96%]. Participant 3 had a standard error of 0.45, likely due to his variable level and trend on the data visualization.

Table 9 Dyspnea-Related Anxiety Results.

Participant	Effect Size			Standard Error for LRR-d Estimate	LRR-d 95% Confidence Interval	Percentage Change 95% Confidence Interval
	Tau-U	LRR-d Estimate	Percentage Change			
1	0.54	-1.09	-66.35	0.60	[-2.26, 0.08]	[-89.53, 7.96]
2	0.31	-0.17	-15.52	0.12	[-0.40, 0.06]	[-32.78, 6.18]
3	0.55	-1.14	-68.15	0.45	[-2.03, -0.26]	[-86.8, -23.14]
4	0.38	-0.25	-22.11	0.18	[-0.60, 0.10]	[-44.85, 10.01]
5	-0.11	NA	NA	NA	NA	NA
6	-0.23	0.82	127.18	1.07	[-1.27, 2.91]	[-71.86, 1734.33]
7	0.00	NA	NA	NA	NA	NA
8	0.58	-0.50	-39.06	0.25	[-0.09, 0.00]	[-62.92, 0.15]
9	0.14	-0.38	-31.47	1.11	[-2.54, 1.79]	[-92.14, 497.82]

3.2.2 Qualitative Phenomenon: Lessened COPD Burden After SKY

A central phenomenon of 'lessened COPD-related mind-body-breath burden after SKY' emerged from the interviews. Overall, the qualitative data revealed that COPD's physiological manifestations and psycho-emotional consequences could be improved via SKY. Specifically, SKY appeared to play a vital role in enhancing aspects of the mind, body, and breath and alleviating or minimizing the cyclical impacts of COPD's physiological and psycho-emotional effects. Significantly, participants not only acknowledged reductions in COPD-specific symptoms but also consequently described how the reductions in symptoms helped enhance other aspects of life - and vice versa.

Three interrelated categorical themes tied to the overall concept of lessened COPD-related mind-body-breath burden surfaced from the qualitative interview data that illustrated the components involved in living with COPD: (a) mind; (b) body; and (c) breath. Figure 5 provides a schematic representation of these themes. The themes are described below, illustrated by participants' own words. More detailed illustrative examples of participant quotes are provided in the appendix.

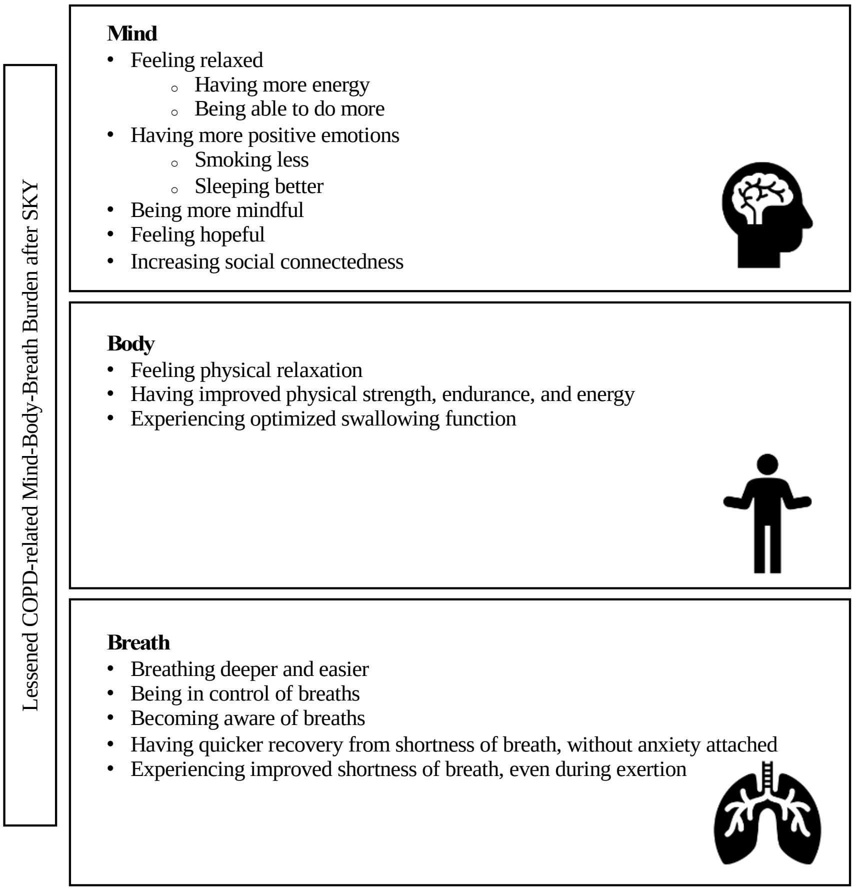

Figure 5 Lessened COPD-related mind-body-breath burden after SKY.

