UNDERSTANDING BREATHING AND SWALLOWING IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE VIA A HOLISITIC LENS

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TING-FEN LIN

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Student: Ting-fen Lin

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This dissertation has been accepted and approved in partial fulfillment of the requirements for the Doctor of Doctor of Philosophy degree in the Department of Special Education and Clinical Sciences by:

Samantha Shune	Chairperson
Rhonda Nese	Core Member
John Seeley	Core Member
Deanna Linville	Institutional Representative

and

Andy Karduna	Interim Vice Provost for Graduate Studies

Original approval signatures are on file with the University of Oregon Division of Graduate Studies.

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DISSERTATION ABSTRACT

Ting-fen Lin

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Chronic obstructive pulmonary disease (COPD) impacts physiological and psycho-emotional aspects of life. COPD-related secondary sequalae also interact with each other, creating the potential for a synergistic downward spiral of quality of life. For example, dyspnea, one of the most common symptoms of COPD, not only affects the severity of breath and the functioning of the body, but also influences the mind (e.g., anxiety, panic, fear). This negative psycho-emotional state can then create a further cascading effect on the breath and the body. This is particularly relevant during oral intake, an activity that is negatively impacted by the high prevalence of dysphagia (swallowing impairments) in individuals with COPD. Given the breadth of the impact of COPD on multiple facets of health and well-being, it is therefore pivotal to investigate more comprehensive approaches to managing COPD, addressing the mind, body, and breath simultaneously. Sudarshan Kriya Yoga (SKY), a breath-based meditation program, has previously been shown to yield physiological and psycho-emotional benefits for other populations, including healthy individuals, veterans, and those affected by trauma, anxiety, and depression. Therefore, using qualitative phenomenology and single-case multiple-baseline methodologies, the feasibility and acceptability of SKY as well as its functional relation with dyspnea perceptions and mealtime enjoyment and difficulty were investigated among individuals with COPD. A total of nine individuals with varying severities of COPD participated. Data collection included: semi-structured, in-depth interviews; ratings of perceived dyspnea as related to work of breathing, shortness of breath, dyspnea-related distress, dyspnea-related anxiety, and mealtime enjoyment and difficulty; and surveys on psycho-emotional status (Hospital Anxiety and Depression Scale and Positive and Negative Affect Schedule), COPD impact (COPD Assessment Test), and oral intake experience (Eating Assessment Test and Dysphagia Handicap Index). Results suggested SKY to be feasible and acceptable for individuals with COPD. Additionally, the results demonstrated proof of concept that SKY can help alleviate aspects of COPD disease burden related to the mind, body, and breath more broadly as well as reduce the cyclical effect of the disease sequalae. This study is the first to demonstrate that SKY can be a viable complementary and integrative health approach among individuals with COPD.

CURRICULUM VITAE

NAME OF AUTHOR: Ting-fen Lin

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, USA
The Ohio State University, USA
National University of Kaohsiung, Kaohsiung, Taiwan

DEGREES AWARDED:

Doctor of Philosophy, Communication Disorders and Sciences, 2021, University of Oregon
Master of Arts, Speech and Hearing Science, 2010, The Ohio State University
Bachelor of Arts, Western Languages and Literature, 2006, National University of Kaohsiung

AREAS OF SPECIAL INTEREST:

Swallowing and Swallowing Disorders
Comprehensive Management

PROFESSIONAL EXPERIENCE:

Graduate Teaching Fellow, Communication Disorders and Sciences, University of Oregon, 2017 – Present

Speech-Language Pathologist, Brigham and Women's Hospital, Boston, Massachusetts, 2014 – 2015

Speech-Language Pathologist, Sunrise Hospital & Medical Center and Sunrise Children's Hospital, Las Vegas, Nevada, 2011 – 2014

GRANTS, AWARDS, AND HONORS:

Special Education and Clinical Sciences Travel Grant, University of Oregon, 2020

Sponsor-a-Student Scholarship, Dysphagia Research Society Annual Meeting, 2020

American Speech-Language-Hearing Association Award for Continuing Education, 2019

Michellesara Levitan Keith Scholarship, University of Oregon, 2019

Third Place Poster Presentation, Dysphagia Research Society Annual Meeting, 2019

University of Oregon General University Scholarship, 2018

Evelyn H. Bullock Fund for Communication Disorders & Science Research, University of Oregon, 2018

PUBLICATIONS:

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To Nature, who provides me with abundance

TABLE OF CONTENTS

Chapter Page

Chapter Page

LIST OF FIGURES

LIST OF TABLES

Table Page

Table Page

CHAPTER I

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a life-threatening lung disease that is characterized by chronically obstructed 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 (Heron, 2019; Mathers & Loncar, 2006). Its common comorbidities include, but are not limited to, anxiety, depression, increased respiratory rate, and difficulty swallowing (dysphagia) (Schneider et al., 2010; Shaker et al., 1992; Steidl et al., 2014). These comorbidities often contribute to increased mortality and morbidities, including COPD exacerbations, admissions/re-admissions to the hospital, economic burden associated with increased healthcare expenses, and reduced quality of life (Dalal et al., 2011; Hynninen et al., 2005; Pooler & Beech, 2014; Yohannes et al., 2010; Yohannes et al., 2016). In 2010, the economic burden attributable to COPD was $36 billion, including total national medical costs of $32.1 billion and $3.9 billion associated with work absenteeism; this number is only expected to increase (Ford et al., 2015).

Similar to COPD, dysphagia is also a physiologically-based condition. Breathing and swallowing work in synchrony to protect against material from entering the lower airway. When these two mechanisms break down or are discoordinated, individuals can experience dehydration, malnutrition, aspiration pneumonia, and even death (Eslick & Talley, 2008; Jones et al., 2018; Langmore et al., 2002). Individuals with dysphagia are more likely to experience a longer hospital stay, higher hospital bills, and a greater likelihood of needing a post-discharge medical placement (Patel et al., 2018). Dysphagia-related psycho-emotional burden is also heavy. Dysphagia can lead to anxiety, depression, social isolation, and decreased quality of life (Ekberg et al., 2002; Nund et al., 2016; Plowman-Prine et al., 2009). Unfortunately, given the current aging demographics worldwide and associated increase in concomitant healthcare consequences, the number of individuals with dysphagia is also excepted to continue to rise (Leder et al., 2016).

Both COPD and dysphagia yield physiological (i.e., breath, body) and psycho-emotional (i.e., mind) consequences. Unfortunately, these mind-body-breath consequences can further negatively influence one another. A mind-body-breath connection, most basically, suggests that the actions of the mind, body, and breath are all interrelated and interdependent, exhibiting bidirectional relations with one another. For example, this multidirectional relationship between physiology (mind/body) and psychology (brain) is apparent under stressful conditions. A stressful state of mind can lead our nervous system into fight-or-flight mode. The activation of the sympathetic nervous system is characterized by a faster respiratory rate, an alteration of breathing patterns, and a heightened alert state. This triangular relationship is also apparent in the context of COPD. The pulmonary deconditioning that occurs in COPD is accompanied by resultant dyspnea (i.e., shortness of breath), swallowing difficulties, and comorbid anxiety and depression, with the latter often worsening perceived dyspnea and increasing the risk of COPD exacerbations (Bentsen et al., 2014; Dalal et al., 2011; Hynninen et al., 2005). Similar to COPD, dysphagia is also a physiological-driven condition that encompasses the mind-body-breath relationship. For example, when respiratory rate is high, the airway is at increased risk for being compromised due to the less-than-ideal breathing and swallowing coupling positioning (breath/body) (Shaker et al., 1992). Also, current research has suggested that dysphagia is independently associated with anxiety and depression, a body-mind connection (Eslick & Talley, 2008; Santos et al., 2007).

Despite the interrelatedness between the physical and psycho-emotional symptoms and sequelae, each of these components (e.g., COPD symptoms, depression/anxiety, dysphagia) is generally treated in isolation (e.g., medication for anxiety/depression, exercises for dysphagia). Yet, as the mind, body, and breath levels are interconnected and jointly impacted, it is may be more effective to look beyond targeted focal remedies. A comprehensive approach aimed at ameliorating disease symptoms, consequences, and their interactions while improving quality of life can better serve our patients through more person-centered care. That is, apart from the individual and overlapping complexities of COPD and dysphagia, both COPD and dysphagia are connected within a mind-body-breath framework. As these medical conditions are more than just physiological or psychological alone, a broader perspective is needed in order to most effectively address their complexity within condition management. To pivot towards person-centered care and to develop a more thorough understanding about the gaps in dysphagia care in the presence of COPD, it is key to look at these chronic diseases through the mind-body-breath lens (Lin & Shune, 2020). Through such a lens, the physiological-, psycho-emotional-, and quality of life-related factors can be accounted for simultaneously, better targeting whole-person, rather than disease-focused, care.

Person-centered care, first and foremost, commences with listening to our patients' experiences (Cheraghi et al., 2017; Constand et al., 2014; Resnick, 2017). This communication is essential for improved quality of healthcare delivery and outcomes among individuals with chronic conditions who experience functional limitations. More globally, person-centered care establishes improved outcomes, patient satisfaction, and self-management (Rathert et al., 2013). The failure to transition from disease-centered care to person-centered care has yielded a significant gap in our ability to optimize patient care targeted at improved overall quality of life (The American Geriatrics Society Expert Panel on Person-Centered Care, 2016). Person-centered care helps shift away from physiological (or illness-centered) foci alone and encompasses the social, emotional, and psychological implications or consequences of that illness — ultimately resulting in a more comprehensive management approach.

One such person-centered care approach that comprehensively addresses the mind, body, and breath is Sudarshan Kriya Yoga (SKY) (Brown & Gerbarg, 2005a, 2005b). SKY is a breath-based meditation program. Previous research on SKY has suggested benefits in both the physiological and psycho-emotional domains, including relieving anxiety and depression (mind), improving cardiovascular and pulmonary functioning (body), and reducing respiratory rate (breath) across populations (e.g., Kale et al., 2016; Seppälä et al., 2014; Sharma et al., 2017). Such a comprehensive approach may be equally appropriate to address the complexities of COPD and dysphagia in particular.

This study explored the impacts of SKY on the oral intake experience of individuals with COPD. This mixed-methods investigation examined participants' qualitative experiences with SKY (i.e., interviews) as well as preliminarily quantified SKY's impact on self-reported outcomes (i.e., mood, pulmonary burden, oral intake experience). In doing so, we are able to gain a more in-depth understanding of the feasibility and acceptability of a person-centered mind-body-breath approach for COPD and COPD-related dysphagia, which can further direct future management.

Chapter II reviews the literature on COPD, dysphagia, and COPD-related swallowing issues. After reviewing the literature, the chapter presents information on the mind-body-breath connection in relation to COPD and swallowing. The latter portion of the chapter focuses on interventions currently available for COPD and dysphagia and introduces the intervention used for the current study. The chapter closes by presenting the research questions, hypotheses, and expected findings. Chapter III presents a description of the research methods, procedures, and analyses for the current study. The chapter describes the experimental design, participant characteristics, and research procedures. It also defines and describes the experimental intervention, the outcome measures, and methods of analyses for answering the research questions. Chapter IV presents the study results. Chapter V presents a discussion of the results relative to the literature review, study limitations, and directions for future research.

CHAPTER II

REVIEW OF LITERATURE

The following literature review consists of several sections. The first presents information about COPD and its disease characteristics. The second describes swallowing and COPD-related swallowing issues. The third describes the mind-body-breath connection in relation to swallowing and COPD. The fourth discusses the intervention to be used in this dissertation study, Sudarshan Kriya Yoga (SKY). The final section provides a statement of the purpose and research questions.

COPD

COPD is a life-threatening lung disease that is characterized by chronically obstructed airflow in the lungs. The mortality associated with this "common, preventable and treatable disease" (p. 1, Global Initiative for Chronic Obstructive Lung Disease; GOLD, 2020) nearly doubled from 1970 to 2000 (Diaz-Guzman & Mannino, 2014). COPD is projected to be the third-leading cause of death (World Health Organization (WHO), 2018) and among the top ten causes of disease burden by 2030 (Mathers & Loncar, 2006). COPD is commonly associated with symptoms like breathlessness, excessive sputum production, and a chronic cough along with comorbid psycho-emotional impacts, such as anxiety, depression, and reduced quality of life. Individuals exposed to tobacco smoking, indoor and outdoor air pollutants, and occupational dusts/chemicals are at risk for developing this lung disease (WHO, 2020). According to the National Ambulatory Medical Care Survey 2016 released by the Center for Disease Control and Prevention (CDC), the number of annual physician office visits with COPD as the primary diagnosis is approximately 5.7 million. Using those visits to describe patient demographics, an estimated 58% of patients with COPD are female and 42% male, and 84% are White, 11% Black or African American, and 6% other (Asian, Native Hawaiian or other Pacific Islander, and American Indian, or Alaska Native persons, and persons with more than one race).

Physiological Characteristics

As an individual breathes, air enters the lower airway from the nose and/or the mouth. The trachea branches into two bronchial tubes and the bronchi branch into bronchioles, ending with round air sacs, alveoli. Each air sac is covered with capillaries. These mesh of tiny blood vessels is where the exchange of oxygen and carbon dioxide takes place. Obstructed airways and air sacs can lead to COPD — hindering airflow in and out of the lungs as well as gas exchange in the alveoli (National Heart, Lung, and Blood Institute, 2019). In 2018, GOLD released a report entitled “Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease”, which detailed the consensus of COPD experts from around the world. Based on the report, a summary of the physiological aspects of COPD is provided here.

COPD is characterized by chronic respiratory symptoms and airflow limitation as a result of airway abnormalities due to significant exposure to noxious particles or gases. A mixture of small airway disease and parenchymal destruction can lead to the chronic airflow limitation in COPD. The chronic inflammation is a result of structural changes, like the narrowing of the small airways and destruction of the lung parenchyma, and it can result in alveolar detachment to the small airways and reduced lung elastic recoil. Consequently, reduced airway opening is observed during expiration, leading to air trapping and CO_2 retention. Airflow limitation and mucociliary dysfunction are also the by-products of a loss of small airways.

The diagnosis of COPD is recommended to be considered if the presenting symptoms include dyspnea, chronic cough, sputum production, and/or history of exposure to risk factors for the disease (e.g., tobacco smoke, smoke from home cooking and heating fuels, occupational exposure to dusts, fumes). Spirometry is utilized in the clinical diagnostic process. Forced expiratory volume in one second, or FEV_1, is the volume of air that can be forcibly blown out in the first second after a full inspiration. Forced vital capacity (FVC) is the volume of air that can be forcibly blown out after a full inspiration. The ratio of these two is used in the diagnosis of obstructive and restrictive lung diseases. A post-bronchodilator $FEV_1/FVC < 0.70$ indicates reduced persistent airflow. The degree of airflow limitation can entail the severity of COPD: mild with $FEV_1 \geq 80\%$ predicted; moderate with $50\% \leq FEV_1 < 80\%$ predicted; severe with $30\% \leq FEV_1 < 50\%$ predicted; very severe with $FEV_1 < 30\%$ predicted.

The most commonly seen symptom of COPD is chronic and progressive dyspnea. Dyspnea can be described by the patients as increased effort to breathe, chest heaviness, air hunger, or gasping. Dyspnea is common in COPD, yet often poorly managed (Swan et al., 2019). In general, up to 16% of individuals experience dyspnea and up to 25% of accidents and emergency admissions are a product of dyspnea (Chin & Booth, 2016). Further, COPD-related dyspnea, and dyspnea in general, is often under-recognized and undertreated (Smallwood et al., 2018). Despite being a physiologically-rooted condition, this subjective experience of difficulty breathing also manifests in the psycho-emotional realms of life. COPD-related dyspnea is a major cause of disability and anxiety (GOLD, 2018). About one in ten individuals experiencing dyspnea present with anxiety (Chin & Booth, 2016). Dyspnea is linked to impeded activities of daily living, unplanned emergency room visits, and reduced quality of life (Swan et al., 2019). Further, individuals with COPD can distinguish affective dyspnea from the effects of chronic respiratory disease (Carrieri-Kohlman et al., 1996). Other symptoms of COPD include: chronic cough (the first symptom of COPD) that is either productive or unproductive; sputum production, intermittent with periods of remission and flare-up; and wheezing and chest tightness, variable between days or within a given day. Patients with more severe COPD may also present with fatigue, weight loss, and anorexia.

COPD exacerbations are characterized by increased airway inflammation during bacterial or viral infections, or as caused by environmental factors (e.g., pollutants). The increased dyspnea during exacerbations can be accounted for by an increased hyperinflation of the lungs and gas trapping due to poor gas exchange with reduced expiratory flow. Hypoxemia (i.e., low level of oxygen in the blood) can also be a result of reduced ventilation/perfusion ratio (V_A/Q) (i.e., the quotient of the air that reaches the alveoli and the blood that reaches the alveoli via the capillaries).

In short, significant chronic lung damage is a physiologic result/cause of COPD and can be associated with increased dyspnea, chronic cough, and sputum production. COPD exacerbations are another physiologic component of the disease process.

Psycho-emotional Characteristics of Anxiety/Depression and Other Related Health Consequences of COPD

COPD affects not only physiological well-being, but psycho-emotional as well. Different methodologies have been used to explore the relationship between COPD and mental health issues. A review was conducted of 81 studies to investigate the psychological characteristics of patients with COPD and the impact of these psychological characteristics on survival, disease severity, functional disability, and quality of life, as well as rehabilitation and treatment (Hynninen et al., 2005). The results revealed a high prevalence of anxiety (10% to 100%) and depression (7% to 79.1%) among this population. Further, emotional functioning, personality traits, and psychopathology scores predicted survival. Personality traits and psychopathology scores even predicted mortality better than the pulmonary function measurements did.

A strong body of research has supported this relationship between COPD and depression and anxiety. One large-scale quantitative study examined individuals over the age of 50 participating in the 2004 Health and Retirement Survey (Schane et al., 2008). Of the 18,588 individuals included in the study, 1,736 self-reported having COPD. The authors investigated potential risk factors for depressive symptoms in COPD and the prevalence of COPD-related depressive symptoms as compared to depression in other chronic illnesses. Results revealed that respiratory symptoms and difficulty walking several blocks were major risk factors for depressive symptoms in individuals with COPD. Additionally, individuals with COPD were more likely to exhibit depressive symptoms as compared to those with other common chronic illnesses (e.g., coronary heart disease, stroke, hypertension, diabetes, arthritis, and cancer). Of interest, a similar risk for depressive symptoms was shared by persons with COPD and those with congestive heart failure. Another large-scale study, involving 35,772 patients with COPD and a matched number of participants without COPD, further supported the finding that COPD is often linked with a subsequent diagnosis of depression (Schneider et al., 2010).

Additional studies using standardized clinical interviews and questionnaires have also explored the relationship between COPD and emotional disturbances, like depression and anxiety. Twenty medically stable, adult inpatients with mild-to-moderate COPD and 20 inpatients with orthopedic complaints (control group) completed standardized clinical interviews and questionnaires regarding the presence of mental disturbances and perceived physical symptoms (Vögele & von Leupoldt, 2008). Compared to the control group, the group with COPD showed higher overall psychological distress, including anxiety. A positive correlation between anxiety levels and physical symptoms was observed in patients with COPD and anxiety disorder, such that the more anxious an individual felt, the more perceived physical symptoms were reported. Additionally, the long-term course of depression in patients with COPD and its impact were investigated in a three-year longitudinal study involving 1,589 patients (Yohannes et al., 2016). The results indicated that about one in four patients with COPD demonstrated persistent depressive symptoms over the three years.

Ultimately, COPD increases the risk for long-term depression. Unfortunately, the consequences of long-term depression and anxiety in patients with COPD can be substantial: comorbid depression and anxiety is associated with increased functional disability, healthcare utilization, and mortality and decreased quality of life in this population (Yohannes et al., 2010). This clinical and financial burden of depression and anxiety have been profiled for individuals with COPD (Dalal et al., 2011). Three thousand seven hundred sixty-one patients with COPD and depression/anxiety were compared to the same number of individuals with COPD only. Patients with concomitant depression or anxiety were at greater risk as compared to the control group for needing to utilize medical expenses. Increased economic burden in the management of COPD in individuals with depression was also significant in one- and two-year follow-ups, supporting the importance of effective therapeutic management of psychological status.

Such psychological distress, particularly long-term depression, can also result in increased COPD exacerbations (Yohannes et al., 2016). A systematic review and meta-analysis supported that comorbid psychological distress in the COPD population yields an increased risk of COPD exacerbation and, potentially, mortality (Atlantis et al., 2013). Researchers have also further studied whether or not the presence of anxiety and depression is related to more frequent exacerbations (≥ 2/year) (Montserrat-Capdevila et al., 2017). Five hundred and twelve patients with COPD (ages ≥ 40) were monitored for 2 years. During the study period, those with anxiety/depression were noted to have a higher incidence of frequent exacerbations than those without (73.8% versus 50.5%). The authors concluded that anxiety and depression are risk factors for frequent exacerbations.

The negative influence of psycho-emotional impairment is not limited to COPD exacerbation alone. Based on a study of thirty patients with mild-to-moderate COPD, researchers found that negative affective states can also amplify the perception of dyspnea in individuals with COPD (Von Leupoldt et al., 2010). In other words, not only can physiological status (e.g., COPD) influence psychological state (e.g., anxiety and depression), the inverse holds true as well (e.g., anxiety/depression leading to increased COPD exacerbation and increased perceived dyspnea). Together, these findings support the interrelationships between the mind, body, and breath in this population.

Laurin and colleagues (2012) proposed two mechanisms that explain how anxiety and depression can lead to increased risk for COPD exacerbations. The first model describes a series of biological pathways. In this model, the increased risk of exacerbations is related to the activation of the hypothalamic-pituitary-adrenal (HPA) axis as well as the increased systemic inflammatory responses associated with anxiety and depression. In other words, immune function may become compromised from the chronic activation of the sympathetic nervous system and the hyperactivity of the HPA axis as a result of chronic psychological stress. A compromised immune function could then lead to the increased risk of respiratory infections and COPD exacerbations seen in this population. The other model illustrates more cognitive and behavioral elements. The authors suggest that poor disease-coping and self-care behaviors related to low self-confidence can be a by-product of anxiety and depression. As a result, patients are less engaged in pulmonary rehabilitation, tobacco cessation, physical activities, good eating habits, and adherence to medical pharmaceutical regimens. The withdrawal from various interventions can increase patients' risk of COPD exacerbations. Additionally, feelings associated with depression (e.g., hopelessness, helplessness, isolation, decreased energy) and those associated with anxiety (e.g., fear, worry) might keep patients from seeking help and also increase their awareness of their physical symptoms. Ultimately, it is clear that the relationship between COPD and anxiety and depression is complex.

Further complicating the picture, the connections between physiological and psycho-emotional impairments in individuals with COPD lead to a variety of additional consequences. A related study aimed to examine the link between anxiety and depression and COPD readmission risk over time (Iyer et al., 2015). Medical records of four hundred and twenty-two individuals with a primary diagnosis of acute exacerbation of COPD were included in the study. Depression was concluded to be a risk factor for acute exacerbation of COPD and related to both short-term (30-day and 90-day) and up to one-year readmissions. An additional systematic review also supported a significant relationship between anxiety, depression, and acute COPD exacerbations with resultant hospital admissions/readmissions (Pooler & Beech, 2014). The relationship between negative affect and physiological impairments appears to have a cascading impact on disease outcomes. As suggested earlier, COPD has also been linked to a number of health consequences known to increase mortality and economic burden and decrease quality of life, such as aspiration pneumonia, more frequent hospital (re)admissions, and increased length of hospital stays (Pooler & Beech, 2014).

Apart from, or perhaps related to, the increased exacerbations and swallowing-related issues, COPD-related anxiety and depression can also have a negative influence on quality of life. A study of 100 patients with COPD was conducted to understand the relationship among anxiety, depression, and disease-specific quality of life as well as generic quality of life (Bentsen et al., 2014). Results indicated that COPD-associated anxiety and depression can negatively impact quality of life. Specifically, age and level of anxiety were related to disease-specific quality of life. That is, worse disease-specific quality of life was reported by younger individuals with COPD and persons with higher levels of anxiety. Further, worse generic quality of life was evident in patients with higher depression scores. Negative affect plays a seemingly key role in individual well-being. Relatedly, a two-year longitudinal study that involved 336 patients was carried out to examine COPD exacerbations and their associated impact on quality of life (Miravitlles, 2004). Over the course of the longitudinal study, a total of 1,050 cases of exacerbations were reported by 287 patients (1.5 exacerbations per patient per year, on average). About 31% of the patients were hospitalized for exacerbations. The authors reported that the health-related quality of life of individuals with moderate COPD was adversely affected by frequent exacerbations. A review of 81 studies investigated the link between psychological characteristics and various aspects of life (e.g., illness, heath, quality of life) (Hynninen et al., 2005). The study revealed that psychological disorders are prevalent in individuals with COPD, which can impact their daily functioning and lead to resultant functional disability. The psychological characteristics were also associated with reduced quality of life and were a predictor of rehabilitation outcomes and survival. Together, these findings support that COPD is a cause of morbidity and disability. Psychological well-being can ultimately be linked to a variety of consequences.

Finally, researchers have looked at the relationship between COPD and brain structure, with notable findings related to the physiological and psycho-emotional links described above. Of interest, COPD has been reported to be associated with structural brain changes (Esser et al., 2016). Thirty stable individuals with moderate-to-severe COPD were compared to a control group (age, sex, and BMI-matched participants without a history of respiratory disease) to illustrate the structural changes of the brain in relation to COPD, disease duration, and disease-specific fears. The authors reported a reduction in gray matter in the posterior cingulate cortex, anterior and midcingular cortex, hippocampus, and amygdala in the COPD group — areas in the brain that are related to processing dyspnea, fear/anxiety, and fear-avoidance behavior. Additionally, the decreased gray matter in the anterior cingulate cortex was correlated with longer disease duration as well as increased fear of dyspnea and physical activity. Given the rise of fear of dyspnea and physical activity, these changes in the brain structure can further impact the course of the disease negatively (e.g., exercise, rehabilitation).

In summary, COPD and its consequences are not only exhibited physiologically within the body and the breath (e.g., shortness of breath, increased effort to breath, wheezing, aspiration pneumonia), but also psycho-emotionally (e.g., anxiety, depression). COPD-associated anxiety and depression can be further linked to increased exacerbations, hospitalizations, length of hospital stays, and economic burden, decreased quality of life, and even changes in brain structures related to fear of dyspnea and physical activity. Given the broad spectrum of consequences and multi-system manifestations of COPD, a more comprehensive management approach that encompasses a mind-body-breath framework may be more effective at improving patient outcomes and may better promote a more person-centered care model.

Dysphagia in COPD

Dysphagia, operationally defined as swallowing difficulties, can also be a comorbidity of COPD. It can result in aspiration, pulmonary-related complications, dehydration, and malnutrition (Cichero et al., 2013; Marik & Kaplan, 2003). Like COPD, dysphagia also affects both the physiological and psycho-emotional domains.

Anatomically, the upper airway is a shared space involved in the coordination between breathing and swallowing to meet nutritional, hydrational, and necessary medical needs. Synchronization between the breathing and swallowing mechanisms prevents material from entering the lower airway (i.e., aspiration), especially during oral intake. One component of such coordination is a short protective cessation of respiration during swallowing (i.e., laryngeal adduction). Disorganized breathing and swallowing mechanisms, a characteristic of dysphagia, is not uncommon among individuals with COPD. Despite frequent reports that it is common, the exact prevalence of dysphagia among individuals with COPD across the general population is unknown (O'Kane & Groher, 2009). Yet, COPD has been reported to be the second strongest predictor for dysphagia-related aspiration pneumonia among nursing home residents (Langmore et al., 2002; Santo et al., 2021).

Perhaps partially underlying the increased risk for pulmonary issues such as aspiration pneumonia, COPD contributes to impairments in the swallowing process. For example, a literature review of 19 studies revealed a relationship between dysphagia and COPD exacerbations in patients with impaired respiratory-swallow patterns (Steidl et al., 2014). A retrospective investigation on the prevalence and nature of dysphagia among outpatients with COPD with suspected dysphagia who were referred for an instrumental fluoroscopic swallow study (modified barium swallow; MBS) revealed that 84.6% did indeed present with dysphagia upon evaluation (Good-Fratturelli et al., 2000). Another study examined the prevalence of dysphagia-related symptoms in individuals with COPD, with a particular focus on gastroesophageal reflux (GER) symptoms (Mokhlesi et al., 2001). The results suggested that individuals with mild-to-severe COPD had an increased prevalence of subjective swallowing complaints and GER symptoms (17%) when compared to those in the control group without COPD (3%). Further, with the aim of understanding swallowing function in patients with mild COPD, two dysphagia tests (Two-step Swallowing Provocation Test; Repetitive Saliva Swallowing Test) were used to examine dysphagia prevalence (Ohta et al., 2009). There was evidence of dysphagia even in patients with mild COPD. Patients with mild COPD presented with a higher rate of abnormal to normal swallows than the control group (6 vs. 0). Given the results suggestive of the presence of dysphagia in mild COPD, the authors suggested that continued monitoring of COPD patients’ swallowing function is warranted. More recently, Garand et al. (2018) reported that underweight individuals with advanced but stable COPD exhibit dysphagia that may not be self-recognized. Further, quantitative analyses of swallowing function have suggested that individuals with stable COPD present with both swallowing safety and swallowing efficiency impairments (Mancopes et al., 2020). These impairments were characterized by impaired mechanism, timing, and duration of the laryngeal vestibule closure as well as increased pharyngeal residue due to poor pharyngeal constriction.

Dysphagia substantially impacts mortality, quality of life, and economic burden. A sample of U.S. hospital discharge data from 2009 – 2013 reported that that individuals with dysphagia (ages 45 – 90) have longer hospital stays, higher hospital bills, a greater likelihood of needing a post-discharge medical placement, and lower inpatient survival rates as compared to individuals without dysphagia (Patel et al., 2018). Individuals with dysphagia also frequently experience anxiety, social isolation, and decreased quality of life (Allen et al., 2019; Marik, 2001; Shune et al., 2012). Therefore, although dysphagia is a physiological condition in nature, it influences life multidimensionally, similar to COPD more broadly.

The following sections will review COPD-related respiratory-swallow patterns and dysphagia characteristics and consequences, both physiologically and psycho-emotionally.

Respiratory-Swallow Pattern

Respiration patterns play a key role in swallowing in order to protect against food and liquids entering the lower airway. Yet, the timely and efficient coordination of the breathing and swallowing mechanisms is often impaired among persons with COPD. To provide a foundation for understanding dysfunction, this section first discusses the typical respiratory-swallow pattern observed in most healthy adults. The complex coupling of the respiratory and the swallowing mechanisms and how they work together in the presence of COPD will then be reviewed.

Multiple studies have examined the typical synchronization between breathing and swallowing coupling during oral intake. A larger-scale systematic investigation into respiratory swallowing patterns in healthy individuals revealed a number of distinct profiles (Martin-Harris et al., 2005). MBS studies were conducted in 82 healthy adults. During the studies, the participants self-administered 5 mL liquid barium sulfate contrast solution twice. Data on the respiratory phase and swallow apnea were recorded via the Swallow Signals Lab. The results suggested that there are four potential respiratory-swallow patterns: 1) expiratory-swallow-expiratory, 2) expiratory-swallow-inspiratory, 3) inspiratory-swallow-expiratory, and 4) inspiratory-swallow-inspiratory. That is, the action of swallowing can be either immediately preceded or followed by inhalation or exhalation. This study concluded that the first pattern, where the swallow is sandwiched in between expiratory flows, is the most common pattern observed in healthy individuals. The larynx is positioned in a paramedian position during expiratory phase. This adducted arytenoid/vocal fold positioning of the true focal folds before or after the swallowing is thought to better protect the airway when compared with the abducted position observed during inhalation. Additional advantages of having expiration before and after swallow include: (a) during expiration, the diaphragm is relaxed with the larynx elevated (vs. during inspiration, the diaphragm contracts with the larynx lowered), which allows for a more optimal position for airway protection for the epiglottis to fully invert and cover the larynx (Martin-Harris et al., 2015); and (b) swallowing followed by expiration can help expel penetrated material out of the airway (Martin et al., 1994). Additional normative data on the respiratory-swallow pattern has also been previously reported based on data from 21 healthy adults (Martin-Harris et al., 2003). The most predominant phase coupling pattern was again expiratory-swallow-expiratory (79% to 82% of the trials), followed by inspiratory-swallow-expiratory (18% to 21% of the trials).

The coordination between breathing and swallowing has also been investigated specifically in the COPD population. Gross et al. (2009) aimed to examine the respiratory-swallow patterns in patients with moderate-to-severe COPD. The patterns were compared between 25 participants with stable COPD and 25 participants in a healthy control group. The authors concluded that the coupling of the breathing and swallowing cycle is disrupted in the presence of COPD, even when the disease is stable. The individuals with COPD exhibited inspiratory-swallow-inspiratory patterns significantly more often than the healthy control participants. Additionally, in a study of 16 patients with moderate COPD and 15 healthy age- and gender-matched individuals, the authors reported that the inspiratory-swallow-expiratory pattern was found to be more common in individuals with COPD, while expiration-swallow-expiration coupling was more frequently observed in healthy controls (Cvejic et al., 2011). Further, individuals with COPD present with the inspiratory-swallow-inspiratory pattern significantly more often during exacerbated states as compared to their basal state (Shaker et al., 1992). Both stable and exacerbated COPD states have, in fact, been found to yield significantly different respiratory-swallow patterns when individuals with COPD are compared to age-matched elderly participants. Such disruption in coordination, namely inhaling before and after swallows, is likely to contribute to episodic suboptimal airway protection during swallowing and is concerning for pulmonary compromises, such as aspiration, aspiration pneumonia, as well as subsequent COPD exacerbations. Beyond the physiological effect on the respiratory system itself that could contribute to exacerbation, the anxiety that can be related to aspiration can further magnify the negative consequences and result in future exacerbation events.

Swallowing dysfunction in COPD, including respiratory-swallow discoordination and subsequent aspiration (i.e., material enters the lower airway below the larynx) and penetration (i.e., material remains above the larynx in the laryngeal vestibule), may also be related to alterations in respiratory rate. To better understand the impact of respiratory rate on swallow function, Shaker and colleagues (1992) compared 10 healthy younger adults (ages 18 – 34), 11 healthy older adults (ages 63 – 83), and 22 individuals with COPD (ages 46 – 77). Swallowing and respiration were recorded for all three groups at rest. In addition, the young healthy individuals were exerted via a stationary exercise bicycle to increase their respiratory rate to 20-24, 25-29, and 30-34 breaths per minute. Then their swallowing and respiration cycle data were collected again. For individuals with COPD, data was also collected at two points of time: during an exacerbated state in the emergency room and during a basal state (once the exacerbation subsided). When the young participants' respiratory rate was increased to >20 breaths per minute, significant changes in the respiratory-swallow pattern were observed in dry swallows. When the respiratory rate was 30-34 breaths per minute, changes in respiratory-swallow pattern were noted with water swallows. Participants with COPD, in both stable and exacerbated states, also presented with a higher respiratory rate than the healthy controls (both the young and elderly). Increased respiratory rate and exacerbations appear to result in the alteration of the airway protection mechanism, modifying the intimate relationship between respiration and swallowing and reducing swallowing safety. Furthering Shaker's findings (1992), increased respiratory rate has also been associated with compromised airway protection (i.e., penetration or aspiration) in individuals with COPD (Cvejic et al., 2011). Sixteen patients with moderate COPD and fifteen healthy age- and gender-matched individuals participated in the study. Half of the individuals with COPD exhibited increased respiratory rate at rest (>25 breaths per minute) with resultant penetration/aspiration. Increased baseline respiratory rate and lower baseline oxygen saturation were also associated with the presence of penetration/aspiration. Namely, a compromised pulmonary status at baseline may be predictive of airway invasion.

In conclusion, for individuals with COPD, uncoordinated respiratory-swallow patterns contribute to airway invasion. The suboptimal respiratory-swallowing coupling puts this population at increased risk for aspiration and penetration. Notably, too, when respiratory rate is high, even in the healthy population, airway protection can be compromised. Finally, while the discoordinated respiratory-swallow patterns are risk factors for aspiration and penetration, the psycho-emotional status may also be negatively impacted (e.g., increased fear or anxiety related to aspiration), which may, by extension, amplify the negative consequences, leading to future exacerbations.

COPD-Related Dysphagia Characteristics

Multiple studies have characterized the oropharyngeal swallowing physiology of individuals with COPD. Characteristics of dysphagia are noted across the oral, pharyngeal, and the esophageal phases of the swallowing process, including decreased laryngeal elevation during swallowing and longer laryngeal closure times relative to the cricopharyngeal opening (Mokhlesi et al., 2002). These impairments pose a particular risk for safely consuming oral intake.

For many individuals with COPD, the swallow physiology is impacted across the length of the swallow sequence and a wide range of dysphagia features, particularly in the oral and pharyngeal stages of swallowing, have been reported. One study characterized the oropharyngeal swallow in patients with stable COPD using MBS (Mokhlesi et al., 2002). Participants included 20 patients with stable COPD and 20 age- and sex-matched controls with no history of any disorder that could lead to oropharyngeal dysphagia. Four individuals with COPD reported subjective complaints of mild and intermittent dysphagia (20%). None of these four had previously complained of these symptoms prior to study participation. MBS results revealed varying disordered swallowing characteristics in different stages of swallowing. They included: reduced tongue control, reduced anterior-posterior tongue movement, reduced lingual stabilization, reduced tongue strength, delayed pharyngeal swallow, reduced tongue base retraction, slowed/delayed vestibule closure, reduced laryngeal elevation, and visible cricopharyngeal bar. Based on these results, COPD is associated with abnormal swallowing physiology. In another study, 14 individuals with COPD referred for swallowing evaluations at a pulmonary unit of a rehabilitation hospital underwent both clinical swallowing and MBS exams (Coelho, 1987). The participants' dysphagia was characterized by consistent aspiration (3/14; 21%) and dysfunctions in bolus control (6/14; 43%), lingual peristalsis (10/14; 71%), swallow reflex initiation (5/14; 36%), pharyngeal peristalsis (10/14; 43%), and cricopharyngeal opening (1/14; 7%). Of note, some of the participants in this study had structural or mechanical alterations of the oropharynx, related to, for example, the presence of a tracheostomy tube or being ventilator-dependent. Similarly, an abnormal swallowing reflex has been found to be significantly more prevalent in individuals with COPD as compared to age-matched controls (22/67 vs. 1/19) (Terada et al., 2010). Other studies have found similar results, with individuals with COPD demonstrating delayed pharyngeal swallow response, laryngeal penetration, silent aspiration, and oral, vallecular, and pyriform sinus stasis (Good-Fratturelli et al., 2000). The specific association between cricopharyngeal (CP) function in COPD was studied in individuals with moderate-to-severe COPD (Stein et al., 1990). Twenty-five participants completed either cineradiography or videofluoroscopic gastrointestinal exams. The findings revealed a significant relationship between CP dysfunction and frequent exacerbations and that there was a high prevalence of CP dysfunction among the individuals with COPD (84%; 21/25). Eight of ten of the participants with severe CP dysfunction underwent cricopharyngeal myotomies with reported improved swallowing and relieved symptoms acute exacerbation of respiratory distress. Ultimately, COPD can negatively impact all of the stages of swallowing physiology, including the oral, pharyngeal, and esophageal stages, negatively impacting both swallowing efficiency and safety (Mancopes et al., 2020). When these oropharyngeal dysphagia impairments are combined with respiratory-swallow coordination dysfunction, the consequences can be particularly severe, increasing the risk for pulmonary complications like aspiration pneumonia.

Finally, and relatedly, individuals with COPD experiencing an acute exacerbation are more likely to demonstrate an impaired swallow reflex as compared to patients with stable COPD (Kobayashi et al., 2007). Further, individuals with COPD who demonstrate an abnormal swallowing reflex present with a significantly higher occurrence of exacerbations (Terada et al., 2010). Therefore, dysphagia can serve as a risk factor for COPD exacerbation, and vice versa.

Dysphagia-Related Psycho-Emotional Characteristics and Quality of Life

Physiological consequences aside, dysphagia also results in many psycho-emotional consequences across populations. Although not extensively studied among individuals with COPD, dysphagia, in general, is a known risk factor for anxiety and depression. Additional areas that are impacted include quality of life, social engagement, personal identity, and the burden placed on the caregivers of individuals with dysphagia.

In the development of SWAL-QOL, a swallowing quality of life outcomes tool, McHorney et al. (2002) reported that “33% of these dysphagic patients would screen positive for major depression” (p. 105). This result has been supported and expanded on by many subsequent studies. Two hundred and forty-five nursing home residents, ages 65 or above, participated in a study examining their mental well-being (Chow et al., 2004). All participants had normal or mildly impaired cognition. The results revealed that swallowing difficulties was one of eleven significant risk factors for depressive symptoms. Another study aimed to understand the root of the depressive symptoms present among forty-one patients with amyotrophic lateral sclerosis (ALS) (Hillemacher et al., 2004). Interestingly, the depressive symptoms were related to the swallowing problem items on the ALS Functional Rating Scale, but not to the total ratings. Further illustrating the impact of dysphagia on psycho-emotional wellness, in another study, 1,000 randomly sampled adult individuals completed a validated self-report questionnaire to assess the potential presence of dysphagia (Eslick & Talley, 2008). Of those who reported the presence of dysphagia (vs. absence), the prevalence of clinical depression was 7% vs. 5%; anxiety 20% vs. 14%; and neuroticism 18% vs. 13%. Relatedly, 36 patients with idiopathic Parkinson's Disease completed self-report assessments, regardless of their swallowing status/function (Plowman-Prine et al., 2009). Results revealed that dysphagia is indicative of reduced quality of life and that reduced swallow-related quality of life is suggestive of depression. Finally, in a retrospective study of 73 patients with complaints of dysphagia post head-and-neck cancer-related surgical and non-surgical managements, the severity of dysphagia was found to be associated with anxiety, depression, and decreased quality of life (Nguyen et al., 2005).

Dysphagia can certainly also impact quality of life in individuals with chronic disease, and reduced quality of life further predicts survival. In a systematic review of 35 studies (Jones et al., 2018), the authors concluded that oropharyngeal dysphagia can decrease health-related quality of life. Further, among 495 participants with head-and-neck cancer, pain, eating, and speech domains of quality of life were associated with survival, after controlling for age, time since diagnosis, marital status, education, tumor site and stage, comorbidities, and smoking status (Karvonen-Gutierrez et al., 2008). The impacts of dysphagia can be wide-spread.

Eating is a social process, with food being intricately tied to culture; unfortunately, changes in these related practices can alter an individual's perceived identity and decrease their social participation. When the mealtime is interrupted by dysphagia, a host of psycho-emotional consequences (e.g., unenjoyable mealtime, anxiety or panic during mealtime), loss of self-esteem, social isolation, and consequent reduced quality of life can arise (Ekberg et al., 2002; Hambraeus et al., 1986). Further, the quality of social relationships and self-identity can be affected by eating-related activities, and the impact of eating-related difficulties in a chronic disease can be magnified by further isolating an individual from their social networks (Klinke et al., 2013; Mintz & Du Bois, 2002; Perry & McLaren, 2003; Plastow et al., 2015). Clearly a variety of psycho-emotional and social consequences of dysphagia coexist with the physiological burden of the dysphagia itself. Given the frequent presence of dysphagia among individuals with COPD (O'Kane & Groher, 2009), it is likely that dysphagia then contributes to the psycho-emotional impacts of COPD on these individuals.

Moreover, dysphagia can even impact caregivers' quality of life, from their food experience to their social lives (Nund et al., 2016). The effects of dysphagia on the caregiver can include the disruption of caregivers' daily lives, the need for caregivers to make adjustments in order to meet the needs of their partners with dysphagia, a mismatch between the reality of the dysphagia and caregivers' expectations, and questionable experiences with services — all adding onto the burden of a caregiver. In a systematic review on the burden of caregivers of community-dwelling older adults with dysphagia, the presence of dysphagia and having worsening feeding-related behaviors was found to be associated with increased caregiver burden (Namasivayam-MacDonald & Shune, 2018). The use of a feeding tube was also linked to feelings of heavy burden. Thus, unfortunately, the cascading effect of dysphagia extends beyond the individual to the family level.

In summary, anxiety, depression, social isolation, decreased quality of life, and caregiver burden can all result from dysphagia. Ultimately, the consequences of dysphagia are not limited to the physiological realms, as both mental well-being and quality of life can be adversely affected by the presence of swallow dysfunction.

Mind-Body-Breath Feedback Loop

As illustrated thus far, both COPD and dysphagia are physiological-based conditions; however, the consequences extend beyond the body level, reaching the mind and the breath domains. The subsequent psycho-emotional sequalae can create a domino effect on the disease, worsening the already impaired physiological status, which may further cyclically impact the psycho-emotional domain (Lin & Shune, 2020). This feedforward and feedback loop can be framed within in a mind-body-breath framework, emphasizing the interrelatedness of the physiological and psycho-emotional aspects of the diseases.

The mind, body, and breath are more than just separate entities, but rather have an intimate relationship with one another (Philippot et al., 2002). The mind-body-breath connection, most basically, suggests that the actions of the mind, body, and breath are all interrelated and interdependent (see Figure 1). For example, this multidirectional relationship between physiology (mind/body) and psychology (brain) is apparent under stressful conditions. A stressful state of mind can lead our nervous system into fight-or-flight mode. This activation of the sympathetic nervous system is characterized by a faster respiratory rate, an alteration of breathing patterns, and a heightened alert state. The triangular relationship may be particularly true for individuals with COPD and dysphagia given the physiologic nature of their impairments in combination with the psychological consequences of each disease.