Firstly, participants reported psycho-emotional changes following the SKY intervention or changes related to the mind. Many indicated feeling "more relaxed" (Participant 1), ultimately benefiting their overall affect. For example, as Participant 6 expressed, "The meditative part of it, you know, getting to that point of relaxation. It was very calming and very peaceful. I enjoyed it, I really did, yeah." Participants also noted experiencing more positive emotions replacing negative ones throughout the day. Another participant stated, "I'm feeling better than I did because I was getting so frustrated with how this world is going right now…I noticed that I don't get ticked off as much as I am" (Participant 3). Notably, this shift in affect led to changes in behaviors, such as decreased smoking and improved sleep.

Significantly, these changed behaviors, in turn, served to improve mood further, as expressed by Participant 9, "I'm in a better mood and happier, but I think because I'm sleeping better." Similarly, participants said being more mindful overall also contributed to a more general improvement in well-being. As one participant explained, "I'm just more mindful, you know it's like the-it's the catalyst to really, you know, try to take better care of myself" (Participant 8). As a result of these positive changes, participants also noticed having more energy during the day and being able to accomplish more. As a further contribution to the positive psycho-emotional impacts of the intervention, SKY also appeared to connect people socially and bring more positivity into the participants' lives.

Secondly, the data revealed physiological benefits that participants experienced as a result of SKY, from increased body relaxation to enhanced physical strength and energy for various activities.

One participant even summarized a clear benefit of these physiological changes on her swallowing physiology: "When I get more stressed at silly things like right now the dog is being a pest but she's but I don't feel stressed about it that's just who she is, see here's your toy. But when I would feel stressed and then go for a drink of water, I know that I have to concentrate or I would choke on it, and now, in fact I just had a sip of water, while we were talking I didn't even think about it, I just know I did because I saw the glass move. So it's I have to concentrate less, and I really think that the connection is the reduction of stress… Does everybody do it a different way, I really think that the tension that I carry I carry most of my tension in my neck, and my shoulders and so when I feel stressed, I think I constrict everything, and I think its physiological as well." (Participant 4).

The third theme that emerged surrounded breath. Participants shared that "I'm not breathing as hard" (Participant 1), which empowered them to be more active, "…knowing that I can control my breathing when I need to…not just huff and puff" (Participant 1). The qualitative data revealed that SKY allowed participants to breathe deeper breaths. Participants also shared that they become more mindful of their breathing. Participants also reported noticing that their shortness of breath had become less severe, even during exertion, and that when an episode of breathlessness did come on, they could recover from it more quickly without the emotional consequences of anxiety attached. One participant also commented that the frequency of their inhaler use had reduced since their participation in SKY: "My breathing is fairly decent now. I haven't been using my inhalers as much… I was using them you know about every six hours and now I'm using them about two or three times a day. It's slowly went down a little bit." (Participant 3).

Overall, participants acknowledged that the impacts of COPD are accurately reflected through a mind-body-breath feedback loop [49] and that this loop occurs across all daily activities, "independent of eating" (Participant 9). They also agreed that SKY, by improving aspects of the mind, body, and breath, was vital in preventing or disrupting such cyclical psycho-physiological consequences. Others shared that optimizing the quality of their breathing ultimately helped prevent further cyclical effects. Participants also described how SKY addresses the mind, body, and breath aspects of COPD simultaneously.

Ten weeks after the completion of SKY, participants were allowed to respond to a written open-ended question about whether there were any changes they noticed since the interview that they thought might have to do with SKY. Participant 5 felt "happy to learn a new method of relaxation." Participant 7 shared that he recovers faster from shortness of breath and that "I think I'm breathing a little better." Several participants commented that they continued to experience an improved state of mind as well as quality of life:

"More attentive to self. More meditative and calm." (Participant 4).

"I am more relaxed when I do the breathing...I enjoyed the training." (Participant 6).