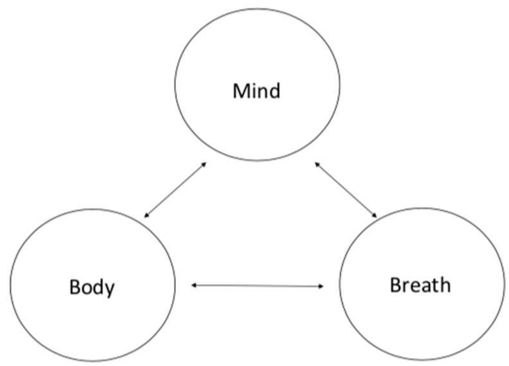

Figure 1. Mind-body-breath connection

While dysphagia is typically considered a more physiologically-focused disorder, it also presents with a comprehensive mind-body-breath connection. For example, dysphagia has a strong physiologic base, exhibiting itself in the oral, pharyngeal, and/or esophageal stage of the swallow as a result of structural, mechanical, and/or neurological impairments. These are the common foci of treatment (McHorney et al., 2000). Yet, dysphagia can also be accompanied by anxiety and depression resulting from the swallowing impairments (body→mind) (Eslick & Talley, 2008; Hillemacher et al., 2004; Lun Chow et al., 2004; Plowman-Prine et al., 2009). When individuals are experiencing negative emotions, such as depression, they often do not have the same interest in food intake (mind→body) (Santos et al., 2007). Further, breath is a vital source of energy for keeping the body alive and the cessation of breath (i.e., a short period of apnea) also serves as a protective mechanism when we swallow to prevent food/liquids from entering the lower airway (breath→body). However, for a patient who is air hungry, or is experiencing the sensation of not enough oxygen, particularly when given a compromised pulmonary status (e.g., an individual with COPD), the body will open the airway to breathe for survival reasons despite the need to close the airway during swallowing (body→breath). In this situation, two opposing systems (i.e., open vs. closed airway) often lead to airway protection issues and consequent aspiration. As a result, aspiration pneumonia may develop and the patient's respiratory load becomes even heavier. More subtly at the mind-breath level, there exists a bidirectional relationship between respiration and emotion. Respiration can influence emotion, and vice versa (Arch & Craske, 2006; Boiten et al., 1994; Kaushik et al., 2006) In the case of COPD, compromised pulmonary status (breath) is often associated with anxiety (mind), which exacerbates the respiratory system (breath) and results in further increased anxiety (mind) (Dudley et al., 1980).

As particularly relevant to individuals with COPD and swallow dysfunction, the intimate interrelationship between the mind and breath among individuals with COPD has also been researched. Fundamentally, dyspnea, according to the American Thoracic Society (1999) is:

> The subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity. The experience derives from interactions among multiple physiological, psychological, social and environmental factors, and may induce secondary physiological and behavioral responses. (p. 322)

Dyspnea is closely related to both COPD and swallowing: this common symptom among individuals with COPD (Carrieri-Kohlman et al., 2001) is a key contributor to functional performance difficulties (Leidy, 1995), and it can lead to increased respiratory rate, which is a physiological factor related to aspiration risk (Steele & Cichero, 2014).

Dyspnea, like pain, is a sensory experience that is perceived, interpreted and rated by the experiencer (Carrieri et al., 1984). Individuals with COPD are able to rate the sensation of breathing effort and discomfort, which suggests that there are both physiological and psycho-emotional aspects of dyspnea: the sensory (i.e., intensity of sensation) and the affective dimensions (i.e., unpleasantness or distress) (Steele & Shaver, 1992). Interestingly, the well-known viscous cycle of anxiety-dyspnea-anxiety (Dudley et al., 1980) can be mediated through exercise training (i.e., exercising on treadmill at increasing levels of speed and grade with coaching), where dyspnea-related anxiety can decrease even in the absence of an improvement in shortness of breath (Carrieri-Kohlman et al., 2001). Namely, the anxiety related to dyspnea, like other fearful stimuli (e.g., pain), can decrease with concomitant coaching about coping strategies and repeated exposure (Carrieri-Kohlman et al., 1993). This indicates that the affective-related dyspnea (vs. sensory-related dyspnea) can be managed and the viscous cycle can be disrupted when considering the disease more broadly. Given the close connection between the mind, body, and breath, particularly in chronic illness, there is a clear need to look beyond physiological impairment or psycho-emotional deficit in isolation and to target interventions at the individual as a whole. Therefore, COPD-related dysphagia may be better understood through a more comprehensive lens that incorporates a mind-body-breath model.

In our previous synergistic review of COPD and dysphagia, we integrated the mind-body-breath model into a framework for understanding COPD, dysphagia and their related sequalae (Lin & Shune, 2020). We concluded that the comorbid anxiety and depression resulting from both COPD and dysphagia contribute to COPD exacerbations and secondary disease sequalae (e.g., social isolation, economic burden, decreased quality of life). The secondary sequalae then, in turn, further impact the psycho-emotional domains, worsening anxiety and depression. See Figure 2 for a graphical representation of this process. It is clear that affective states (e.g., anxiety, depression) both manifest from and create respiratory burden and physiological consequences (e.g., exacerbation) and also yield multifaceted psycho-emotional loads (e.g., social isolation, economic burden, quality of life).

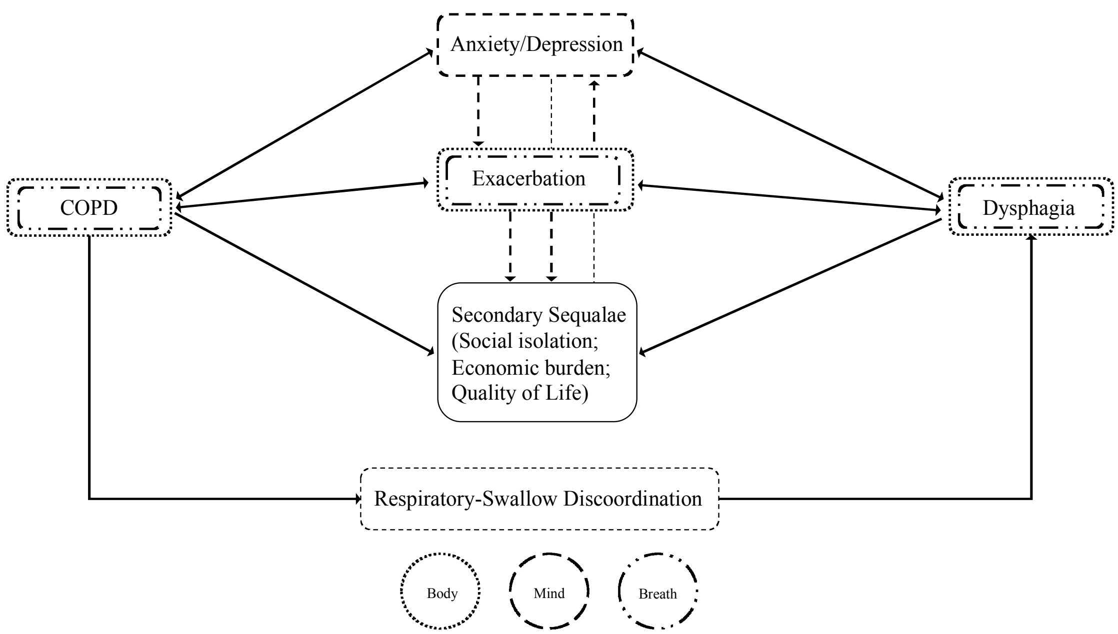

Figure 2. Mind-body-breath connection in relation to COPD and dysphagia — reproduced under the creative common license (Lin & Shune, 2020).

Taken together, given the complexity of the feedback and feedforward loops involved in COPD and dysphagia and the involvement of aspects of the mind, body, and breath, focusing on one component in isolation might not yield the systemic improvements desired across the whole person. Instead, focusing on more holistic interventions that simultaneously target both the respiration that is fundamental to the physiology of COPD-related dysphagia and the anxiety/depression may, by extension, better eliminate the further cascading consequences of the disease (Figure 2). A comprehensive person-centered care that takes the mind-body-breath relationship into consideration, therefore, may better address the synergistic connection of the different systems.

Treatment Options in COPD and Dysphagia

Traditional Treatments

COPD and dysphagia treatments have largely centered around addressing physiological impairment or a single psycho-emotional consequence at a time. For example, dysphagia diet modifications and rehabilitative or compensatory strategies to target swallow dysfunction are common (Garcia & Chambers, 2010; McHorney et al., 2000). While these management approaches (e.g., oropharyngeal dysphagia interventions) do offer support in decreasing symptom severity and improving health-related quality of life (Jones et al., 2018), the psycho-emotional consequences can play a bigger role in life as the affective burden can increase somatic complaints (Verdonschot et al., 2013, 2017). In fact, the perception of improved quality of life may be limited despite improved swallowing function (Patterson et al., 2014). Relatedly, the actual impairment level may not be truthfully reflected in the patient-perceived handicap. That is, even with a minimal degree of improvements in the impairment, patients do not always see the improvements mirrored in the perceived handicap (Ward et al., 2002). Psycho-emotional factors can also contribute to the perception of dysphagia- and COPD-related handicap.

Similarly, in COPD, the psycho-emotional consequences can create a snowball effect, like increased exacerbation, economic burden, and hospital re-admissions. Yet, many treatments commonly used to treat the depression/anxiety and/or the COPD, such as antidepressant drug therapy, pulmonary rehabilitation, cognitive behavioral therapy, education, and self-management, have shown a paucity of evidence for treatment outcomes for improving the comorbid anxiety and depression (Yohannes et al., 2010) and have inconclusive long-term benefits (Yohannes et al., 2017). Not only has the efficacy of psychopharmacological treatment in COPD shown to be limited, patients are often reluctant to take additional medication (Farver-Vestergaard et al., 2018). The delivery of pulmonary rehabilitation has also been questioned in a narrative review (Ambrosino & Fracchia, 2019). The authors suggested that issues like the high number of patients accessing health facilities, high costs of programs, and acceptability can all pose an issue for patients when participating in pulmonary rehabilitation. Fear of dyspnea and exercise can also be related to rehabilitation program adherence (Harrison et al., 2015). Unfortunately, the well-documented presence of disease-related anxiety and depression often impede the progress of disease management. Anxiety and depression have been reported as significant predictors of poor adherence to COPD interventions, including pulmonary rehabilitation (Yohannes et al., 2010).

Given the cascading negative effects anxiety and depression have on swallowing and pulmonary somatic complaints, quality of life, and other socio-economic burden, there is a need to target negative affect in management approaches. First, more research and resources in the management of anxiety and depression in individuals with COPD and dysphagia is warranted. Secondly, managing COPD and dysphagia through the mind-body-breath lens may more comprehensively target person-centered care; yet this is unknown. The utilization of a comprehensive lens, incorporating the physiological and the psycho-emotional aspects of life, can likely yield a more holistic outcome. That is, by managing anxiety and depression (the mind) in concert with the breath (as illustrated in Figure 2), we may be able to prevent further exacerbations and other secondary sequalae from taking place.

Complementary and Integrative Health Interventions

A growing body of literature has supported meditation-based interventions to alleviate anxiety and depression and to improve physiological and psychological well-being (Singleton et al., 2014; Wielgosz et al., 2019). While complementary and integrative health interventions have not been explored as a treatment approach for individuals with dysphagia, these complementary and alternative health interventions have been previously researched among individuals with COPD in terms of managing the disease, although the research remains limited and results mixed. For example, one study examined the use of meditation-focused mind-body classes on individuals with stable COPD in the community (Chan & Lehto, 2016). The authors employed concentration and insight meditation skills as well as mind-body exercises over eight weekly one-hour meetings. The participants showed significant improvement in physical and emotional symptoms, including improved overall breathing, less severe dyspnea exacerbations, improved mood, less reactivity, less anxiety related to the COPD, and better acceptance of their COPD. The efficacy of combined mindfulness-based stress reduction (MBSR; eight weeks) and relaxation response training (two weeks) was investigated in a randomized control study of 86 participants with COPD (Mularski et al., 2009). Results showed no improvement in dyspnea, health-related quality of life, 6-minute-walk test distance, exacerbation rates, stress, or mindfulness. The authors also reported low retention, which may have impacted the findings. Further, a pilot study investigated the feasibility and efficacy of a 12-week yoga program (yoga postures and timed breathing) and its impact on dyspnea intensity and dyspnea-related distress (Donesky-Cuenco et al., 2009). They found that yoga training was safe and feasible for individuals with COPD. There was a greater reduction in distress caused by dyspnea than dyspnea intensity after a 6-minute walk test, indicating that dyspnea-related distress can be managed through yoga. This program also improved the 6-minute walk distance and self-reported functional performance. Some positive changes in muscle strength and health-related quality of life were also reported. The review of complementary and integrative health interventions thus far indicates that some programs help improve physiology and psycho-emotional aspects among individuals with COPD while others do not. However, the previous literature all employed differing breathwork or meditation techniques, or a combination of both. Unfortunately, there is a lack of standardized interventions used in the previous literature. That is, the design of the interventions were a fusion of different components or multiple approaches. Additionally, these programs required multiple weeks of time commitment. Given the fact that individuals with COPD have been reported to have questionable adherence to treatment (Janssens et al., 2019), a shorter program with less time involvement may be more effective in this population.

Breathing-related rehabilitation (e.g., re-training the respiratory coordination pattern) has also been investigated among individuals with dysphagia and individuals with COPD. Re-training typical, or optimized, breathing and swallowing coordination has been investigated in the head-and-neck cancer population (Martin-Harris et al., 2015). Thirty participants with dysphagia re-learned the typical coordination patterns given visual feedback of respiratory phase and lung volume for swallow initiation to help them learn a more optimal timing to elicit a safe swallow. Such retraining has also been completed among individuals with anoxic brain injury. Using single-case methodology, clinical improvements in the coordination of respiratory-swallow coordination were also reported for the participant following the intervention (Curtis et al., 2020). These results demonstrate that improvements in respiratory-swallow coordination can be obtained, thereby improving swallow safety.

Similarly, breathing exercises have been studied in the COPD population to investigate their effects on dyspnea and quality of life (Ubolnuar et al., 2019). A systematic review and meta-analysis of 19 studies showed that pursed-lip breathing, ventilatory feedback plus exercise, diaphragmatic breathing exercise, combined breathing exercises, and singing can improve ventilation and quality of life. However, given low-to-moderate quality of evidence, a strong conclusion was not able to be drawn. Another systematic review evaluated controlled breathing exercises (i.e., diaphragmatic breathing, pursed-lip breathing, yoga breathing) and respiratory muscle training (i.e., strengthening the respiratory muscles) — both often used to improve dyspnea (Borge et al., 2014). It was concluded that pursed-lip breathing can improve breathlessness, and respiratory muscle training can play a role in improving breathlessness, fatigue, and disease-specific quality of life. A single study within this systematic review showed that yoga breathing can improve lung capacity after two months of training for individuals with mild and moderate COPD (Soni et al, 2012). Together, the previous research on breathing-related rehabilitation suggests that breathing can be trained and/or re-learned and that such breathing-focused exercises can yield measurable benefits in decreasing physiological (e.g., lung capacity, swallowing safety) and psycho-emotional (e.g., quality of life) burden.

Additionally, research has been carried out to understand the impact of breathing on wellness more broadly. Past research suggests that respiration and emotion bidirectionally influence each other (Boiten et al., 1994; Ley, 1999; Philippot et al., 2002). For example, breathing interventions have been demonstrated to enhance emotion regulation in healthy individuals (Arch & Craske, 2006). Sixty healthy undergraduate and graduate students responded to the picture slides from the International Affective Picture System during focused breathing and when they were told to “let their minds wander”. Participants who underwent focused breathing exhibited consistent positive responses whereas the groups induced to have unfocused attention and worry demonstrated more negative responses. Breathing interventions have also been reported to normalize parasympathetic activities in anxious populations (Kaushik et al., 2006). One hundred individuals with essential hypertension with and without anti-hypertensive drugs participated in the study. They underwent trainings on mental relaxation (i.e., thinking of something pleasant) and slow breathing (i.e., taking slow and deep breaths with focus on inspirations and expirations). It was reported that both techniques lead to a reduction in systolic blood pressure, diastolic blood pressure, heart rate, and respiratory rate; however, slow breathing resulted in a significant decrease in all-mentioned areas, as compared to other approaches. Therefore, controlled breathing can be effective in normalizing cardio-pulmonary parameters. Finally, breathing interventions are also helpful in healthy populations with experimentally-induced anxiety (Sakakibara & Hayano, 1996). To understand the effect of controlled slowed respiration on cardiac parasympathetic response to threat (i.e., an anticipated electric shock), thirty healthy college students were randomly assigned to slow, fast, and non-paced breathing groups. Results suggested that cardiac parasympathetic withdrawal response to threat is reduced with slowed breathing. Breathing, while an act of survival, also provides a mean to regulate physiological (e.g., blood pressure, bodily response to threat) and psycho-emotional (e.g., remaining positive, regulating emotions) aspects of life.

Further, the act of breathing can be either voluntary or involuntary, or a combination of both. It involves complex feedback mechanisms in the automatic visceral networks, brainstem nuclei, limbic system, cortical areas, and neuroendocrine system (Brown & Gerbarg, 2005a). Yogic breathing adjusts imbalances in the autonomic nervous system and, by extension, influences mental and physical status (Sovik, 2000) as voluntary controlled breathing can influence autonomic nervous system functions (e.g., heart rate variability, cardiac vagal tone, chemoreflex sensitivity, baroreflex, and control nervous system) (Brown & Gerbarg, 2005a).

In summary, while past research theoretically supports the benefits of breathwork and/or meditation for individuals with COPD, their limitations include non-standardized interventions, long interventions and time commitments, and lack of prior research support for the programs themselves. An evidenced-based program that is taught per a manual can enhance the treatment fidelity. Additionally, in a population like COPD, where treatment adherence can pose an issue, a shorter program may improve involvement. Further, work has not explored the benefits of breathwork and/or meditation for individuals with dysphagia. As comorbid anxiety and depression are common in COPD-related dysphagia, trained breathwork may help regulate emotions to remain positive and decrease physiological burden (e.g., as measured by blood pressure, bodily response to threat, lung capacity). Therefore, taken together, utilizing breath-based meditation that is short in duration and delivered according to a manual may be a viable approach to address the physiological and psycho-emotional consequences of COPD and COPD-related dysphagia by directly targeting anxiety and depression, while also addressing pulmonary physiology through structured breathing.

Sudarshan Kriya Yoga

Sudarshan Kriya Yoga (SKY) is a cyclical controlled breath meditation by the Art of Living Foundation (Brown & Gerbarg, 2005a, 2005b). SKY is nine-hour program that is delivered across three days according to a manual. The manual details the flow of the program, precautions to take, and suggested as-needed alterations. The program is facilitated by teachers, who have received over 1000 hours of practicing and teacher training in meditation and breathing. They are certified to modify the instruction of the techniques depending on the medical conditions of the participants.

SKY is composed of four components: ujjayi, bhastrika, “Om”, and Sudarshan Kriya. The victorious breath (ujjayi) is done in three stages of arm positions at a rhythmical and timed pace. The bellows breath (bhastrika) is completed with forceful inhalations and exhalations in a specific cycle. The sound “Om” is said three times. Sudarshan Kriya is carried in cyclical rhythms of three different rates.

Over 100 independent studies across different populations and age groups have been conducted on SKY. Overall, research on SKY (breath) suggests improved physiological (body) and psycho-emotional well-being (mind) (e.g., Seppälä et al., 2014; Sharma et al., 2017). Of relevance to the current proposal, a number of studies have explored the impact of SKY on pulmonary and anxiety/depression-related measures. For example, in one research study, 100 healthy participants completed the SKY program and cardiovascular and respiratory outcomes were collected (Kale et al., 2016). Post-intervention, participants presented with decreased cardiovascular markers (i.e., pulse rate and systolic and diastolic blood pressure) as well as increased respiratory measures (i.e., forced vital capacity, FVC; forced expiratory volume in one second, FEV_1; peak expiratory flow rate, PEFR; breath holding time) when compared to the control group. Another study that involved 63 healthy individuals also showed improved FEV_1, FVC, and PEFR after SKY (Bodi et al., 2008). Based on the normative data, the authors suggested that SKY is an appropriate complementary treatment to pre-existing medical management for individuals with obstructive airway disease. Improved cardiorespiratory parameters were also confirmed in a study of 30 healthy individuals, where decreased heart rate, systolic and diastolic blood pressures, and respiratory rate was reported (Somwanshi et al., 2013). Such physiological improvement following SKY has also been noted in U.S. military veterans with posttraumatic stress disorder symptoms (Seppälä et al., 2014). Reductions in respiratory rate were reported in the intervention group ($n = 11$), but not in the waitlist control group ($n = 10$). Further, past research investigating SKY on the lung function of healthy individuals has suggested exploring the impacts of SKY on obstructive airway disease (e.g., asthmatics) as a future direction (Bodi et al., 2008).

In terms of psycho-emotional well-being, SKY has also demonstrated promise. A total of 25 participants with major depressive disorder who demonstrated inadequate response to anti-depressants participated in the SKY intervention (Sharma et al., 2017). No adverse events were reported in the intervention group (n = 13). Results showed improvements on the Hamilton Depression Rating Scale, the Beck Depression Inventory, and the Beck Anxiety Inventory in the SKY group when compared to the waitlist control. In a recent randomized control trial, SKY was compared to the Foundations of Emotional Intelligence (EI) and Mindfulness-Based Stress Reduction (MBSR) programs in a group of university students (Seppälä et al., 2020). Four groups were compared: SKY (n = 29), EI (n = 21), MBSR (n = 34), and non-intervention control (n = 47). SKY exhibited the greatest positive impact across six outcomes: depression, stress, mental health, mindfulness, positive affect, and social connectedness. EI showed benefit in mindfulness, and MBSR revealed no change as compared to the control group and when controlling for variance of baseline measurements and multiple comparisons. Similarly, SKY was compared to the Wisdom on Wellness (WOW) program across 69 undergraduate and graduate students in a university setting (Goldstein et al., 2020). Both programs showed similar ratings on workshop evaluations and retention rates. However, SKY demonstrated greater improvements on perceived stress, sleep, social connectedness, distress, anxiety, depression, conscientiousness, self-esteem, and life satisfaction.

Literature on SKY has thus far suggested improved respiratory-related functions among healthy individuals and psycho-emotional outcomes in healthy and otherwise affected groups. These positive outcomes can potentially translate to individuals with COPD; however, no literature to date has investigated the acceptability and effectiveness in this population. Previous research has indicated that modifications can be made to SKY in order to serve this population by doing SKY more gently at first to reduce airway irritation (Brown & Gerbarg, 2005b). Further, SKY is a relatively short program in length, compared to other programs discussed earlier. In a population where adherence is an issue, a short program may yield improved compliance and, therefore, improved outcomes. Additionally, SKY is a program that is delivered per a manual when other literature discussed prior used approaches from different sources. As comorbid anxiety and depression are common among individuals with COPD and dysphagia, SKY may be a particularly valuable intervention to comprehensively address these diseases from a mind-body-breath framework.

Statement of Purpose and Research Questions

The purpose of the present study was to investigate the acceptability and feasibility of the SKY breathing-based intervention among individuals with COPD as well as to preliminarily explore the impact of this intervention on self-reported pulmonary burden (body), oral intake experience (body-mind), and overall well-being (mind). This study utilizes a comprehensive lens and offers a unique direction in swallowing and COPD research by providing new insights into the feasibility and acceptability of an approach that moves beyond impairment-level focus to better address the whole person, taking the interconnectedness of the mind, body, and breath into consideration.

This study specifically investigated the following questions:

1. What is the acceptability and feasibility of SKY among individuals with COPD?
   Hypothesis: Nil (phenomenon will be based on participants' narratives).
2. Is there a functional relation between SKY and improved consequences of COPD (i.e., pulmonary burden and oral intake experience)?

a. Is there a functional relation between SKY and dyspnea perceptions (i.e., work of breathing, WOB; shortness of breath, SOB; dyspnea-related distress, DD; and dyspnea-related anxiety, DA)?
b. Is there a functional relation between SKY and increased oral intake enjoyment?
c. Is there a functional relation between SKY and decreased oral intake difficulty?

Hypothesis: It is anticipated that the magnitude of dyspnea-related perceptions and oral intake difficulty will decrease and mealtime enjoyment will increase after SKY.

CHAPTER III

METHODS

Participants

Sixteen individuals with COPD were recruited. Inclusion criteria were: fluency in English, functional cognitive-linguistic skills, and a physician's diagnosis of COPD. Per the recommendations of the SKY Research Committee, all participants were between 30 and 75 years of age. Those with uncontrolled hypertension, neurological disorders, tracheostomy tubes, naso-gastric 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 (within the past 8 weeks), or congestive heart failure were excluded. The study was open to individuals with a range of COPD severity, and severity was not used as inclusion or exclusion criteria. No inclusion criteria related to dysphagia status were used. Additionally, participants were required to have stable internet access and a device to connect to Zoom video and audio features. They were instructed to continue their medical routine as usual.

Participants were recruited via word-of-mouth, flyers posted in healthcare-associated settings (e.g., physician offices) and public/community social media platforms (e.g., Facebook), and email through ResearchMatch. Since this study was conducted virtually, we welcomed participants from anywhere in the United States of America. Additionally, in order to profile the COPD severity of each participant, we attempted to collect information about pulmonary status, including FEV_1 and FVC, directly from the participants; when available, participants shared their most recent pulmonary function test report with the research team.

Participants residing in the same time zone were assigned to the same intervention group (i.e., Pacific, Central, and Eastern). 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 assigned group intervention timing; therefore, they were presented with the timing of the next group.

Of the 16 initial participants who were consented and enrolled in the study, six did not continue into the start of the intervention (three had schedule conflicts with the intervention timings and decided to discontinue; the other three did not provide a reason). One dropped out of the intervention on the second day due lack of interest. Thus, a total of nine participants completed the study. Demographic information for these nine participants is displayed in Table 1, with their most recent pulmonary function test results from their respective clinics in Table 2. Participants' COPD severity was determined stepwise, based on Johnson & Theurer (2014) 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
WA	1	Ohio	70	Male	White/Non-Hispanic	Hypertension, status post 2/3 of right lung lobectomy secondary to cancer	Current smoker	NA
RK	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	NA
RT	1	Ohio	71	Male	White/Non-Hispanic	Skin cancer, hypertension, glaucoma, neuropathy of feet, tinnitus, neck/back issues	Quit smoking	Yes, when weather allows
JL	2	Oregon	61	Female	White/Non-Hispanic	Heart murmur, hypercholesterolemia, skin cancer	Current smoker	Yes
GG	2	Oregon	68	Female	White/Non-Hispanic	Celiac, melanomas, irritable bowel syndrome, osteoarthritis, esophageal dysphagia	History of second-hand smoke	Yes
SS	2	Ohio	59	Female	White/Non-Hispanic	Recurrent major depression	Quit smoking	Yes
JK	2	Illinois	69	Male	White/Non-Hispanic	Prostate cancer, history of pulmonary embolism, shoulder and leg operations	Quit smoking	Yes, at pulmonary rehabilitation

Table 1 (Continued).

Participant	SKY Group	State	Age (Years)	Gender	Race/ Ethnicity	Additional Medical Diagnoses	Smoking History	Prior Exercise Behavior
PS	3	Texas	57	Female	White/Non-Hispanic	NA	Quit smoking	Yes
RF	3	Florida	61	Male	White/Non-Hispanic	Sinus infections, vocal cord damage from house fire	No, history of being in house fire	Yes

Note. NA = not applicable

Table 2

Participants' Pulmonary Function Status

	FVC (%Ref)	FEV_1 (%Ref)	FEV_1/FVC (%)	Pulmonary Function Reference	Severity Based on American Thoracic Society Grades (Johnson & Theurer, 2014)
WA	NA	NA	NA	NA	NA
RK	105	64	44	NHANES III – Caucasian	Moderate
RT	74	53	53	NHANES – Caucasian	Moderately severe
JL	81	45	46	Knudson	Severe
GG	90	89	65	Eigen/Bieler	Mild
SS	NA	NA	NA	NA	NA
JK	93	78	62	NHANES III – Caucasian	Mild
PS	54	22	32	NHANES III	Very severe
RF	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.

Study Design

This study used a mixed-methods design, involving qualitative and single-case methodologies. These methodologies allowed for a broader investigation of the feasibility and potential utility of a mind-body-breath-based intervention for individuals with COPD. A comprehensive lens focusing on both the physiological and the psycho-emotional aspects of dyspnea was adapted. To control for potential effects of the season, all of the intervention sessions and single-case data collection timepoints were completed in the same month. Additional details for each method are provided below.

Qualitative phenomenology aims to capture complete and accurate descriptions of particular human experiences and emotions (Groenewald, 2004). Since the acceptability and feasibility of SKY among individuals with COPD has not yet been explored, this approach was appropriate to employ in order to gain a more complete description of participants' experiences with SKY. Primary sources of data included semi-structured interviews and field notes.

Single-case methodology is utilized to document functional relations between independent and dependent variables. It is a rigorous experimental approach to involve a small number of participants, observing them over time, and it allows each participant to provide their own experimental control (Horner et al., 2005). Further, single-case methodology is ideal for establishing the effects of a new intervention in real-life settings before attempting them on a large scale, such as in a randomized control trial (Byiers et al., 2012; Horner et al., 2005; Lobo et al., 2017). Since SKY has not been studied with individuals with COPD, single-case methodology was employed to explore if there is a functional relation between SKY and improvements in dyspnea, oral intake enjoyment, and oral intake difficulty. This design allowed for understanding of any functional changes in the participants' functional respiratory status after the intervention.

Lastly, quantitative information about anxiety and depression, affect, swallowing status, and COPD were collected to further describe the participant population before and after the intervention. Data were collected through self-report questionnaires including the Hospital Anxiety and Depression Scale, Positive and Negative Affect Schedule, COPD Assessment Test, Eating Assessment Tool-10, and Dysphagia Handicap Index.

Procedure and Analysis

Procedures

This research was conducted with approval from the University of Oregon Institutional Review Board and The Art of Living SKY research committee. Table 3 outlines the procedures and data collection process across all study timepoints; a detailed description of each follows.

Table 3

Procedures 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 victorious 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. Collect questionnaires

Individuals who were interested in participating in the study were contacted by the principal investigator (PI). They were screened on the phone to determine eligibility for study participation. For participants that met the eligibility criteria and chose to enroll in the study, the informed consent process took place via Zoom. Following study enrollment, all of the participants were divided into their time zone groups, and the groups were randomized to determine the order of receipt of intervention. Two individuals had a schedule conflict with their group intervention timings; they were both allowed to join the next group.

Below, I first describe the SKY intervention. Then I discuss the specific data collection procedures associated with the qualitative and single-case portions of the study.

Intervention. SKY is an evidenced-based breath-based meditation program, offered by the Art of Living Foundation. It has previously been shown to result in improvements in mental and physiological well-being, including cardio-pulmonary functioning, in populations other than COPD (Anju et al., 2015; Brown & Gerbarg, 2002; Ghahremani et al., 2013; Seppälä et al., 2014; Sharma et al., 2015). The SKY training is a nine-hour group program that takes place across three days (three hours each day), consisting of victorious breathing (ujjayi), bellow breathing (bhastrika), “Om”, and Sudarshan Kriya. Victorious breath is done via light constriction of the laryngeal muscles. Bellow breath is done via rapid inhalation and forceful exhalation. “Om” is said thrice. Sudarshan Kriya uses cyclical and rhythmic breathing patterns (Brown & Gerbarg, 2005a). Participants in the current study were instructed to complete the breathing techniques more gently at first to reduce airway irritation, as has been suggested previously in the literature (Brown & Gerbarg, 2005b); additional breathing modifications were made as needed, at least in the beginning of the intervention, to allow participants time to acclimate to conscious breathing.

A trained and experienced SKY instructor, who was blinded to the study hypotheses, facilitated the program per the SKY manual. During the intervention phase, the SKY instructor provided visual (e.g., demonstration) and auditory (e.g., verbal instructions) cues to ensure adequate learning of the SKY. She also reviewed breathing techniques every session. Finally, a trained data collector was present throughout the three days of intervention for each group to document intervention fidelity in addition to the instructor (further details below). The intervention was completed via teleconferencing. The first and the second day of SKY mainly focused on breathwork; the participants practiced the home practice on the third day. The home practice consists of victorious breathing, bellow breathing, and a short version of Sudarshan Kriya. The PI was present and supported the SKY instructor as needed.

Five days prior to the start of the intervention (Time 1), participants learned a component of SKY (i.e., victorious breathing) via Zoom in their respective groups. The purpose of this initial training was to help participants get acclimated to the controlled and trained breathing technique. Generally, this instruction was provided in a group setting by the SKY instructor for one hour over a single session. The exception was made for one participant (GG), who could not make it to the scheduled session and had a 1:1 session with the SKY instructor instead. Participants were instructed to practice the victorious breathing daily until the start of the intervention.

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

Upon completion of the three-day intervention, participants were instructed to continue to practice daily for the next ten weeks. Additionally, participants were instructed to attend weekly group follow-up booster sessions, where SKY was completed in the group setting. The weekly ~60-minute follow-up sessions continued for approximately 10 weeks, allowing participants to supplement their daily individual practice with a group via Zoom. Participants were encouraged to attend 75% of the follow-up booster sessions. A follow-up attendance log was also kept.

Qualitative Data Collection. The PI interviewed each participant individually between five and thirteen days after the completion of the three-day SKY training (Time 2 in Table 3). The PI presented brief, open-ended questions to understand the participants' perceptions related to their acceptability and feasibility of the SKY training. The PI did not know 8/9 of the research participants before the study. According to both the PI and the data coders during the analysis process, the interview with the familiar participant followed the standard procedure and no differences were noted. Further, the

PI is a volunteer SKY instructor. To reduce the introduction of bias and limit the potential for the PI's relationship with SKY from impacting the data analysis process, bracketing was utilized to allow the participant narratives and experiences to surface from their own perspective (e.g., interview questions were directed to the participants' experiences and feelings, the researcher "bracketed" her own preconceptions) (Groenewald, 2004) and additional members of the research team were involved in the data analysis process, as will be described below.

The use of phenomenological qualitative methodology allowed the participants' voices to reveal their experience of the SKY intervention (Groenewald, 2004). For a complete list of questions, please refer to Table 4. These questions served as guiding questions — follow-up probes were used depending on participants' responses. The semi-structured interviews took place online via Zoom. Each interview was conducted by the PI and lasted about 30 – 50 minutes. Video and audio recordings were completed. Field notes were also taken to serve as an additional source of primary data.

Table 4

Interview Questions

Qualitative interview questions — adapted from Linville et al. (2018)
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?

Table 4 (continued).

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?

Single-Case Data Collection. A single-case, multiple baseline design across participants was utilized for this study. Participants received the SKY intervention at three different points in time, and the order in which they received the intervention was determined via randomization. Baseline data collection began simultaneously for all participants across all groups (Time 0 in Table 3), and at least five baseline data points were collected before participants received the SKY intervention. On each day of baseline data collection, a Modified Borg scale and a six-point Likert scale were emailed to each participant to use to rate the target questions/outcomes of interest. The former was used for participants to rate different dyspnea perceptions, including work of breathing (WOB), shortness of breath (SOB), dyspnea-related distress (DD), and dyspnea-related anxiety (DA), and the latter was used to rate mealtime enjoyment and mealtime difficulty. Given the goal of exploring eating-related dyspnea and the mealtime experience, prior to data collection commencing, the PI asked the participants about their typical dinner schedule in order to time data collection appropriately. The PI and research team called the participants at the agreed time (i.e., right after their meal) and recorded the participants' ratings of perceived dyspnea and mealtime enjoyment and difficulty.

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).

Once a baseline had been established for the first group (i.e., at least five stable baseline data points or worsening responses) the SKY intervention 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 on their responses. Once the second group received SKY, the same protocol of staggered implementation was applied to the third group.

Four outcomes were aimed to measure different dyspnea perceptions. They were: WOB, SOB, DD, and DA. After dinner each evening, across Time 0, Time 1, Intervention, and Time 2, participants were asked to respond to the following questions based on how they were feeling right now, 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) (Carrieri-Kohlman et al., 1996). Participants provided their rating for each of the four dyspnea perceptions individually using the Modified Borg Scale (Burdon et al., 1982) (see Table 5 below).

Additionally, following the same data collection schedule (across Time 0, Time 1, Intervention, and Time 2), the participants also responded to the questions "How enjoyable was your meal experience?" and "How difficult was eating during your meal?"

using a six-point Likert scale (Table 6 below). Likert scales are often used in the social sciences to measure individual traits, such as self-efficacy and self-perception (Boone Jr. & Boone, 2017; Croasmun & Ostrom, 2011).

Table 5

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

Table 6

Six-point Likert Scale

0	Not at all
1	Very slightly
2	Somewhat
3	Moderate
4	Very much
5	Maximal

Descriptive Data. Data on self-reported anxiety, depression, overall affect, COPD experience, and swallowing-related quality of life were collected online via a single Qualtrics survey from all participants. Participants completed the survey at Time 0, Time 2, and Time 3. Namely, these data were collected about five days before SKY (Time 0), after SKY (Time 2), and 10 weeks after SKY (Time 3). The link to the

Qualtrics survey was shared via email so that participants were able to fill it out independently. The four outcome tools are discussed below.

The Hospital Anxiety and Depression Scale (HADS) is validated and used to reliably determine degree of clinical anxiety and depression for individuals with physical health problems (Zigmond & Snaith, 1983). It is a self-administered questionnaire that takes approximately 5-10 minutes to complete. There are seven items on anxiety and another seven on depression. Each item on the questionnaire is scored from 0 to 3. Total scores range from 0 to 42. Lower scores mean less presence of anxiety and depression. HADS 0-7 suggests normal, 8-10 suggests presence of respective state or borderline base, 11-21 suggests presence of case (Snaith, 2003). For individuals with COPD, ~1.5 points or ~20% change from baseline can correspond to the minimal important difference of HADS in interpreting the importance of treatment effects (Puhan et al., 2008).

The Positive and Negative Affect Schedule (PANAS) is a brief, easy-to-administer, valid and reliable tool to measure positive and negative affect (Watson et al., 1988). Positive affect is defined as a person feeling enthusiastic, active, and alert; negative affect is defined as a person feeling anger, contempt, disgust, guilt, fear, and nervousness. This 5-10-minute self-administered measure can be used by everybody regardless of health status. There are 20 items; each item on the questionnaire is scored from 1 to 5. Total scores range from 20 to 100: positive affect scores can range from 10 to 50, with higher scores representing higher levels of positive affect; negative affect scores can range from 10 to 50, with lower scores representing lower levels of negative affect.

The COPD Assessment Test (CAT) is a validated assessment for individuals with COPD (Jones et al., 2009). This eight-item, self-reported questionnaire assesses the impact of COPD on health status. Each item is associated with a six-point scale (e.g., I'm very happy 0 — 5 I'm very sad). A total score is obtained by summing the responses across all eight items. Each item on the questionnaire is scored from 0 to 5, and total scores range from 0 to 40. Higher scores represent worse health status. The CAT user guide (http://www.catestonline.org) categorizes scores into severity bands: upper limit of normal in healthy non-smokers (score 0 to 5), low impact (6 to 9), medium impact (10 to 20), high impact (21 to 30), and very high impact (31 to 40). GOLD recommends a cutoff score of 10 to measure the presence of a symptomatic impact of COPD (Jones et al., 2011; Tsiligianni et al., 2016). CAT, as a complementary clinical assessment tool, can be used to predict COPD exacerbation, health status deterioration, depression, and mortality (Karloh et al., 2016).

The Eating Assessment Tool (EAT-10) is validated and targets individuals with dysphagia (Belafsky et al., 2008). It is a patient-reported outcome tool that was designed to evaluate dysphagia-related symptom severity, quality of life, and treatment outcome. There is a total of ten questions, and total administration time is less than two minutes. Each item on the questionnaire is scored from 0 (no problem) to 4 (severe problem), yielding total available scores ranging from 0 to 40. Higher scores indicate increased severity. For the EAT-10, a cut-off value of 9 has been shown to predict aspiration in 92% of adults with stable COPD (Regan et al., 2017), and an EAT-10 score of ≥ 3 can demonstrate dysphagia (Belafsky et al., 2008).

The Dysphagia Handicap Index (DHI) is validated and targets individuals with dysphagia as a result of a variety of medical diagnoses (Silbergleit et al., 2012). It is a patient-reported outcomes tool that measures physical, functional, and emotional aspects of dysphagia. It is a 25-item, self-administered questionnaire that takes 5-10 minutes to complete, and total scores range from 25 to 175. The first section requires participants to answer 'never', 'sometimes', 'always' to each statement and then self-rate their perceived dysphagia severity from 1 to 7 with 1 being normal and 7 being severe. Lower scores indicate less perceived impact from dysphagia. The last section is a self-rating of swallowing severity.

Data Analysis

Qualitative. Qualitative methodology helps to better understand a phenomenon within certain groups of interest (Wu et al., 2016). It allows participants' words to inform model and theory development in exploring intervention outcomes, rather than the analysis being guided by pre-existing researcher hypotheses (de Visser et al., 2015; Hess & Straub, 2011). Phenomenological qualitative methodology, in particular, allows the participants' voices to speak, shaping the overall narrative of the experience in the intervention (Groenewald, 2004; Linville et al., 2018). The data analysis methods for the current study were adopted from Groenewald (2004) and Linville and colleagues (2018).

First, the auto-generated interview transcripts (generated through the Zoom software) were manually checked and updated by the research team as needed. Further, if any parts of the transcript did not make sense semantically during the subsequent coding process, the transcript was cross-checked again against the recording. These verbatim transcripts served as a primary source of data along with the field notes as 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 PI and three additional coders. The four-person research team completed the coding process while being careful 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 as well as individual coding variations were recorded, leading to the thematic building (vertical analysis process). The reported findings were based on the final themes and the sub-themes that emerged across the coding process. Questions regarding the coding process were addressed at weekly meetings; reconciliation of the discrepancies in data coding took place at these meetings across coders.

The trustworthiness of the findings was ensured through multiple steps. First, one of the dissertation committee members (i.e., DL) acted as an external auditor throughout the entire research as outlined by the Robert Wood Johnson Foundation (http://www.qualres.org/HomeExte-3704.html). Second, the research team attended data analysis training and debriefing sessions frequently. This was to ensure research effectiveness and that the emerging themes and categories remained truthful to the data. Third, bracketing was employed to avoid personal preconceptions and biases from entering into the data analysis.

Single Case. The single-case design data were first analyzed through visual analysis, a traditional approach (Horner et al., 2005). Visual analysis was completed for each dyspnea perception rating and both eating experience ratings. The level, trend, variability, immediacy effect, overlap, and consistency of data with and across phases was observed. Data visualization was further augmented by two quantitative analyses to explore the effect size of the intervention 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 (Parker et al., 2011). 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: .65 or lower: weak or small effect; .66 to .92: medium to high effect; and .93 to 1: large or strong effect (Parker et al., 2011). 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 (Pustejovsky, 2018). The LRR, a general metric of an effect size index, compares two mean levels. Direction of improvement is indicated as LRR-d for decrease (in the measures of WOB, SOB, DD, DA, and mealtime difficulty) or LRR-i for increase (in the measure of mealtime enjoyment) based on the questions wording and the scales used. Confidence level was set for .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/.

Descriptive Data. Raw scores were calculated according to the standard procedures associated with each questionnaire and presented quantitatively for the HADS, PANAS, CAT, EAT-10, and DHI. Additionally, using descriptive statistics, both the overall patterns for the entire group as well as the individual patterns of change across time were explored.

CHAPTER IV

RESULTS

This chapter presents the results of the analyses conducted to answer the two research questions. Results include: (a) qualitative analyses using phenomenological methodology of the interviews for understanding the feasibility and the acceptability of SKY; and (b) visualization of the data collected during the single-case multiple baseline design for measures of perceived dyspnea and mealtime experience and the statistical analyses of the intervention effects.

Intervention Fidelity and Adherence

Important to interpreting the results of the intervention, first I present the fidelity- and treatment-adherence-related data (see Tables 7 – 11). All participants attended all three days of the SKY intervention (see Table 7). There was excellent agreement between the SKY instructor's self-rating and trained data collector's ratings that each component of SKY was covered in the training (see Tables 8 and 10) and that each participant accurately demonstrated every component of SKY across the training sessions (see Tables 9 and 11). At the 10-week follow-up survey, a majority of the participants reported continuing with the SKY home practice after the intervention: 11.11% (1/9) practiced every day, 55.56% (5/9) practiced 4 – 6 days a week, and 33.33% (3/9) practiced 1 – 3 days a week. Additionally, 44.44% (4/9) attended at least six of the weekly follow-up sessions for intervention, 44.44% (4/9) attended at least one but less than five, and 11/11% (1/9) attended none (see Table 12 for post-intervention adherence). Thus, SKY was delivered as intended (fidelity), and participants adhered to the program.