"I have learned to significantly relax more than in the past. There are things that seem to not bother me as much as they had before. I have found it easier to go to sleep after the exercises. I feel that my breathing is somewhat easier after exercising. I feel the training was well worth my time." (Participant 3).

Perhaps even more broadly, one participant also expressed that he continues to feel hopeful about life and "a bit more interested in improving my health" (Participant 2).

4. Discussion

This study explored the viability of SKY Breath Meditation for improving dyspnea among individuals with COPD. A growing body of research supports the impact of COPD on psycho-physiological aspects of life. Yet, effective evidence- and fidelity-based treatments that target both the physiological and the psycho-emotional nature of these diseases remain underexplored. Interventions that promote a positive mind-body-breath feedback loop, such as SKY, may comprehensively address this need. Using a mixed-methods design, this study investigated the overall effectiveness of SKY, specifically 1) the functional relation between SKY and dyspnea perceptions (i.e., WOB, SOB, DD, and DA) and 2) the feasibility and general perceived effectiveness of SKY. This study represents the first systematic examination of the viability of SKY as an intervention for individuals with COPD, including its role in influencing the psycho-physiological aspects of life in this population.

4.1 Feasibility and Effectiveness of SKY Among Individuals with COPD

4.1.1 Single Case Perspectives

Our results suggest that SKY positively impacted the perceptions of WOB, SOB, DD, and DA for at least some participants with COPD [50]. Indicators of the improvements were based on visual analyses and Tau-U and LRR effect sizes. It is important to note that the nature of COPD is that even in stable, community-dwelling individuals, their breathing functions can vary from moment to moment. This pattern was mirrored in the current data visualization, as not all participants achieved a stable baseline or stability in the study phases. This variability was additionally evidenced by some of the large standard errors for LRR and the wide confidence intervals. Overall, though, many participants did grossly demonstrate a stabling of the level and trend in the four domains of dyspnea measured, often achieving less drastic variability in perceptions after SKY, especially compared to the baseline period before the intervention. The visual analyses corresponded to the Tau-U and LRR calculations, especially for Participants 1 and 3. These two participants, in particular, achieved improved variability, reaching a more stable pattern of the data with corresponding medium-high effects and large percentage changes across a number of the outcome measures.

While SKY improved dyspnea to different degrees across participants, participants' overall responses were more consistently apparent in the affective/distress domain(s) associated with dyspnea than in the intensity/sensory domain(s). Dyspnea can be measured in different facets, as individuals with COPD can distinguish affective dyspnea from the effects of chronic respiratory disease [45]. Our findings that the affective components of dyspnea showed greater improvements are consistent with a pilot study by Donesky-Cuenco et al. examining the benefits of yoga for individuals with COPD [24]. One rationale for the greater response in the affective/distress domain relates to the bidirectional relationship between emotions and respiration. This bidirectional relationship allows for the emotions associated with dyspnea to be optimized through respiration, while the disease process itself takes longer to reverse or influence [51-54]. SKY's systematic approach to respiratory modifications may similarly alleviate some of the chronic psycho-emotional burden related to dyspnea experienced by individuals with COPD in the shorter term, with perhaps greater physiological impacts over time.

4.1.2 Qualitative Perspective

Our qualitative data and fidelity outcomes support SKY as an acceptable and feasible program for individuals with COPD. The participants found the program enjoyable, helpful, and easy to follow. Their positive experience with the program was reflected in their high attendance rate and willingness to share SKY with other individuals with COPD.

Firstly, all participants were able to engage in the intervention successfully. As reflected in the intervention fidelity data, all participants could perform every SKY component accurately. Further, no adverse effects of SKY were reported. The qualitative data further supported participants' engagement, acceptability, and feasibility of the techniques. Notably, participants recognized that most individuals could complete the intervention, with few physical requirements that would limit participation. Further, a couple of participants shared, after learning the advanced victory breath, that "Finished one just a little while ago. It does seem to help my breathing some. Looking forward to doing more" (Participant 3), and "It definitely helps to practice" (Participant 6).