Table 7

Participant Attendance

Participant	SKY Attendance		
	Day 1	Day 2	Day 3
WA	Yes	Yes	Yes
RK	Yes	Yes	Yes
RT	Yes	Yes	Yes
JL	Yes	Yes	Yes
GG	Yes	Yes	Yes
JK	Yes	Yes	Yes
SS	Yes	Yes	Yes
PS	Yes	Yes	Yes
RF	Yes	Yes	Yes

Table 8

SKY Instructor Self-rating Whether Each Component of SKY Was Covered

	Group 1	Group 2	Group 3
Ujjayi	Yes	Yes	Yes
Bhastrika	Yes	Yes	Yes
"Om"	Yes	Yes	Yes
Sudarshan Kriya	Yes	Yes	Yes

Table 9

SKY Instructor Rating Whether Each Participant Demonstrated the SKY Components Accurately

Participant	SKY Components			
	Ujjayi	Bhastrika	"Om"	Sudarshan Kriya
WA	Yes	Yes	Yes	Yes
RK	Yes	Yes	Yes	Yes
RT	Yes	Yes	Yes	Yes
JL	Yes	Yes	Yes	Yes
GG	Yes	Yes	Yes	Yes
JK	Yes	Yes	Yes	Yes
SS	Yes	Yes	Yes	Yes
PS	Yes	Yes	Yes	Yes
RF	Yes	Yes	Yes	Yes

Table 10

Data Collector Rating Whether Each Component of SKY Was Covered by SKY Instructor

	Group 1	Group 2	Group 3
Ujjayi	Yes	Yes	Yes
Bhastrika	Yes	Yes	Yes
"Om"	Yes	Yes	Yes
Sudarshan Kriya	Yes	Yes	Yes

Table 11

Data Collector Rating Whether Each Participant Demonstrated the SKY Components Accurately

Participant	SKY Components			
	Ujjayi	Bhastrika	"Om"	Sudarshan Kriya
WA	Yes	Yes	Yes	Yes
RK	Yes	Yes	Yes	Yes
RT	Yes	Yes	Yes	Yes
JL	Yes	Yes	Yes	Yes
GG	Yes	Yes	Yes	Yes
JK	Yes	Yes	Yes	Yes
SS	Yes	Yes	Yes	Yes
PS	Yes	Yes	Yes	Yes
RF	Yes	Yes	Yes	Yes

Table 12

Self-reported SKY Home Practice Frequency (10 weeks Post-Intervention) and Optional Weekly Follow-up Session Attendance

Participant	Self-reported daily SKY home practice frequency	Optional weekly post-intervention follow-up sessions (Sessions attended/10 weeks)
WA	4-6 days a week	3/10
RK	4-6 days a week	8/10
RT	4-6 days a week	6/10
JL	4-6 days a week	2/10
GG	1-3 days a week	7/10
JK	4-6 days a week	7/10
SS	1-3 days a week	0/10
PS	1-3 days a week	1/10
RF	Every day	4/10

Acceptability and Feasibility of SKY Among Individuals with COPD

The first research question was aimed at understanding the acceptability and feasibility of SKY in our study population. As emerging from the interviews, a central phenomenon of 'lessened COPD-related mind-body-breath burden after SKY' developed. Overall, the qualitative data revealed that COPD's physiological manifestations and psycho-emotional consequences can be improved via SKY. Specifically, SKY appeared to play a vital role in enhancing aspects of the mind, body, and breath as well as in 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. Participants shared:

> Absolutely, I think I think [SKY] affects everything, that maybe those emotional manifestations I think can be attributed to many different activities of daily living, and if you can alleviate that or slow it down or be aware of it in a different way then certainly that's going to help coughing, breathing, awareness, movement. All those things. (JL)

> [SKY] could teach you to be able to relax a little bit better when you're feeling shortness of breath coming on because that just, you know, it kind of builds on itself so if you're able to relax a little bit and to breathe more- more deeply and all. (GG)

> That [SKY] is helpful to deal with those [negative] feelings, with the shortness of breath and the feelings and able to manage those kinds of feelings. (SS)

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 3 provides a schematic representation of these themes. The themes are described below, illustrated by participants' own words.

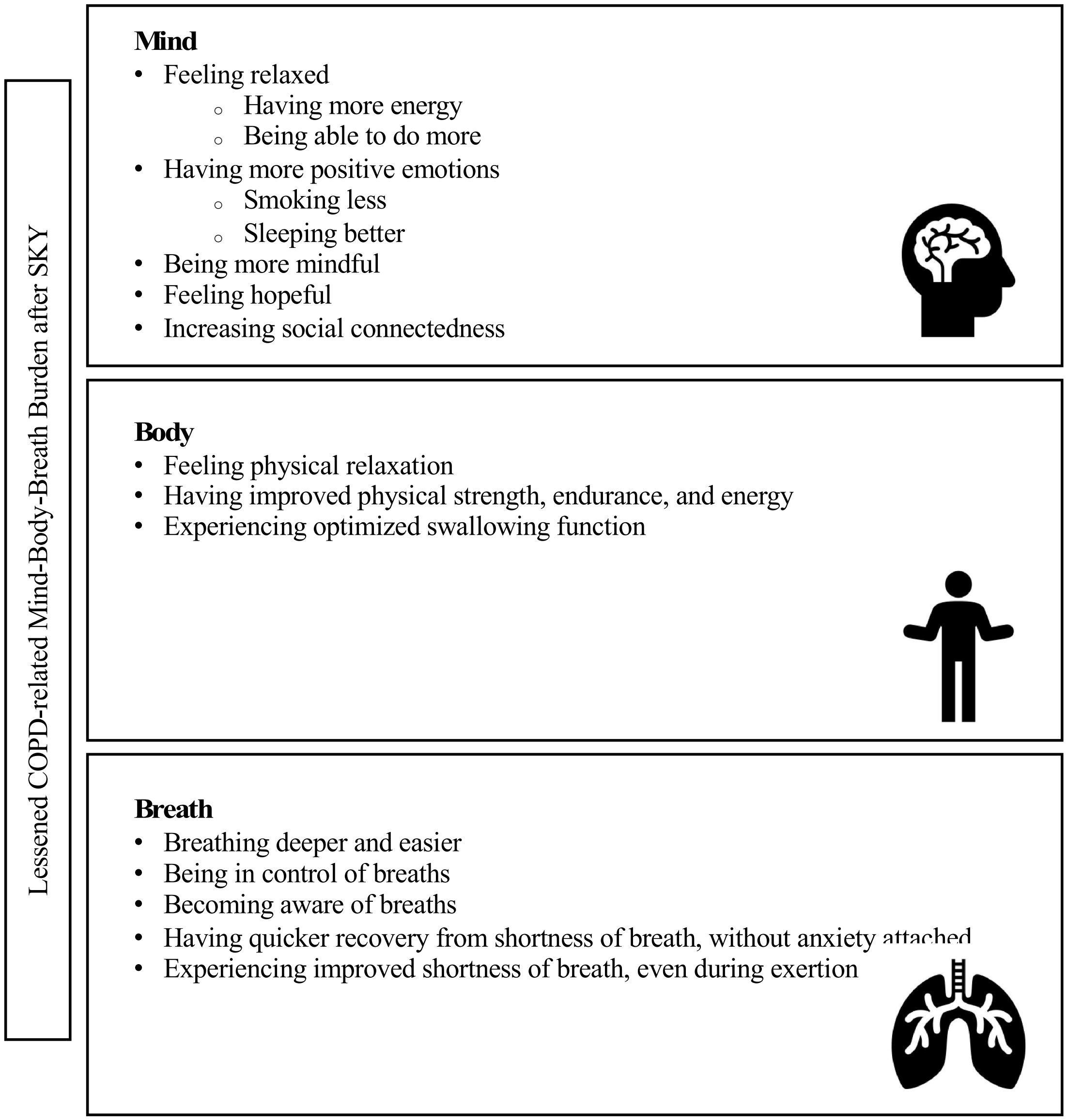

Figure 3. Lessened COPD-related mind-body-breath burden after SKY

Firstly, participants reported psycho-emotional changes following the SKY intervention, or changes related to the mind. Many indicated feeling “more relaxed” (WA) that ultimately benefitted their overall affect. For example, as Participant SS 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. As 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” (RT). Notably, this shift in affect led to changes in behaviors, such as decreased smoking and improved sleep, as three participants noted here:

> Often I smoke to combat a current, I don't know, stressor. That desire to go smoke seems to just go away, I- I don’t think I even realized that was happening until I realized, you know, how many pack of cigarettes, I still have left, for example, so it wasn't as conscious as one might think. (JL)
>
> I’ve always been a lousy sleeper. I fall asleep faster [now]. I mean and that's unheard of for me, usually takes me an hour to fall asleep so- so that's pretty good. I have not backed off on my sleeping medications at all…That's a huge jump. (JL)
>
> …lately I’ve just felt more peaceful where I'm not, you know, scatterbrained… and I quit taking the Zzzquil. I’ve only been taking the melatonin for about three days, and I've been sleeping just fine, usually I take both. (RF)

Significantly, these changed behaviors in turn served to further improve mood, as expressed by Participant RF, “I'm in a better mood and happier, but I think because I'm sleeping better.” Similarly, participants expressed being more mindful overall, which also contributed to 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” (PS). As a result of these positive changes, participants also noticed having more energy during the day and being able to accomplish more.

> I seem to get up and have a little bit more go than I used to… It used to be when I got up, you know, I feel drowsy and sleeping all day long. I still take a nap and stuff in the afternoon early afternoon for maybe 15 minutes or 20 minutes I'm not doing sleeping all the time, like I used to. (RT)
>
> And I'm not needing a nap in the afternoon, like I was before, I mean, there were many, many days a week where I would just feel worn out by 3:30 or four and that's not true, so. (JL)

> I feel fairly relaxed and I seem to do a little bit more than I was. (RT)

> I've increased my jump rope, my weight lifting and all that. I up everything, and I think it's because I'm resting so much better at night that I have more energy. I've had more energy, so I felt like I can do more lately. (RF)

As 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.

> I really enjoyed the breakout session that was, those were fun. That was kind of fun to meet somebody, you know. A complete stranger and to sit and talk, you know, even if it was for a few minutes and how quickly found common ground we found common ground. That was fun, I liked that. (SS)

> Making friends with [RF] that was kind of cool. We may actually stay in touch we- we exchanged email addresses. (PS)

> This is something to that I may be a little, I don't know, if you call it confident, but I always woke up in a morning wishing that I hadn't woke up, you know, I always wished, I was dead. And now it seems a little bit more than, you know, I would like to try a little harder at living because, you know, it's pretty final, the dead part once you're dead is. So I would like to, you know, I think [SKY] has changed my attitude, a little bit, you know, as far as looking at you know life that maybe- maybe I would like to hang around a while and see my grandkids grow up and so. (RK)

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.

> I could feel my lower back relaxed, I could… I felt like I was getting better circulation down in my legs. (PS)

> And I actually do feel calmer, my shoulders are not up to my ears and sore as much as they were before, so I find value in it that way as well, not just emotionally but physically. (JL)

> More active. Doing more stuff. It kind of a pick-me-up. You know, it's kind of the vitamin. I don't know how but I noticed, I was doing more… I'm just doing more. It doesn't bother me as much, the physical activity. (RT)

> I could walk a little longer than normal…even in the winter… I can at least walk a mile… [Previously], if I'm lucky, maybe half a mile…[now] takes a little longer but I can get it done. (WA)

> I have increased how I am the resistance on the bike so that I'm getting a better workout. That's happened within the past week, just feel like I can tolerate more. (SS)

Of particular significance to the purpose of the current study, one participant 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. (JL)

The third theme that emerged surrounded breath. Participants shared that, "I'm not breathing as hard" (WA), which empowered them to be more active, "…knowing that I can control my breathing when I need to…not just huff and puff" (WA). The qualitative data revealed that SKY allowed participants to breathe deeper breaths in particular. As multiple participants indicated:

> When I take, I take a deep breath, I get it now. Before, it just seemed like I was, I get three quarters of a breath in. But I can really feel it in my lungs now… It makes me feel good. (RT)

> I felt like I noticed when I do my nebulizer treatment that I'm taking deeper breaths and it made me wonder if I have (it) expanded my lungs some from these exercises...when I take my nebulizer I can tell I'm taking deeper more meaningful breaths. (RF)

Participants also shared that they become more cognizant about their breathing.

> I'm much more aware of the way I breathe and try to improve the transfer of oxygen and CO_2 and stuff like that. (JK)

> I am finding myself- my awareness of my breathing in general is heightened… Definitely- definitely thinking more about and sort of evaluating my breathing. (JL)

They 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.

> I found that I don't seem to be quite as short of breath when I climb a flight of stairs well, so I think it's just because I- I've noticed there's like, I've really noticed in the past, how it affects me it just doesn't seem to be as difficult… working on the deep breathing and just the relaxation of the deep breathing. I don't know. I’ve just noticed I haven't been in short of breath. (SS)
>
> I haven't noticed any difference in just my regular breathing, but I have noticed that when I feel short of breath, I seem to recover faster and part of that is being more mindful of my recovery breathing you know… it recovers it really well without that anxiety, you know. (PS)
>
> The walks that I take, and you know, I’m- I used to feel forced into them by the dog. But I think that our pace has increased. And my breathlessness upon walking uphill has reduced a little bit, I have noticed that. I'm not as out of breath when I go up all the hills that I go up... I noticed the lack of breathlessness after going on hills. (JL)

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. (RT)

Overall, participants acknowledged that the impacts of COPD are accurately reflected through a mind-body-breath feedback loop (Lin & Shune, 2019) and that this loop occurs across all daily activities, “independent of eating” (RF). They also agreed that SKY, by improving aspects of the mind, body, and breath, was key in preventing or disrupting such cyclical psycho-physiological consequences.

> Well yeah- yeah because it's, you know, I got some- some tools to- to use to combat the concern or frustration. (JK)

Others shared that optimizing the quality of their breathing ultimately helped prevent further cyclical effects.

> Yeah the more you have trouble breathing and you get all those other things is anxiety and frustration and anger. That causes more shortness of breath so. It's a vicious circle. (RK)

> I think [SKY] would help control your breathing...That way, you wouldn't have fear or panic once you control your breathing. (WA)

Participants also described how SKY addresses the mind, body, and breath aspects of COPD simultaneously.

> I mean you're always concerned about your breathing but, you know, there's frustration and there's concern, and then it builds to anxiety and then it builds to fear and then it builds to panic and, if you can, if you can lower any of those that's going to be a benefit. (PS)

> I think [SKY will] address all of them [mind, body, breath]. (RT)

> The fear, anxiety, concern, panic, frustration causes an adrenaline rush, and then the adrenaline rush tends to lock up your throat. And then locking up your throat causes the coughing and shortness of breath and then that just further panics you which it's a- it feeds upon itself is what it does. I'm very familiar with this… The breathing exercises [from SKY] can help prevent these simple. (RF)

Notably, participants had an overall positive experience with the SKY intervention. Participant JK felt "like I've accomplished something". Three participants commented on how the SKY techniques were helpful as well as interesting and easy to learn.

> That was very interesting and helpful. (WA)

> You know it's not that strenuous of an exercise that it's gonna hurt you physically, you know, and which- which I like. (RK)

> It's been interesting. It's been I think it's helped me a lot… I've never done anything like this before and I think I've learned a lot from it, you know, from you

> guys have been, I just didn't know what to expect and but it was, it's been fun. (RT)

One participant shared that the depth of the program was worthwhile.

> My experience was positive, I learned a lot about breathing and the technique of breathing just breathing normally I became more aware of my breathing… I thought it was very comprehensive, as far as the three days. The overall program was comprehensive. (SS)

Finally, all participants, regardless of disease severity, reported that based on their personal experiences with SKY, they would recommend such a program to their peers with COPD:

> For somebody that has [COPD], I guess, I would recommend [SKY]. It might possibly help them breathe deeper, become a little bit more relaxed. (GG)

> I know I’ve got a couple of friends that I’m already gonna tell about [SKY]. And I’m going to talk to my pulmonologist about trying to get a class going, I don't know, if we have any instructors nearby but obviously we can do it on Zoom. (PS)

In particular, participants felt that they would recommend SKY because it was interesting and beneficial.

> Well yeah, I would recommend. Like I said, if you want some more people I’ll tell them over at the rehab thing but well, because it's interesting and I think it's helping- it's helping me. (JK)

> I think with COPD, the reason I did [SKY] is if I can do anything to help my breathing I'm going to do it. I think almost anybody in any physical condition can do it because it's all sitting and nothing really strenuous, which it doesn't, you know, I mean I don't hurt or get real sour, nothing, because of it. To me, it was worth it. You know, I mean it's helped me, I think. (RT)

Overall, the participants also shared that SKY brought a new perspective of life, greatly contributing to its value.

> Hey I can't see any reason why anybody wouldn't want to, you know, after a while, improve the breathing or improve their attitude. I would recommend the program to them. (RK)

> You know what was really good for me, was to see the variety of people that you had. Um, it wasn't, you know, things like this, have their own, I don't know, people have opinions about just a certain type of people that will do any sort of meditation or breathing exercises, etcetera, and, to me, the variety was. It made me feel good, made me feel like I could be a part of it and not feel like I had to pretend to be anybody or anything else. So that's- that's really good. I would recommend it because you know what COPD has a lot to do with personal stress and taking the time to reevaluate what sets you off and what doesn't set you off. And I think that's- that's an important discovery for me. (JL)

Ten weeks after the completion of SKY, participants were given an opportunity to respond to a written open-ended question about whether there are any additional changes that they noticed since the interview that they think might have to do with SKY. Participant GG felt "happy to learn a new method of relaxation." Participant JK 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." (JL)

> "I am more relaxed when I do the breathing...I enjoyed the training." (SS)

> "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." (RT)

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" (RK).

Functional Relation Between SKY and Improved Consequences of COPD

The second research question was aimed at exploring the functional relation between SKY and improved consequences of COPD (i.e., pulmonary burden and oral intake experience). Specifically, this question asked whether there exists a functional relation between SKY and (a) dyspnea perceptions (i.e., work of breathing, WOB; shortness of breath, SOB; dyspnea-related distress, DD; and dyspnea-related anxiety, DA); (b) increased oral intake enjoyment; and (c) decreased oral intake difficulty. I hypothesized that the magnitude of perceived dyspnea would be reduced after the intervention (i.e., reduced dyspnea), and the mealtime enjoyment and difficulty will improve and reduce respectively. Below, I discuss the data visualizations, Tau-U and LRR statistical analyses.

Figure 4 graphically displays participants' ratings of WOB on the Modified Borg Scale. At the individual level, a majority of the participants, except for Participants GG and JK, demonstrated variability in level (i.e., 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 WA, RK, and JL, 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 WA demonstrated a shift in level in the post-intervention phase, with the data indicating a stable level and trend. While he did demonstrate a single spike in the post-intervention phase, he quickly returned to his post-intervention stability. Participant RT demonstrated a decreased trend towards the end of SKY with reduction in perceived WOB. For Participant SS, there was less drastic variability in perceived WOB during the post-intervention phase as compared to baseline. Overall, the influence of SKY on WOB differed across all of the participants, and each participant's WOB rating differed across the study timepoints.

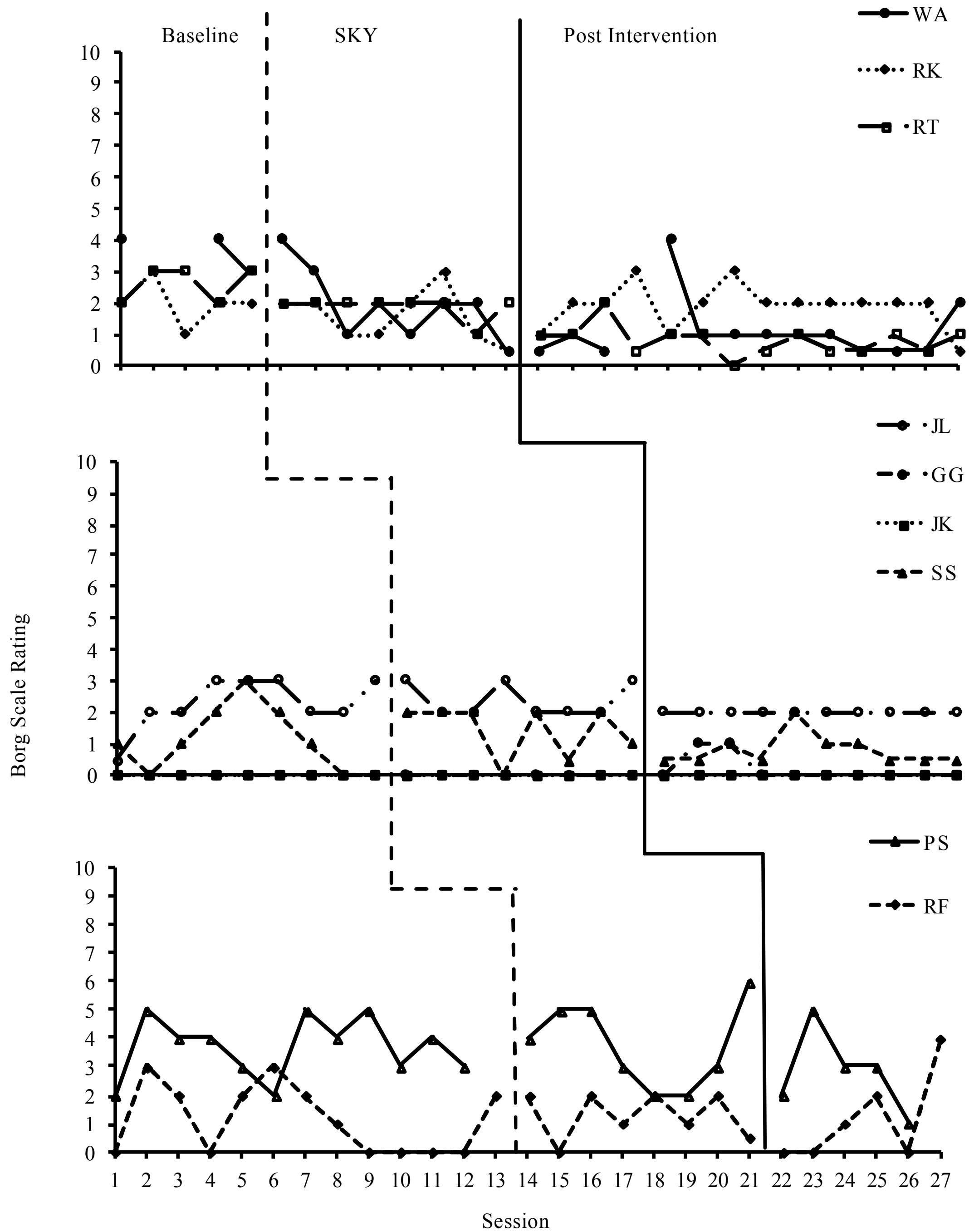

Figure 4. Perception of work of breathing severity.

The results of the statistical analyses for WOB are summarized in Table 13 below. The majority of participants demonstrated a small Tau-U effect size. A medium-to-high effect size was calculated for Participant WA (.83) and Participant RT (.87). Participant JK had a Tau-U of zero; this was mirrored in the data visualization, where his perceptual ratings were consistently zero. Based on the LRR, six of the participants (i.e., WA, RK, RT, JL, SS, and PS) demonstrated varying degrees of improvement for perceived WOB (i.e., reduced WOB), ranging from 5.5% (SE = .13) to 61.28% (SE = .19); the other three participants (i.e., GG, JK, RF) showed no change. The greatest improvement was observed for Participant WA, followed by Participant RT. The treatment effect on WOB for Participant WA was estimated as -.95, 95% CI: [-1.33, -.57], corresponding to a decrease in WOB of 61.28%, 95% CI: [-73.52%, -43.38%]. Similar to the findings from the data visualization, a number of participants showed a high degree in variability across their ratings. In particular, Participants SS and RF had relatively high standard errors (SE = .35 and .38 respectively), corresponding to the variable level and trend observed on the data visualization.

Table 13

Work of Breathing Results

Partici-pant	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			
WA	0.83	-0.95	-61.28	0.19	[-1.33, -0.57]	[-73.52, -43.38]
RK	0.15	-0.13	-12.12	0.18	[-0.48, 0.23]	[-38.39, 25.34]
RT	0.87	-0.77	-53.55	0.15	[-1.06, -0.47]	[-65.45, -37.56]
JL	0.26	-0.06	-5.50	0.13	[-0.31, 0.20]	[-26.6, 21.66]
GG	-0.11	NA	NA	NA	NA	NA
SS	-0.05	-0.06	-6.13	0.35	[-0.75, 0.63]	[-52.93, 87.18]
JK	0.00	NA	NA	NA	NA	NA
PS	0.13	-0.08	-7.32	0.15	[-0.37, 0.22]	[-30.83, 24.18]
RF	-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 5 (below) graphically displays participants' ratings of perceived SOB on the Modified Borg Scale. At the individual level, Participants WA, RT, JL, and SS demonstrated a more stable level post-intervention as compared to the other phases. Participants RT and SS demonstrated a change in level post-SKY, and Participants WA and JL exhibited more stability after SKY than before. Participant RK showed decreased variability in SOB ratings post-SKY as compared to before. Overall, the influence of SKY on SOB differed across all of the participants, and each participant's SOB ratings differed across the study timepoints.

The results of the statistical analyses for SOB are summarized in Table 14 (below). In examining Tau-U, Participant RT demonstrated a medium-to-high effect (.82), while the effect size was small for the rest of the participants. Based on the LRR calculations, no improvements were observed for Participants GG and JK, which was reflected in their data visualizations, where their perceptions were mostly rated as zero. The remaining seven participants all demonstrated varying degrees of improvement, with percentage changes ranging from 2.9% (SE = .11) to 64.88% (SE = .51). Participants WA and RT exhibited the greatest degree of improvement in SOB. The effect of treatment estimated for Participant WA was -1.05, 95% CI: [-2.04, -.06], which corresponded to a decrease in SOB of 64.88%, 95% CI: [-86.96%, -5.41%]. Participants WA and SS had the largest standard error, at .51 and .42 respectively, likely representative of the variable level and trend in perceived SOB across the baseline and SKY phases observed in data visualization.

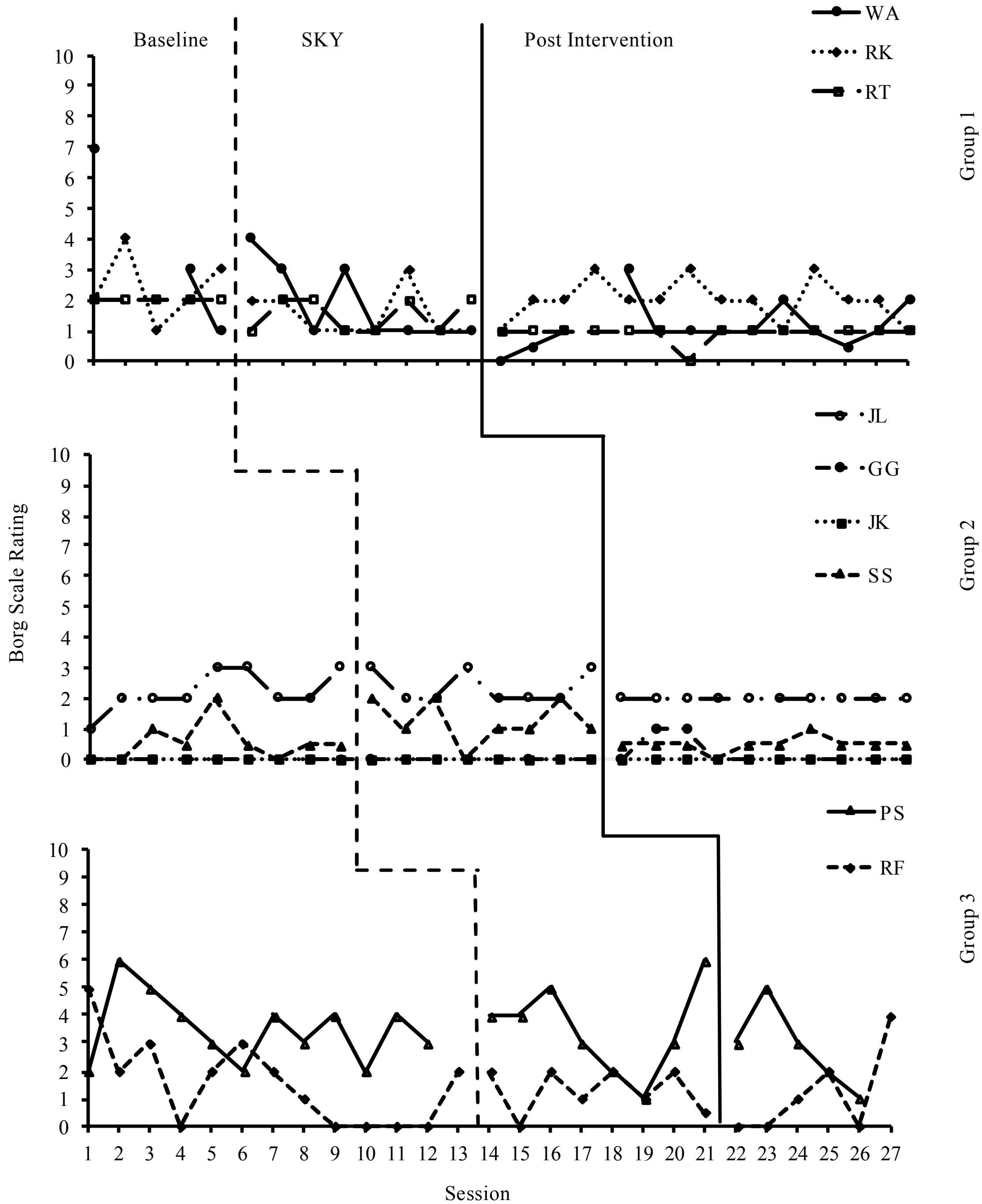

Figure 5. Perception of shortness of breath severity.

Table 14

Shortness of Breath Results

Partici-pant	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			
WA	0.49	-1.05	-64.88	0.51	[-2.04, -0.06]	[-86.96, -5.41]
RK	0.32	-0.30	-25.66	0.23	[-0.75, 0.15]	[-52.56, 16.49]
RT	0.82	-0.56	-42.96	0.09	[0.73, -0.39]	[-51.97, -32.26]
JL	0.17	-0.03	-2.90	0.11	[-0.24, 0.18]	[-21.48, 20.07]
GG	-0.11	NA	NA	NA	NA	NA
SS	-0.28	0.35	41.66	0.42	[-0.47, 1.17]	[-37.69, 222.05]
JK	0.00	NA	NA	NA	NA	NA
PS	0.03	-0.08	-7.37	0.17	[-0.40, 0.25]	[-33.23, 28.5]
RF	-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 6 graphically displays participants' ratings of DD on the Modified Borg Scale. Comparing the baseline phase with the intervention phase, Participant WA demonstrated a more stable level and trend post-SKY. Participant RT exhibited stable level post-SKY. Participant JL demonstrated greater stability post-SKY, and Participant SS presented a change in level post-SKY. Finally, Participant RF 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 of the participants, and each participant's DD rating differed across the study timepoints.

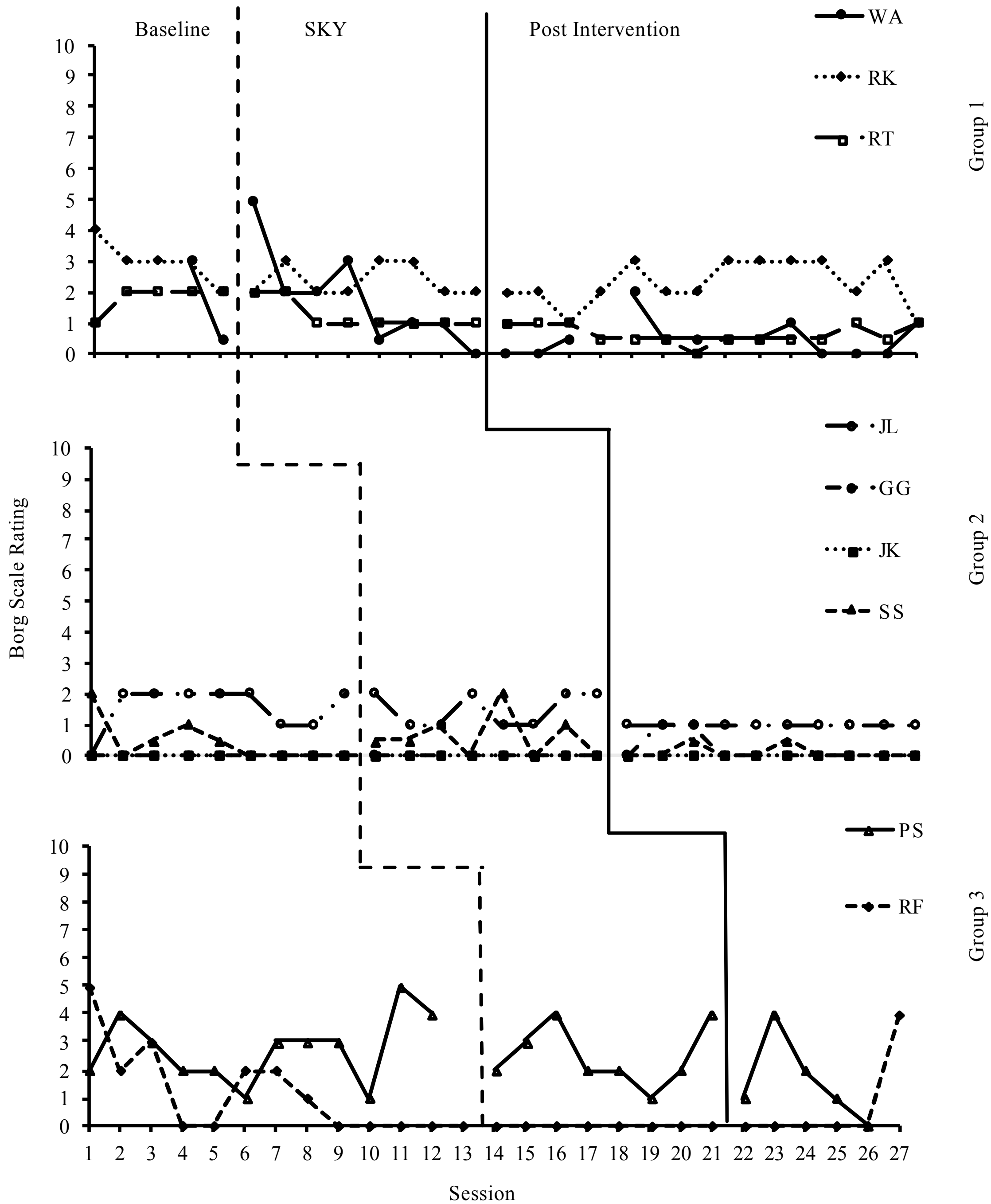

Figure 6. Perception of dyspnea-related distress severity.

As displayed in Table 15, participants' responses varied based on effect size calculations. Participant RT showed the greatest treatment effect (.83; medium-to-high) while a majority of the other participants demonstrated a small effect. Participant JK had a Tau-U of zero; this was mirrored in the data visualization, where his perceptual ratings were consistently zero. Based on the LRR calculations, no improvements were observed for Participants GG and JK, likely reflecting the majority of their ratings being zero as observed in the data visualization. The remaining six participants all demonstrated varying degrees of improvement, with percentage changes ranging from 21.25% (SE = .21) to 61.99% (SE = 1.07). Of those six, the greatest improvement was observed for Participant RF, with the effect of treatment estimated as -.97, 95% CI: [-3.06, 1.13], which corresponded to a decrease in DD of 61.99%, 95% CI: [-95.32%, 208.96%]. Participant RF also demonstrated the largest standard error at 1.07, likely reflecting his variable level and trend in the baseline phase as well as a spike in severity rating observed on the last day of data collection post SKY.

Figure 7 graphically displays participants' ratings of DA on the Modified Borg Scale. Most noticeably, participants WA, RK, RT, and JL demonstrated multiple days of stable level and trend post-SKY, without a clear change in variability, when compared to the baseline and SKY phases.

Table 15

Dyspnea-Related Distress Results

Partici-pant	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			
WA	0.33	-0.50	-39.27	0.58	[-1.63, 0.63]	[-80.37, 87.82]
RK	0.43	-0.26	-23.02	0.12	[-0.50, -0.02]	[-39.27, -2.41]
RT	0.83	-0.73	-52.00	0.16	[-1.05, -0.42]	[-64.93, -34.29]
JL	0.36	-0.25	-22.11	0.18	[-0.60, 0.10]	[-44.85, 10.01]
GG	-0.11	NA	NA	NA	NA	NA
SS	-0.03	-0.35	-29.18	0.64	[-1.60, 0.91]	[-79.77, 147.86]
JK	0.00	NA	NA	NA	NA	NA
PS	0.33	-0.24	-21.25	0.21	[-0.65, 0.17]	[-47.67, 18.51]
RF	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.

Statistics for DA are displayed in Table 16. Based on the Tau-U calculations, six participants (WA, RK, RT, JL, PS, and RF) demonstrated a small effect size, and the remaining three (GG, SS, and JK) demonstrated no effect. For example, Participant JK had a Tau-U of zero, which was mirrored in the data visualization, where his perceptual ratings were consistently zero. With regard to LRR calculations, no improvements were observed for Participants GG, SS, and JK, which was consistent with their data visualizations, where perceptual responses hovered around zero. The remaining six participants all demonstrated varying degrees of improvement, with percentage changes ranging from 15.52% (SE = .12) to 68.15% (SE = .45). Participant WA exhibited the greatest improvements. His estimated LRR for DA was -1.09, 95% CI: [-2.26, .08], corresponding to a decrease in DA of 66.35%, 95% CI: [-89.53%, 7.96%]. RT had a standard error of .45, which was likely a result of his variable level and trend on the data visualization.

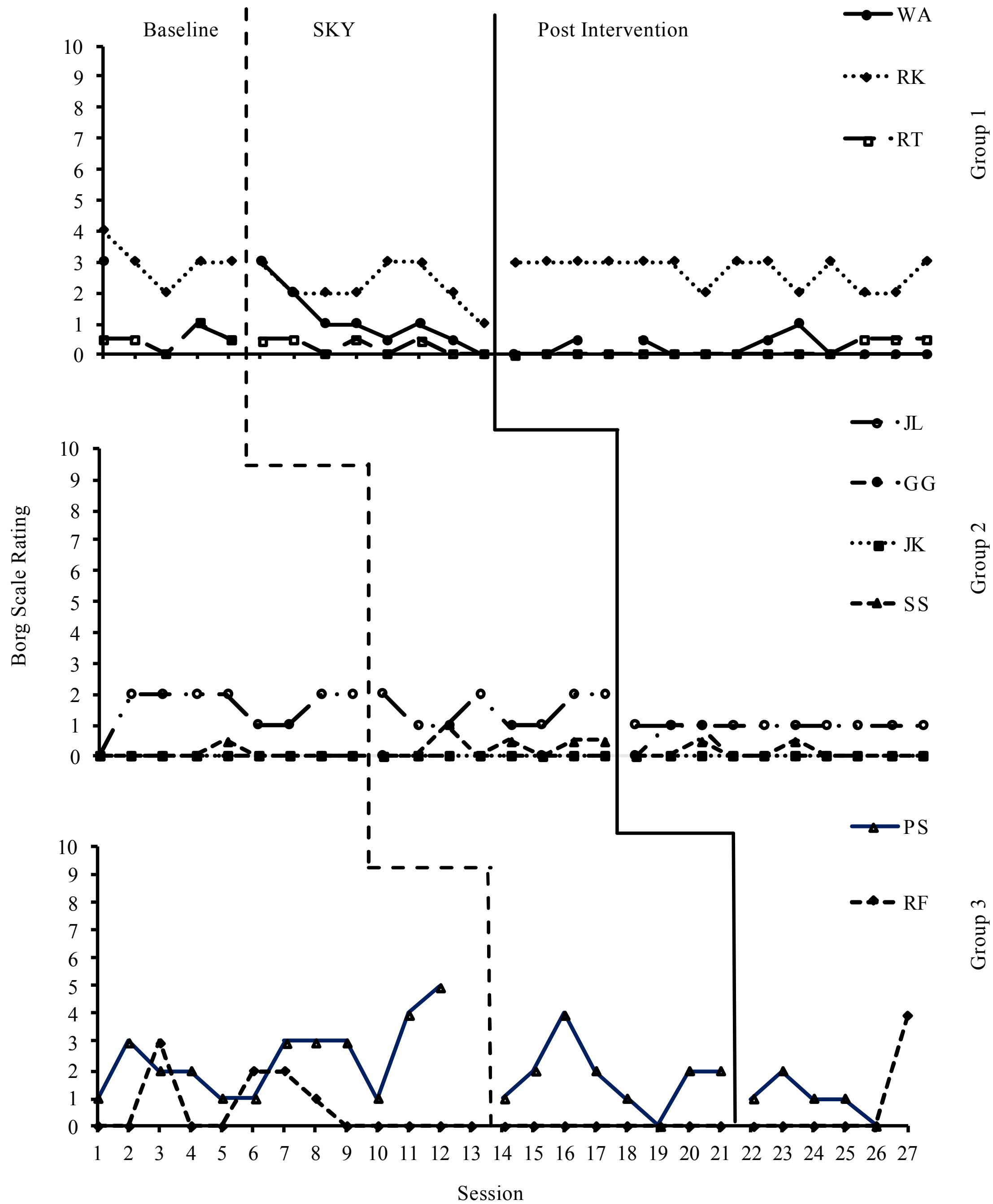

Figure 7. Perception of dyspnea-related anxiety severity.

Table 16

Dyspnea-Related Anxiety Results

Partici-pant	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			
WA	0.54	-1.09	-66.35	0.60	[-2.26, 0.08]	[-89.53, 7.96]
RK	0.31	-0.17	-15.52	0.12	[-0.40, 0.06]	[-32.78, 6.18]
RT	0.55	-1.14	-68.15	0.45	[-2.03, -0.26]	[-86.8, -23.14]
JL	0.38	-0.25	-22.11	0.18	[-0.60, 0.10]	[-44.85, 10.01]
GG	-0.11	NA	NA	NA	NA	NA
SS	-0.23	0.82	127.18	1.07	[-1.27, 2.91]	[-71.86, 1734.33]
JK	0.00	NA	NA	NA	NA	NA
PS	0.58	-0.50	-39.06	0.25	[-0.09, 0.00]	[-62.92, .15]
RF	0.14	-0.38	-31.47	1.11	[-2.54, 1.79]	[-92.14, 497.82]

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

With regard to the mealtime experience questions, a functional relation was questionable between perceived mealtime enjoyment and SKY, as displayed in Figure 8. No individual patterns were observed.

Table 17 summarizes the statistics for mealtime enjoyment. The Tau-U effects were small to none for all participants. The LRR calculations suggested five participants (RK, RT, JL, GG, and SS) demonstrated varying degrees of change, ranging from 4.20% (SE = .08) to 31.09% (SE = .08). The greatest potential improvement was observed for Participant JL, where the effect of treatment was estimated as .27, 95% CI: [.11, .43], corresponding to an increase in enjoyment of 31.09%, 95% CI: [12.1%, 53.29%]. This improvement was likely accounted for by dental issues she was experiencing during the first few days of the baseline data collection phase and is consistent with data visualization, in which she demonstrated an initial decrease in ratings, indicating little to no mealtime enjoyment, and later rise, suggesting more mealtime enjoyment.

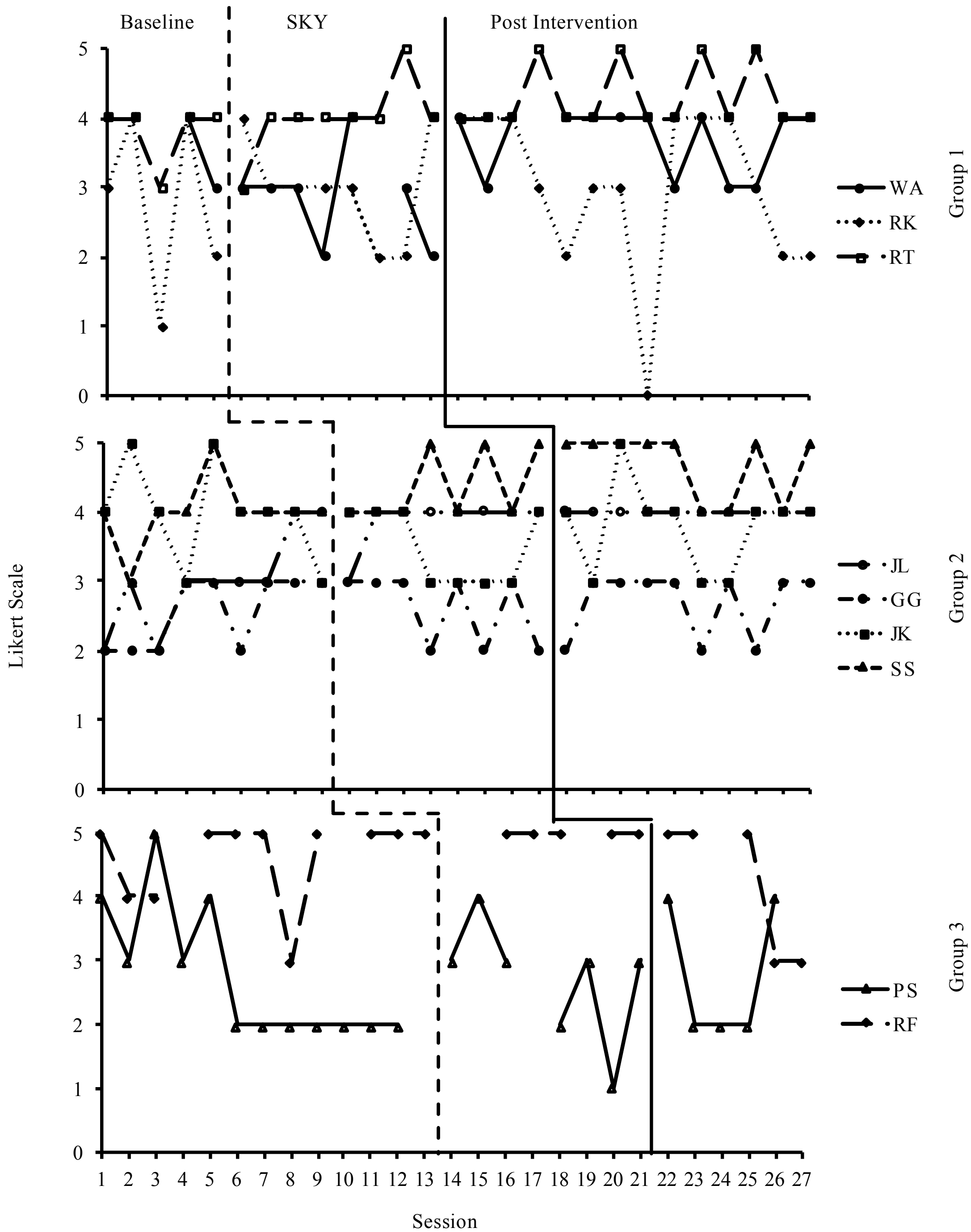

Figure 8. Perception of mealtime enjoyment.

Table 17

Mealtime Enjoyment Results

Partici-pant	Effect Size			Standard Error for LRR-i Estimate	LRR-d 95% Confidence Interval	Percentage Change 95% Confidence Interval
	Tau-U	LRR-i Estimate	Percentage Change			
WA	-0.17	-0.08	-7.56	0.10	[-0.28, 0.12]	[-24.21, 12.75]
RK	0.09	0.05	5.12	0.22	[-0.38, 0.48]	[-31.78, 61.98]
RT	0.34	0.09	9.93	0.06	[-0.02, 0.21]	[-1.98, 23.29]
JL	0.60	0.27	31.09	0.08	[0.11, 0.43]	[12.10, 53.29]
GG	0.01	0.04	4.20	0.08	[-0.12. 0.20]	[-11.10, 22.13]
SS	0.46	0.13	13.83	0.05	[0.03, 0.23]	[3.33, 25.39]
JK	-0.20	-0.09	-8.43	0.07	[-0.23, 0.05]	[-20.20, 5.09]
PS	0.30	0.00	-0.10	0.15	[-0.30, 0.29]	[-25.57, 34.08]
RF	-0.05	-0.01	-0.71	0.07	[-0.15, 0.14]	[-13.90, 14.49]

Note. LRR-i is log response ratio – increase.