Secondly, our qualitative findings suggest that SKY is a feasible intervention for benefiting multiple aspects of life in individuals with COPD, encompassing the mind, body, and breath, regardless of disease severity. Benefits reported by the participants included reduced dyspnea, anxiety, and sleep disturbance; enhanced exercise endurance, energy, and social connection; and a disrupted dyspnea-anxiety-dyspnea cycle. Pulmonary rehabilitation (PR) is a commonly prescribed non-pharmaceutical intervention for COPD [18]; however, some studies have suggested that individuals with COPD may show reserved opinions about PR [55]. The elevated symptoms of dyspnea, anxiety, and reduced exercise capacity can also contribute to the premature discontinuation of PR [20]. In contrast, participants in the current study reported the SKY experience as "interesting" and "helpful." They enjoyed SKY because it was "not that strenuous of an exercise that it's gonna hurt you physically" (Participant 2).

4.1.3 Overall Effectiveness of SKY

Triangulation of the single-case and qualitative results suggest SKY may be effective at more comprehensively improving COPD psycho-physiological burden. Our findings also support the beneficial role of CAM more broadly in supplementing traditional, physiologic-based treatments for COPD. Notably, SKY is more time efficient when compared to traditional PR [56] or other home-based programs [57, 58]. It is also an evidence-based program taught per a manual in contrast with other CAM approaches [22-24, 59] that may be more time-consuming and utilize techniques from different sources.

Further, the current results suggest that SKY may target many of the key concerns and needs associated with COPD. A recent meta-synthesis, aimed at systematically understanding the lived experience of COPD revealed several themes that described the experience and the ongoing needs of individuals with COPD [60]. These themes included: (a) understanding of the condition (individuals wanting a better understanding of the condition); (b) sustained symptom burden (breathlessness, fatigue, and frailty); and (c) the unrelenting psychological impact of living with COPD (anxiety, social isolation, loss of hope, and maintaining meaning). Relatedly, managing the symptoms and concerns of individuals with COPD encompass treatment for breathlessness, fatigue, anorexia, pain, depression, anxiety, cough, and daytime sleepiness and insomnia [61-63]. Significantly, these reported lived experiences, management symptoms, and concerns map onto the single-case results and qualitative themes from the current study, particularly in aspects of daily life that SKY positively influenced. Based on the changes our participants reported, it is evident that the program can serve individuals with COPD multi-dimensionally. It suggests that SKY can target multiple important domains of disease burden in COPD.

The lessened psycho-physiological COPD burden after SKY is consistent with the previous SKY research in which widespread benefits were observed across multiple populations. Significant reductions in stress, anxiety, and depression have been found across heterogeneous populations. [64-67]. A considerable improvement in life satisfaction, resilience, and sleep quality has been reported with SKY, along with restoring and enhancing mental well-being, improving social connectedness, and enhancing sleep quality [32, 33, 65]. Previous SKY research has also supported enhancements at the biochemical level, including rapid and significant effects on gene expression, reducing stress markers (e.g., cortisol, corticotrophin, blood lactate), and increasing biomarkers associated with well-being [67-69].

Further, improved pulmonary function (e.g., reduced respiratory rate and increased lung capacity) has also been associated with SKY [27-30, 34, 70]. Participants in the current study described improved well-being across the mind, body, and breath domains after SKY, including feeling relaxed, sleeping better, having more energy, breathing deeper and more effortless, being in control of breaths, and having quicker recovery from shortness of breath without anxiety attached. Individuals with COPD perceive similar benefits of SKY compared to individuals with other health conditions and healthy individuals targeted in the previous literature.

The perceptual improvements in dyspnea observed in this study following SKY, mainly related to work of breathing and shortness of breath, may be a product of several different mechanisms. Individuals' perceived progress can result from strengthening the respiratory muscles, increased diaphragm and lung excursions, and increased thoracic compliance [71, 72]. By engaging in the active, volitional breathing required of the SKY intervention and home practice (vs. regular breathing that is spontaneous and involuntary), the respiratory muscles may become strengthened. Such practice can also lead to the relaxation of the respiratory muscles, induced by supraspinal mechanisms, which increases expiratory reserve volume, contributing to a rise in vital capacity [73].

Changes after SKY may be associated with an increased parasympathetic dominance via vagal stimulation from vagal somatosensory afferents, resulting in a reduction in sympathetic activity [26, 71, 72]. The Polyvagal Theory also supports the role of the vagus nerve in regulating emotions, social connections, and fear [74]. The various breathing techniques in SKY likely activate diverse fiber groups innervated by the vagus nerve, which passes through the throat, improving vagal tone and leading to improvements in mood and anxiety. Brown & Gerbarg [25] previously used a neurophysiologic model to explain the role of SKY in improving autonomic function, neuroendocrine release, emotional processing, and social bonding as a result of the activation of vagal afferents as well as activation of the limbic system, hippocampus, hypothalamus, amygdala, and stria terminalis.