With regard to mealtime difficulty, a functional relation was questionable between difficulty and SKY, as displayed in Figure 9.

Table 18 summarizes the statistics for mealtime difficulty. Small effects were observed for most participants. Participant JK had a Tau-U of zero, which was mirrored in the data visualization, where his perceptual ratings were consistently zero. Based on the LRR calculations, three participants (WA, RK, and RT) demonstrated varying degrees of change, ranging from 48.53% (SE = .39) to 82.19% (SE = 1.24). Data for Participants WA and RT indicated the greatest magnitude of reductions in difficulty. Participant WA achieved an effect of treatment estimated as -1.73, 95% CI: [-4.15, .7], which corresponded to a decrease in difficulty of 82.19%, 95% CI: [-98.43%, 101.47%]. His amount of percentage change was likely a result of a change in variability when comparing baseline and SKY phases with post intervention. Participant RT exhibited an

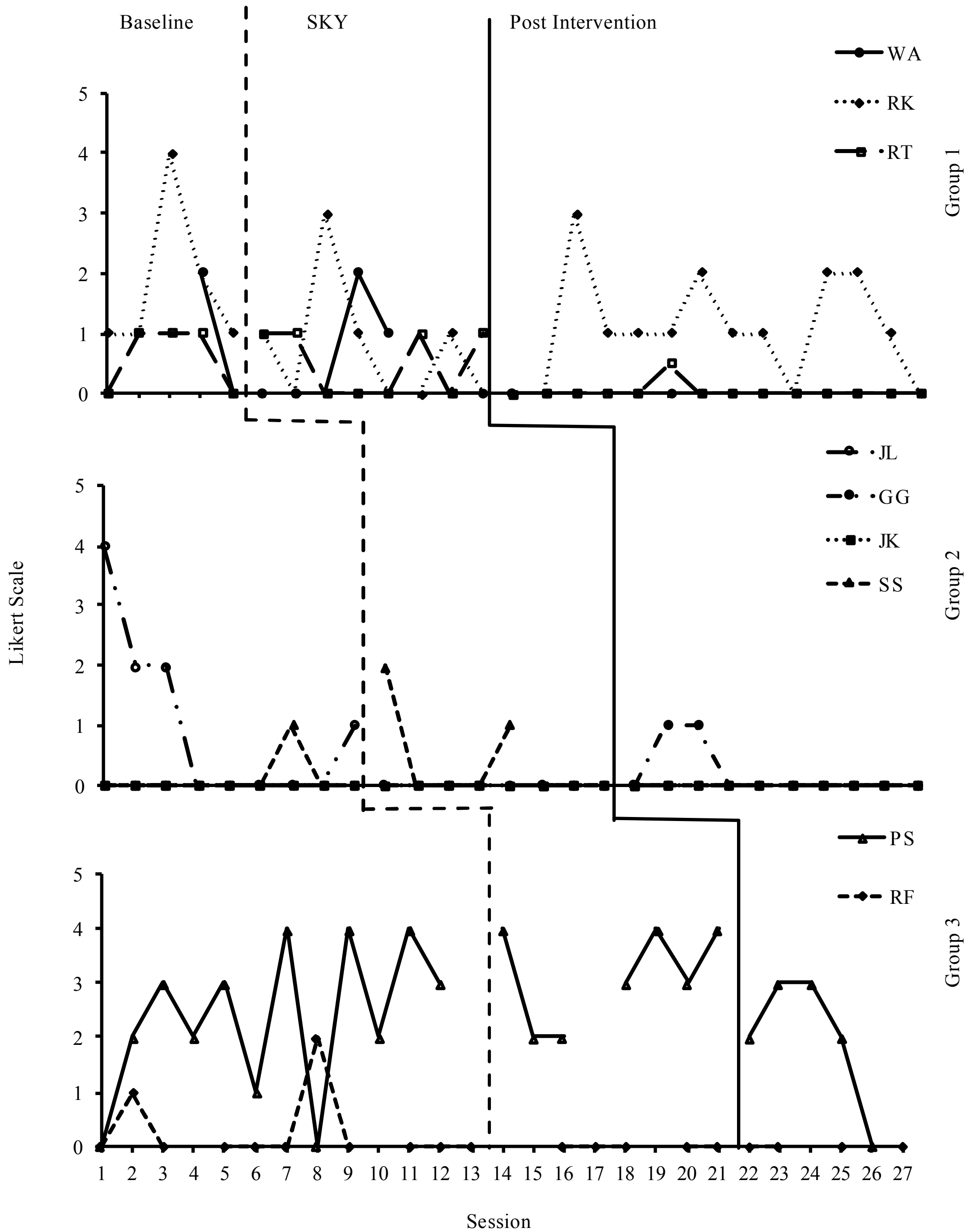

Figure 9. Perception of mealtime difficulty.

effect of treatment estimated as -1.07, 95% CI: [-2.21, .07], corresponding to a reduction in difficulty of 65.81%, 95% CI: [-89.08, 70].

Table 18

Mealtime Difficulty 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			
WA	0.25	-1.73	-82.19	1.24	[-4.15, 0.70]	[-98.43, 101.47]
RK	0.43	-0.66	-48.53	0.39	[-1.42, 0.09]	[-75.91, 9.94]
RT	0.40	-1.07	-65.81	0.58	[-2.21, 0.07]	[-89.08, 70]
JL	0.35	NA	NA	NA	NA	NA
GG	-0.11	NA	NA	NA	NA	NA
SS	0.02	0.17	18.55	1.24	[-2.25, 2.59]	[-89.50, 1238.38]
JK	0.00	NA	NA	NA	NA	NA
PS	0.02	0.13	13.38	0.22	[-0.30, 0.55]	[-25.92, 73.54]
RF	0.13	NA	NA	NA	NA	NA

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

Descriptive Results

Participants were also asked to fill out surveys at three different study timepoints: Time 0 (before SKY), Time 2 (1-25 days post SKY), and Time 3 (10 weeks post SKY). Using the Hospital Anxiety and Depression Scale (HADS), Positive and Negative Affect Schedule (PANAS), COPD Assessment Test (CAT), Eating Assessment Tool (EAT-10), and Dysphagia Handicap Index (DHI), we explored potential changes in psychological status, COPD impact on life, and swallowing-related functioning. The survey results before and after the intervention for each participant are available in Table 19, and a summary of the descriptive statistics across all participants is in Table 20.

Below I discuss the results of the observed changes across these surveys, drawing on the clinical interpretation of scores as supported by the previous literature. For each survey, changes in Times 0 (baseline), Time 2 (immediately post SKY), and Time 3 (10-weeks post SKY) are presented.

HADS

At Time 0, one participant (WA) had a score indicative of the presence of depression ("case"). When comparing Time 0 to Time 2, WA demonstrated improvement, with his score at Time 2 indicating within the normal range. Two participants continued to have scores in the same category of severity across these two timepoints: one was suggestive of the presence of a suspected case (RK) and the other borderline risk of depression (PS). However, Participant PS also had a change of >1.5 points from baseline, which is the suggested threshold for determining a minimal important difference among individuals with COPD (Puhan et al., 2008). The remaining six participants scored within the normal range at Times 0 and 2. By Time 3, eight participants (all but RK) scored within the normal range; Participant RK's score remained suggestive of the presence of a suspected case.

With regard to the degree of anxiety, three participants (RK, JL, PS) had scores indicative of the presence of anxiety ("case") at baseline. When comparing Time 0 to Time 2, all three demonstrated improvement, with scores indicating within the normal range (RK and JL) or risk of anxiety ("borderline base"; PS). At Time 0, one participant (RT) had a score suggestive of borderline risk of anxiety. When comparing Time 0 to Time 2, his scores demonstrated improvement, indicating within the normal range by

Time 2. The remaining five participants scored within the normal range at Times 0 and 2. At Time 3, all nine participants' scores fell within the normal range.

Overall, across the three timepoints, there was a trend for decreased mean scores across all participants for both depression (*M* = 6.44, *SD* = 4.07; *M* = 4.67, *SD* = 4.58; *M* = 4.00, *SD* = 4.03, for Time 0, 2, and 3, respectively) and anxiety (*M* = 6.33, *SD* = 3.31; *M* = 5.56, *SD* = 2.13; *M* = 4.56, *SD* = 1.51, for Time 0, 2, and 3, respectively).

PANAS

In terms of the changes in positive and negative affect for Times 0 and 2, eight participants (WA, RK, RT, JL, SS, JK, PS, RF) demonstrated an upward shift in positive emotions, with change in scores ranging from 1 to 17 (see Table 19). GG demonstrated a decrease of positive affect by 14. At Time 3, the same eight participants (WA, RK, RT, JL, SS, JK, PS, RF) exhibited improved positive affect as compared to Time 0, with change in scores ranging from 3 to 13 points. Participant GG again showed a decrease of positive affect, with a change in score of 4 from Time 0 to Time 3. For negative affect, five participants (RT, JL, SS, PS, RF) showed decreased negative affect, with change in scores ranging from 4 to 13 points. Three participants had the same scores at Time 0 and Time 2 (WA, GG, and JK). RK demonstrated an increase in negative affect score by 4. At Time 3, eight participants (WA, RK, RT, JL, SS, JK, PS, RF) exhibited lowered negative affect as compared to Time 0, with change in scores ranging from 1 to 17 points. Participant GG had the same score at both Time 0 and Time 3.

Overall, across the three timepoints, there was increased positive affect (*M* = 4.78, *SD* = 8.77; *M* = 29.33, *SD* = 8.40; *M* = 30.22, *SD* = 8.56, for Time 0, 2, and 3, respectively) and decreased negative affect (*M* = 17.89, *SD* = 7.07; *M* = 14.67, *SD* = 7350; *M* = 12.89, *SD* = 4.65, for Time 0, 2, and 3, respectively) across the participants.

CAT

At Time 0, three participants (WA, JL, PS) demonstrated scores indicative of high symptomatic impact of COPD. When comparing Time 0 to Time 2, two of these participants demonstrated scores suggestive of improvements, with scores at Time 2 indicating a medium impact for Participants WA and PS. Scores for JL remained in the same category of impact (i.e., high), although there was a drop of score by three points. Four participants (RK, RT, SS, JK, RF) demonstrated scores indicative of medium symptomatic impact of COPD at Time 0. When comparing those to Time 2, two participants (SS, RF) demonstrated scores suggestive of improvements, with scores indicating low impact for both. Two participants (RT, JK) remained in the same level of impact (i.e., medium) at Time 2, with a decrease of five points and an increase of one point, respectively. Further, when comparing Time 0 with Time 2, Participant GG shifted from normal to low impact. At Time 3, one participant (JL) had score that reflected high COPD symptomatic impact (same rating as Time 0 and Time 2); six participants (WA, RK, RT, JK, PS, RF) had scores indicating medium impact; one participant (SS) had a score indicating low impact; and one participant (GG) scored in the normal range.

Examining the mean scores across all participants, there was a reduction of COPD symptomatic impacts and decreased standard deviation from Time 0 to Time 2 that was maintained at Time 3 (*M* = 17.89, *SD* = 8.07; *M* = 14.56, *SD* = 6.29; *M* = 14.78, *SD* = 6.20, for Time 0, 2, and 3, respectively), although all of these mean scores are classified in the medium impact range.

EAT-10

At Time 0, six participants (WA, RK, RT, JL, GG, PS) had scores ≥ 3, which is indicative of the presence of dysphagia (Belafsky et al., 2008). Comparing Time 0 to Time 2, four of the participants (WA, RK, RT, GG) presented with the same profile; however, at Time 2, the scores for Participants JL and PS did not suggest the presence of dysphagia. The remaining three participants' scores (SS, JK, RF) did not suggest presence of dysphagia at Time 0 or Time 2. Additionally, at both Times 0 and 2, Participant RK's scores were indicative of risk of aspiration (Regan et al., 2017). Participant WA similarly had a score suggestive of risk of aspiration at Time 0, but not at Time 2. At Time 3, one participant (RK) remained to be at risk for aspiration, and three participants (WA, RK, JL) had scores that still suggested presence of dysphagia.

Across all participants, group means suggested a slight reduction in self-reported swallowing difficulties from Time 0 to Time 2 that were maintained at Time 3 ($M = 4.33$, $SD = 3.64$; $M = 3.11$, $SD = 4.28$; $M = 3.44$, $SD = 4.82$, for Time 0, 2, and 3, respectively).

DHI

When looking at the combined physical, functional, and emotional scores, five participants (RT, JL, SS, PS, RF) demonstrated a reduction in scores from Time 0 to Time 2, ranging from 2 to 6 points. Two participants (WA, GG) scored the same. Two participants (RK, JK) demonstrated an increase in scores from Time 0 to Time 2, ranging from 6 to 14 points. At Time 3, seven participants (WA, RT, JL, GG, SS, PS, RF) demonstrated a reduction in total points as compared to Time 0, ranging from 2 to 12 points. Two participants (RK, JK) exhibited an increase in total points from Time 0 to Time 3, ranging from 1 to 2 points. For the self-perceived difficulty, at Time 0, four participants (WA, JL, JK, RF) rated difficulty as normal and five (RK, RT, GG, SS, PS) rated difficulty as mild. At Time 2, five participants (GG, SS, JK, PS, RF) rated difficulty as normal and four (WA, RK, RT, JL) rated difficulty as mild. At Time 3, the same five participants (GG, SS, JK, PS, RF) rated difficulty as normal and the remaining four (WA, RK, RT, JL) rated difficulty as mild.

Across all participants, group means suggested a slight reduction in the physical impact of swallowing score across all three timepoints (M = 8.6, SD = 4.01; M = 8.44, SD = 4.56; M = 7.11, SD = 4.62, for Time 0, 2, and 3, respectively). The overall functional impact of swallowing score indicated a reduction from Time 0 to 3 (M = 2.22, SD = 2.73; M = 1.56, SD = 3.28, for Time 0 and 3, respectively). The group means suggested a slight reduction in the emotional impact of swallowing score across time (M = 2.22, SD = 2.73; M = 1.78, SD = 2.73; M = 1.56, SD = 1.94, for Time 0, 2, and 3 respectively). The overall self-perceived swallowing difficulty showed a slight increase from Time 0 to Time 3 (*M* = 1.56, *SD* = .73; *M* = 1.56, *SD* = .73; *M* = 1.67, *SD* = .87, for Time 0, 2, and 3, respectively).

Table 19

Survey Scores for Each Participant at Times 0, 2, and 3 (T0 / T2 / T3)

Participant	HADS	PANAS	CAT	EAT-10	DHI
WA	Depression 12 / 3 / 2 Anxiety 2 / 4 / 3	Positive 13 / 23 / 20 Negative 11 / 11 / 10	30 / 16 / 15	9 / 4 / 7	Regular food and liquid (T0, T2) Soft food, meats cut small and regular liquid (T3) Physical 10 / 12 / 8 Functional 2 / 2 / 0 Emotional 2 / 0 / 2 Swallowing difficulty 1 / 3 / 3
RK	Depression 12 / 15 / 13 Anxiety 8 / 7 / 7	Positive 13 / 17 / 16 Negative 30 / 34 / 24	20 / 21 / 18	9 / 14 / 15	Regular food and liquid Physical 12 / 16 / 16 Functional 2 / 8 / 2 Emotional 4 / 8 / 2 Swallowing difficulty 2 / 2 / 2
RT	Depression 5 / 3 / 4 Anxiety 8 / 7 / 5	Positive 25 / 34 / 38 Negative 16 / 12 / 11	18 / 13 / 14	8 / 3 / 2	Regular food and liquid Physical 12 / 12 / 12 Functional 4 / 2 / 2 Emotional 2 / 2 / 2 Swallowing difficulty 3 / 2 / 3
JL	Depression 7 / 4 / 7 Anxiety 11 / 4 / 6	Positive 21 / 38 / 28 Negative 17 / 12 / 16	25 / 22 / 27	4 / 1 / 3	Moist-easy-to-chew food with regular liquid (T0, T2) Soft foods, meats cut small and regular liquid (T3) Physical 10 / 8 / 8 Functional 8 / 12 / 10 Emotional 8 / 4 / 6 Swallowing difficulty 1 / 2 / 2

Table 19 (continued).

Participant	HADS	PANAS	CAT	EAT-10	DHI
GG	Depression 1 / 0 / 0 Anxiety 5 /5 / 5	Positive 34 / 20 / 30 Negative 10 / 10 / 10	3 / 8 / 5	4 / 3 / 1	Regular food and liquid Physical 6 / 4 / 1 Functional 0 / 2 / 0 Emotional 0 / 0 / 0 Swallowing difficulty 2 / 1 / 1
SS	Depression 3 / 2 / 0 Anxiety 3 / 2 / 2	Positive 36 / 37 / 40 Negative 17 / 13 / 9	10 / 6 / 8	0 / 0 / 0	Regular food and liquid Physical 2 / 2 / 4 Functional 0 / 0 / 0 Emotional 0 / 0 / 0 Swallowing difficulty 1 / 1 / 1
JK	Depression 5 / 6 / 4 Anxiety 4 / 7 / 4	Positive 22 / 24 / 26 Negative 14 / 14 / 13	17 / 18 / 14	0 / 1 / 0	Regular food and liquid Physical 2 / 8 / 3 Functional 0 / 0 / 0 Emotional 0 / 0 / 0 Swallowing difficulty 1 / 1 / 1
PS	Depression 10 / 8 / 4 Anxiety 11 / 9 / 4	Positive 24 / 32 / 35 Negative 29 / 16 / 12	23 / 20 / 17	4 / 1 / 2	Regular food and liquid Physical 12 / 10 / 6 Functional 4 / 2 / 0 Emotional 4 / 2 / 2 Swallowing difficulty 2 / 1 / 1
RF	Depression 3 / 1 / 2 Anxiety 5 / 5 / 5	Positive 35 / 39 / 39 Negative 17 / 10 / 11	15 / 7 / 15	1 / 1 / 1	Regular food and liquid Physical 8 / 4 / 6 Functional 0 / 0 / 0 Emotional 0 / 0 / 0 Swallowing difficulty 1 / 1 / 1

Note. CAT = COPD Assessment Test. DHI = Dysphagia Handicap Index. HADS = Hospital Anxiety and Depression Scale. PANAS = Positive and Negative Affect Schedule. T0, T2, and T3 are Time 0, before SKY; 2, immediately after SKY; and 3, 10-week after SKY, respectively.

Table 20

Descriptive Statistics Across All Participants at Times 0, 2, and 3 (T0 / T2 / T3)

Participant	HADS	PANAS	CAT	EAT-10	DHI
Mean	Depression 6.44 / 4.67 / 4.00 Anxiety 6.33 / 5.56 / 4.56	Positive 4.78 / 29.33 / 30.22 Negative 17.89 / 14.67 / 12.89	17.89 / 14.56 / 14.78	4.33 / 3.11 / 3.44	Physical 8.60 / 8.44 / 7.11 Functional 2.22 / 3.11 / 1.56 Emotional 2.22 / 1.78 / 1.56 Swallowing difficulty 1.56 / 1.56 / 1.67
Max	Depression 12 / 15 / 13 Anxiety 11 / 9 / 7	Positive 36 / 38 / 40 Negative 30 / 34 / 24	30 / 22 / 27	9 / 14 / 15	Physical 12 / 16 / 16 Functional 8 / 12 / 10 Emotional 8 / 8 / 6 Swallowing difficulty 3 / 3 / 3
Min	Depression 1 / 0 / 0 Anxiety 2 / 2 / 2	Positive 13 / 17 / 16 Negative 10 / 10 / 9	3 / 6 / 5	0 / 0 / 0	Physical 0 / 2 / 1 Functional 4 / 0 / 0 Emotional 0 / 0 / 0 Swallowing difficulty 1 / 1 / 1
SD	Depression 4.07 / 4.58 / 4.03 Anxiety 3.31 / 2.13 / 1.51	Positive 8.77 / 8.40 / 8.56 Negative 7.07 / 7.50 / 4.65	8.07 / 6.29 / 6.20	3.64 / 4.28 / 4.82	Physical 4.01 / 4.56 / 4.62 Functional 2.73 / 4.14 / 3.28 Emotional 2.73 / 2.73 / 1.94 Swallowing difficulty .73 / .73 / .87

Note. CAT = COPD Assessment Test. DHI = Dysphagia Handicap Index. HADS = Hospital Anxiety and Depression Scale. PANAS = Positive and Negative Affect Schedule. T0, T2, and T3 are Time 0, before SKY; 2, immediately after SKY; and 3, 10-week after SKY, respectively.

CHAPTER V

DISCUSSION

The purpose of this study was to explore the viability of SKY, a breathing-based meditation program, for improving dyspnea and the mealtime experience among individuals with COPD. A growing body of research supports the impact of COPD and dysphagia on both the physiological and the psycho-emotional aspects of life. However, effective evidence- and fidelity-based treatments that target both the physiological and the psycho-emotional nature of these diseases remain underexplored. Interventions grounded in promoting a positive mind-body-breath feedback loop, such as SKY, may effectively address this need. Therefore, using a mixed-method design, this study investigated the feasibility and acceptability of SKY among individuals with COPD as well as the functional relation between SKY and (a) perceived dyspnea and (b) mealtime enjoyment and difficulty. This study represents the first systematic examination of the potential for SKY to be used as an intervention for individuals with COPD, including the role it plays in influencing the psycho-physiological aspects of life in this population. I hypothesized that following SKY, perceived work of breathing (WOB), shortness of breath (SOB), dyspnea-related distress (DD), and dyspnea-related anxiety (DA) would improve, mealtime enjoyment would increase, and mealtime difficulty would decrease.

This chapter first discusses the findings from both the qualitative (Research Question 1) and the single-case (Research Question 2) components of the current study with mention of the descriptive statistics where appropriate. Then, the limitations, future directions, and overall conclusions will be presented.

Acceptability and Feasibility of SKY Among Individuals with COPD

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

Firstly, all participants were able to engage in the intervention successfully. Five days before the start of SKY, participants learned a component of the technique (i.e., victorious breath). The purpose of this initial training was to help participants get acclimated to the controlled and trained breathing technique, particularly given concerns that the breathing techniques may be more challenging for individuals with COPD. However, as reflected in the intervention fidelity data, all of the participants were able to perform all of the SKY components accurately; excellent inter-rater reliability was achieved to support intervention fidelity. Further, no adverse effects of SKY were reported. The qualitative data further supported participants' engagement and the feasibility of the techniques. A couple of participants shared, after learning the victorious breath, that "Finished one just a little while ago. It does seem to help my breathing some. Looking forward to doing more" (RT), and "It definitely helps to practice" (SS).