Our data suggest that SKY can play a beneficial role in alleviating the disease burden of COPD broadly through its influence on the mind, the body, the breath, and the relationship between the three. The sequelae of COPD often influence one another via feedback and feedforward loops [17, 49]. With this knowledge, our study approached the management of dyspnea for individuals with COPD through a broader lens by focusing on improving both physiology-associated and the psycho-emotional-related dyspnea. Targeting both the physiology and accompanying distress is crucial as interrupting the anxiety-dyspnea-anxiety cycle may allow individuals to tolerate more activities of daily living and experience an improved quality of life [15]. Notably, the decreased COPD-related dyspnea burden associated with the SKY intervention suggested here further supports the psycho-physiological relationships associated with dyspnea and chronic illness. For example, past research has indicated that even with improvement in the impairment, patients do not always see these improvements mirrored in their perceived handicap [75]. Our findings highlight the importance of targeting factors influencing patient perceptions of functional disability as researchers continue to explore the inextricable relationship between physiology and psycho-emotional functioning. Our research on SKY adds to the existing literature base in supporting the benefits of CAM.

4.2 Limitations

This study has a few limitations. Firstly, regarding the single-case data collection, due to the variable nature of COPD, it was not always possible to obtain consistent worsening, improving, or stabling data points for every group participant before or after the subsequent group intervention. Secondly, a few restrictions were related to the design and participants. For instance, most data collection was limited to a single-month timeframe after the SKY intervention. The longer-term impacts and maintenance of the intervention effects for individuals with COPD remain unexplored. Additionally, the makeup of the participants limits the generalizability of the findings. Future studies should consider scaling up the study by increasing the sample size, recruiting a more heterogenous sample concerning race and ethnicity, COPD status, and disease severity, involving multiple sites/regions, and including a control group to help strengthen the findings. Lastly, due to COVID-19, the study was limited to remote intervention presentation and data collection, relying on subjective reporting rather than physiological measurements. Physiological measures like pre- and post-pulmonary functions and imaging can shed light on actual respiratory changes and allow for more generalizable conclusions to be drawn about the link between physiological changes, perceived changes in dyspnea, and emotional responses to dyspnea. Despite these limitations, the study's findings lay the foundation and invitation for further research directions.

5. Conclusion

COPD is the third-leading cause of death and a major cause of disability worldwide. It greatly limits physiology and influences the psycho-emotional and social facets of life as well. These COPD-related manifestations can interact with and magnify each other, creating a snowball effect that worsens health and quality of life. Therefore, it is crucial that COPD management comprehensively targets the psycho-physiological consequences of the disease. This study is the first to explore the feasibility, acceptability, and potential effectiveness of SKY among individuals with COPD for reducing dyspnea-related burden. Supported by our qualitative and single-case data, and in light of the absence of any adverse events, the results suggest proof of concept that SKY can be a viable option for alleviating aspects of COPD disease burden related to the mind, body, and breath more broadly as well as reduce the cyclical effect of the disease sequelae. Findings preliminarily support the presence of decreased perceived dyspnea surrounding work of breath, shortness of breath, dyspnea-related distress, and dyspnea-related anxiety after SKY. Larger-scale trials are warranted. Notably, however, despite differing COPD severities, the findings here support that following SKY, individuals with stable COPD can experience improvements in the physiological and psycho-emotional domains of the disease consequences and, by extension, improve quality of life. This suggests that SKY may be a valuable supplement to more traditional therapeutic approaches for this population to address disease impacts comprehensively.

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Author Contributions

TL: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Writing – Review & Editing, Visualization. DL: Methodology, Writing – Review & Editing. RN: Methodology, Writing – Review & Editing. JS: Methodology, Writing – Review & Editing. SS: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft; Writing – Review & Editing, Visualization.

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Competing Interests

The authors have declared that no competing interests exist.

Additional Materials

The following additional materials are uploaded at the page of this paper.

1. Appendix: Qualitative data — Detailed Illustrative Examples of Participant Quotes to Support the Qualitative Phenomenon of Lessened COPD Burden After SKY.

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