Secondly, our data reveal that intervention adherence was 90% (1/10 drop-out rate), with all nine of those participants completing SKY in its entirety. Further, most of the participants (66.67%; 6/9) were even able to continue their daily SKY home practice regularly at least four times a week; the remaining three had a practice frequency of 1-3 days a week. These numbers likely suggest that SKY was acceptable to the participants and that they were willing to commit their time to the SKY schedule and practice. Notably, these rates are in stark contrast with the adherence rates previously reported for more standard COPD-related treatments. The Global Initiative on Obstructive Lung Disease recommends that patients with COPD, whose FEV_1 falls below normal, should be referred for pulmonary rehabilitation. Pulmonary rehabilitation has been reported as an important non-pharmacological treatment for COPD, with its benefits ranging from improved exercise tolerance and quality of life to reduced perceived fatigue and dyspnea (Nici et al., 2006; Ries et al., 2007). However, treatment drop-out is often a concern. One study reported a 23% drop-out rate with pulmonary rehabilitation (Fischer et al., 2009). Other studies report the noncompletion rates of pulmonary rehabilitation can be over 70%, although usually they are reported to be between 20% and 40% (Fischer et al., 2009). Various factors can influence treatment adherence. It has been postulated that among the COPD comorbidities, anxiety and depression plays a major role in adherence (Qian et al., 2014; Yohannes et al., 2010). An individual's "common sense" towards whether a certain treatment is considered a sensible thing to do can also play a role (Kaptein et al., 2009). As explained by Leventhal's Common Sense Model, the individual's schemata towards the underlying illness, or their perception of the illness, guides the person's actions in coping with health threat, which would contribute to adherence (or nonadherence) (Leventhal et al., 1992). It has also been reported that an individual's perceived health status is most influential in the completion of rehabilitation (Selzler et al., 2012). Finally, fear of dyspnea and exercise can also be related to rehabilitation program adherence (Harrison et al., 2015). The high adherence rate (i.e., low drop-out) achieved in this current study was likely related, in part, to its lack of needed exertion or other physical activities. In the interviews, participants specifically stated that anyone in any physical condition can participate because SKY is “all sitting and nothing really strenuous” (RT). Not surprisingly given the variable drop-out rates, 30% of patients who participate in pulmonary rehabilitation do not demonstrate improved health status or exercise tolerance (Garrod et al., 2004). On the contrary, all of our participants reported at least some gains related to mind-body-breath.

Thirdly, as related to the burden of disease, our findings also 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. Participants 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” (RK). They also shared mind-body-breath benefits after SKY as evidenced by improved COPD-related burden: feeling relaxed, sleeping better, having more energy, breathing deeper and easier, being in control of breaths, and having quicker recovery from shortness of breath without anxiety attached.

These psycho-physiological results are consistent with the previous SKY research in which widespread benefits were observed across multiple populations. For example, most recently, an online SKY program delivered to 92 healthcare professional during COVID-19 demonstrated a significant reduction in stress, anxiety, and depression immediately after the program, as well as significant improvement in life satisfaction, resilience, and quality of sleep (Divya et al., 2021). Prior to the pandemic, research on in-person interventions indicated that SKY can help restore and enhance mental health, by relieving anxiety and depression (Katzman et al., 2012, Kjellgren et al., 2007; Seppälä et al., 2014, Vedamurthachar et al., 2006), reduce addictive behaviors (Kochupillai et al., 2005), improve emotional regulation (e.g., Descilo et al., 2010, Goldstein et al., 2016, Newman et al., 2020, Sureka et al., 2014, Katzman et al., 2012, Kharya et al., 2014), increase self-esteem, optimism, joviality, life satisfaction, and quality of life (Descilo et al., 2010; Jyotsna et al., 2012; Kjellgren et al., 2007; Sureka et al., 2014; Warner & Hall, 2012), improve social connectedness (Seppälä et al., 2020), and enhance sleep quality (Sulekha et al., 2006). Previous SKY research has also supported enhancements at the biochemical level, including a reduction of stress markers (e.g., cortisol, corticotrophin, blood lactate) (Carter et al., 2013, Kumar et al., 2013; Mulla & Vedamuthachar, 2014, Sharma et al, 2003, Vedamurthachar et al., 2006) as well as an increase in biomarkers associated with well-being (Shetty et al., 2006). Further, improved respiratory function (e.g., reduced respiratory rate and increased lung capacity) has also been associated with SKY (Bodi et al., 2008; Chavhan et al., 2013, Kale et al., 2016; Seppälä et al., 2014, Somwanshi et al., 2013). Based on our qualitative data, it is clear that individuals with COPD perceive similar benefits of SKY as compared to individuals with other health conditions as well as healthy individuals, who have been targeted in the previous literature.

A recent meta-synthesis of the qualitative research, aimed at systematically understanding the lived experience of COPD, revealed a number of themes that described the experience and the ongoing needs of individuals with COPD (Disler et al., 2014). These themes included: (a) understanding of the condition (individuals wanting better understanding of 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, the management of the symptoms and concerns for individuals with COPD often encompass treatment for breathlessness, fatigue, anorexia, pain, depression, anxiety, cough, and daytime sleepiness and insomnia (Farquhar et al., 2016; Higginson et al., 2014; Maddocks et al., 2017). Significantly, these reported lived experiences as well as management symptoms and concerns map onto the qualitative themes that emerged in the current study, particularly in terms of aspects of daily life that were positively influenced by SKY. Based on the changes that our participants shared after their participation in SKY, it is evident that the program can serve individuals with COPD multi-dimensionally and, when taken together with the previous literature, suggests that SKY can target multiple important domains of disease burden in COPD.

The sequelae of COPD often influence one another via feedback and feedforward loops (Lin & Shune, 2019, 2020). For example, the consequences of anxiety and depression in individuals with COPD are associated with increased functional disability and healthcare utilization as well as decreased quality of life and survival. Health-related quality of life in individuals with COPD is further complicated and adversely affected by frequent exacerbations, which further increase anxiety and depression (e.g., Yohannes et al., 2010; Yohannes et al., 2016). The secondary sequalae, such as increased economic burden and decreased quality of life, are a likely result of this combination of the primary physiological and psycho-emotional impacts of COPD (Bentsen et al., 2014; Hynninen et al., 2005; Miravitlles, 2004; Yohannes et al., 2010). COPD exacerbations are also linked to dysphagia in a cyclical manner (Steidl et al., 2014): when an individual’s swallow response is impaired, they are at increased risk for exacerbation; and when an individual undergoes acute exacerbation, they are more likely to exhibit an impaired swallow reflex (Kobayashi et al., 2007; Terada et al., 2010).

Similar cyclical relations between disease sequelae have also been reported in individuals with COPD without a diagnosis of dysphagia during oral intake (Lin & Shune, 2019). In that study, participants acknowledged the ways that their bodies physiologically responded during oral intake (i.e., dyspnea, coughs), but also how they then responded emotionally to those physiological sensations (e.g., fear, anxiety, panic). Consequently, the physiological-rooted emotions triggered more physiological responses, thereby further disrupting the oral intake experience and oral intake enjoyment. Given the substantial impact COPD has on eating and drinking, in light of the feedback and feedforward influences on oral intake, it is essential to investigate comprehensive treatment programs that account for both the physiologic and psycho-emotional components of the disease. While the emerging themes did not immediately address oral intake, our data suggest that SKY can feasibly play a vital role in alleviating the disease burden of COPD more broadly through its influence on the mind, the body, the breath, and relationship between the three.

Functional Relation Between SKY and Improved Consequences of COPD

I hypothesized that SKY would result in a functional decrease in perceived dyspnea, operationalized as WOB, SOB, DD, and DA, along with an improvement in mealtime enjoyment and reduction in mealtime difficulty. Fidelity of treatment was ensured by: (a) a trained data collector with fidelity frequency of 100% observing the intervention sessions and completing a checklist outlining whether the SKY instructor taught all the components and whether the participants were able to correctly perform each component and (b) the SKY instructor documenting whether each component was taught and whether the participants were able to demonstrate the breathing techniques accurately after instruction. All of the participants who completed the program attended the complete three-day SKY training in its entirely, all of the components of the intervention were covered in the training, and all of the participants accurately demonstrated each of the four intervention components across the training.

Dyspnea Perceptions

Our results suggest that SKY positively impacted the perceptions of WOB, SOB, DD, and DA for at least some participants with COPD. Indicators of the improvements were based on visual analyses as well as Tau-U and LRR effect sizes. The nature of COPD is that even in stable, community-dwelling individuals, their breathing functions can vary from moment to moment. This pattern was certainly mirrored in the current data visualization as not all participants achieved a stable baseline or stability in the phases of the study. This variability was additionally evidenced by some of the large standard errors for LRR and the wide confidence intervals.

Overall, 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 as compared to the baseline period before the intervention. The changes in the dyspnea perceptions observed in the visual analyses corresponded to the Tau-U and LRR calculations, especially for Participants WA and RT. These two participants, in particular, were able to achieve 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 led to improvements in dyspnea to different degrees across the different participants, participants' responses overall were more consistently apparent in the affective/distress domain associated with dyspnea as compared to the intensity/sensory domain. For example, based on LRR calculations, Participants WA and RT exhibited the most individual percentage change in dyspnea-related anxiety, and Participant RF had the greatest percentage change in dyspnea-related distress, followed by dyspnea-related anxiety. Participants WA and RT both also exhibited improvements in shortness of breath and work of breathing, respectively, although these changes were not as large in magnitude. Even in the presence of 'Very Severe' COPD (i.e., Participant PS), the greatest perceptual percentage changes were reported in dyspnea-related anxiety, followed by dyspnea-related distress. While this pattern was not present for all participants, there was a trend for more consistent improvements to be noted in the affective domain. For example, although Participant RK exhibited the greatest percentage change in shortness of breath, he also showed improvements in dyspnea-related distress. These findings that the affective components of dyspnea showed greater improvements, are consistent with a pilot study by Donesky-Cuenco et al. (2009). The researchers examined the benefits of yoga for individuals with COPD and found that while small effects were observed for dyspnea intensity after exertion (i.e., shortness of breath), there was a greater reduction in dyspnea-related distress in the yoga group as compared to the control group. 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 to be optimized through respiration, despite the disease process itself taking longer to reverse or influence (Arch & Craske, 2006; Boiten et al., 1994; Carrieri-Kohlman et al., 1993; Kaushik et al., 2006; Philippot et al., 2002). Despite the inconsistency of responses across participants in the current study, the overall data suggest that SKY can help to alleviate some of the chronic dyspnea burden experienced by individuals with COPD, at both the physiological and the psycho-emotional levels.

Interestingly, not all participants demonstrated strong perceptual changes in dyspnea. In particular, minimal perceptual changes were reported by Participants GG and JK. According to the participants' COPD severity, these individuals also both presented with mild disease severity. It is plausible that due to the more limited symptomatic impacts of COPD at baseline, perceptual changes were consequently less noticeable after SKY and/or there was less potential for improvement.

Our findings are of importance as dyspnea is common in COPD, yet often poorly managed (Swan et al., 2019). In general, up to 16% of individuals experience dyspnea, and up to 25% of accidents and emergency admissions are a product of dyspnea (Chin & Booth, 2016). Further, COPD-related dyspnea, and dyspnea in general, is often under-recognized and undertreated (Smallwood et al., 2018). Despite being a physiologically-rooted condition, this subjective experience of difficulty breathing also manifests in the psycho-emotional realms of life. COPD-related dyspnea is a major cause of disability and anxiety (GOLD, 2018). Dyspnea is linked to impeded activities of daily living, unplanned emergency room visits, and reduced quality of life (Swan et al., 2019). In actuality, dyspnea can be measured in different facets as individuals with COPD can distinguish affective dyspnea from the effects of chronic respiratory disease (Carrieri-Kohlman et al., 1996). This differentiations between affective (i.e., DD and DA) and disease effect (i.e., WOB and SOB) is certainly reflected in our data, where each participant demonstrated different degrees of effect sizes and percentage changes across the study phases.

Our findings among individuals with COPD expand upon the research of the benefits of SKY for healthy individuals. Following SKY, healthy individuals have been reported to show significantly improved pulmonary function as measured by vital and forced vital capacities as well as a reduction in respiratory rate by 5% in one week and 15% in 12 weeks (Bodi et al., 2008; Chavhan et al., 2013; Kale et al., 2016; Sahasrabudhe et al., 2019; Seppälä et al., 2014; Somwanshi et al., 2013). While we did not collect physiologic measures of pulmonary function, the data from the current study showing improvements in perceived dyspnea mirror previous findings related to the respiratory system more broadly. Most likely our WOB and SOB measures are closely linked to the intensity/sensory aspects of pulmonary functioning, which can be affected by DD and DA, and vice versa, as the physiological and the psycho-emotional levels are synergistic. This relationship is supported by our data in that most participants demonstrated changes across the various facets of dyspnea. Unlike the previous studies among healthy individuals, we did not find overall improvement across the whole group. This is likely in part due to the heterogeneity of our small sample of participants, especially in terms of different COPD severities. Further, this likely reflects a difference between healthy participants, who exhibit relative stability in their respiratory functioning, and individuals with COPD, who experience greater variability day to day.

The perceptual improvements in dyspnea observed in this study following SKY, particularly as related to work of breathing and shortness of breath, can be supported by previous literature that investigated underlying physiologic improvements. Individuals' perceived progress can be a result of strengthening of the respiratory muscles, increased excursions of the diaphragm and the lungs, and/or increased thoracic compliance (Vempati & Telles, 2002; Wenger, 1961). It is possible that by engaging in the active, volitional breathing required of the SKY intervention and home practice (vs. typical breathing that is spontaneous and involuntary), the respiratory muscles become strengthened. Further, yogic breathing is associated with a reduction in airway resistance (Mauch, 2008) and long-term yoga practice is associated with increased control of respiratory musculature such that individuals can consciously override typical physiological response of the respiratory centers (Vyas & Dikshit, 2002). 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 (Vyas & Dikshit, 2002). Additionally, surfactant and prostaglandins can be released through physiological stimuli like lung inflation to near total lung capacity, which, in turn, increases lung compliance and decreases bronchiolar smooth muscle tone (Vyas & Dikshit, 2002).

The improvements noted in dyspnea-related distress and anxiety in our study support the previous research on SKY's influence on anxiety (e.g., Doria et al., 2015; Seppälä et al., 2014; Sharma et al., 2017). Significant reductions in anxiety have been found across many populations following SKY (e.g., individuals with generalized anxiety disorder with or without comorbidities, alcohol dependent individuals, United States military veterans). For example, 73% of individuals with generalized anxiety disorder who did not respond to medication and psychotherapy treatments showed a reduction in anxiety, and 41% of the same individuals experienced a complete remission (Katzman et al., 2012). These changes may be associated with an increased parasympathetic dominance via vagal stimulation from vagal somatosensory afferents, leading to a resultant reduction in sympathetic activity (Brown & Gerbarg, 2005b; Vempati & Telles, 2002; Wenger, 1961). The Polyvagal Theory also supports the role of the vagus nerve in regulating emotions, social connections, and fear (Porges, 2007). 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 (2005a) 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.

Ultimately, the physiological and psycho-emotional domains are related bidirectionally. Using this knowledge, our study approached the management of dyspnea for individuals with COPD through a broader lens than is typically used, focusing on improving both the physiology associated with dyspnea as well as the psycho-emotional distress associated with dyspnea. Targeting both the physiology and accompanying distress is crucial as interrupting the anxiety-dyspnea-anxiety cycle may ultimately allow individuals to be able to tolerate more activities of daily living and experience improved quality of life (Dudley et al., 1980). Importantly, the decreased COPD-related dyspnea burden associated with the SKY intervention provides further support for the psycho-physiological relationships associated with dyspnea and chronic illness. For example, past research has suggested that even with improvement in the impairment, patients do not always see these improvements mirrored in their perceived handicap (Ward et al., 2002). This highlights the importance of targeting factors influencing patient perceptions related to functional disability as researchers continue to explore the inextricable relationship between physiology and psycho-emotions.

Further support for the psycho-physiological relationships after SKY is evident in the descriptive survey data. For many participants, SKY resulted in a range of short-term and long-term benefits across both the physiological (i.e., COPD-related impact) and psycho-emotional (i.e., mood, affect) realms. For example, there was reduction in the means for Hospital Anxiety and Depression Scale across the study timepoints, and there was an increase in positive affect as well as a reduction in negative affect. In fact, two of the participants whose depression subscores were consistent with case or borderline case at baseline, improved to the normal range after SKY. Three of the participants, whose anxiety subscores were consistent with case or borderline case at baseline, improved to the normal range after SKY. Additionally, when comparing baseline scores to scores 10 weeks after SKY, there was a decrease in the mean of the symptomatic impact of COPD based on the COPD Assessment Test.

The current findings suggest that SKY can yield physiological and psycho-emotional benefits for individuals with COPD. These findings are in alignment with the results from a number of previous reviews, systematic reviews, and meta-analyses across both the healthy elderly and COPD populations exploring the benefits of complementary and integrative intervention programs more broadly (Cramer et al., 2019; Li et al., 2018; Patel et al., 2012; Ratarasarn & Kundu, 2020; Tulloch et al., 2018). For example, based on quantitative and qualitative synthesis, one systematic review and meta-analysis suggested that the benefits of yoga may exceed conventional exercise interventions for self-rated health status, aerobic fitness, and strength (Patel et al., 2012). Previous literature on the specific benefits of various complementary and integrative health interventions have mostly yielded results that support such interventions among the COPD population. Significant changes in anxiety, perception of dyspnea, and reduction in respiratory rate were reported after a meditation program (Reaves & Angosta, 2021). Improved pulmonary function, ability to ambulate, and quality of life were also noted after a 12-week yoga program (Kaminsky et al., 2017; Yudhawati & Hs, 2019). Another pilot study also reported that a 12-week yoga program yielded significant positive effects on dyspnea-related intensity and dyspnea-related distress (Donesky-Cuenco et al., 2009). The feasibility and compliance for an eight-week meditation program was reported, and the results revealed long-term benefits on psychological distress (Bensliman et al., 2020). SKY adds to the existing literature base in supporting the benefits of complementary and integrative interventions.

However, not all of the previous research has yielded positive findings. One study revealed that an eight-week yoga and meditation program did not impact lung function for individuals with moderate-to-very-severe COPD (Rasam et al., 2019). An absence of a significant finding for the benefit of mindfulness-based stress reduction and relaxation response training was also reported in a randomized controlled trial (Mularski et al., 2009). The discrepancies across the past research and the current one can be attributed to a few factors. Firstly, it is plausible that the different participants' COPD severities across the studies contributed to the differences in findings. For example, of note, individuals with mild COPD in the current study exhibited the most limited benefits, if at all. The inconsistent results could also be attributed to differences in treatment adherence as the characteristics of COPD (e.g., anxiety, depression, fear of dyspnea) can yield issues with adherence (Fischer et al., 2009; Qian et al., 2014; Yohannes et al., 2010). The amount of time required can serve as an additional variance. When compared to SKY, the previous studies required more substantial time commitments. Further, SKY is an evidence-based program that is taught per a manual, whereas other studies often appeared to utilize approaches from different sources, which may lead to questionable treatment fidelity and effectiveness.

Mealtime Enjoyment/Difficulty and Swallowing Function

In terms of rating mealtime enjoyment and difficulty after SKY, our participants demonstrated varying degrees of responses. For example, JL demonstrated a relatively high gain in mealtime enjoyment. However, this positive outcome was likely influenced by her experiencing dental issues at the beginning of the data collection, which was later resolved. Overall, the role that SKY plays in increasing mealtime enjoyment for individuals with COPD was not able to be fully captured in the current study, even though past research on SKY has revealed enhancement of optimism and life satisfaction in healthy adults (Divya et al., 2021; Goldstein et al., 2016; Goldstein et al., 2020; Kjellgren et al., 2007). Further, the minimal changes that were observed in mealtime enjoyment after SKY could often be explained by additional individual-level factors, such as the participants had not eaten, ate already, or had other conflicts at the time of the call. Thus, limited conclusions can be determined about the effects of SKY on mealtime enjoyment from the current study.

However, our data did suggest that individuals who exhibited the most consistent reduction in dyspnea burden across domains also demonstrated the greatest decreases in mealtime difficulty (i.e., WA and RT). In the work of Lin & Shune (2019), it was reported that dyspnea during oral intake can lead to negative emotions, like fear, anxiety, panic, which further deteriorate the breathing status (i.e., mind-body-breath feedback loop). This occurred even in the absence of diagnosed dysphagia, although many participants did report signs and symptoms suggestive of a swallowing impairment. Our current findings expand on this previous work by specifically targeting a reduction in dyspnea burden, potentially interrupting the mind-body-breath feedback loop and allowing for decreased perceived mealtime difficulty. Consequently, with the reduction in both dyspnea burden and the corresponding oral intake difficulties (i.e., taking less work to eat), it is possible that individuals with COPD may have more respiratory reserve for other activities of daily living (Dudley et al., 1980). In fact, when an individual struggles to breathe, the basic drive for respiration can override the drive for nutrition via oral intake. This creates clear downstream consequences, as malnutrition is an issue among individuals with COPD, with up to 60% of inpatients and 45% of outpatients being at risk (Hodson, 2016; Hoong et al., 2017). Unfortunately, malnutrition is an independent predictor of one-year mortality and healthcare utilization (e.g., increased risk of hospitalization, longer hospital stay, more readmissions, increased hospitalization costs by 20%) (Hoong et al., 2017). Also, underweight individuals with advanced but stable COPD have been reported to present with dysphagia that may not be self-recognized (Garand et al., 2018), further contributing to their nutritional concerns. Therefore, it is plausible that reducing mealtime difficulties through decreased dyspnea may lead to more widespread benefits on nutrition and overall well-being.

The relationship between decreased perceived dyspnea burden and improved eating and/or swallowing function is also supported by the results for the Eating Assessment Tool (EAT-10) and the physical, functional, and emotional aspects of the Dysphagia Handicap Index (DHI). When comparing the baseline group mean of EAT-10 with the group mean after SKY, there was a slight reduction, indicating improvements. Although there was a slight increase in the group mean for perceived swallowing difficulty on the DHI, when comparing baseline scores across the different domains with those after SKY, there was an overall reduction of the means, suggestive of improvements. The slight increase in perceived swallowing difficulty might be attributed to increased self-awareness after SKY (Goldstein et al., 2020; Seppälä et al., 2020), particularly as related to breathing, as no participants reported any major medical issues during the span of the research. Thus, the observed link between dyspnea and perceived mealtime difficulty described above likely corresponded, at least in part, to the impact of dyspnea burden on the swallowing mechanism, especially with regard to safety and airway invasion.

The elevated respiratory rate associated with dyspnea commonly observed in individuals with COPD (Berliner et al., 2016) is linked to discoordination between breathing and swallowing in this population (Shaker et al., 1992). Both consequences of dyspnea (i.e., increased respiratory rate and discoordinated breathing and swallowing) increase the risk of airway invasion during oral intake (Steele & Cichero, 2014), and COPD is a common risk factor for aspiration pneumonia (Santo et al., 2021). When an individual is at risk for aspiration pneumonia and/or present with dysphagia, malnutrition can be expected (Langmore, 1999). Further, dyspnea itself can yield a negative oral intake experience (affectively); these negative emotions then worsen the existing dyspnea (Lin & Shune, 2019). Dysphagia can also impede quality of life more broadly by impacting affect, mood, and social interactions (Eslick & Talley, 2008; McHorney et al., 2000; Nguyen et al., 2005; Plowman-Prine et al., 2009). Together, underlying dyspnea and dysphagia likely magnify a negative oral intake experience, contributing to further widespread, cascading consequences (e.g., increased anxiety, increased dyspnea, decreased intake). It is therefore pivotal to tap into the management of dyspnea from the root, through approaches like SKY, in order to optimize fundamental activities of daily living, like oral intake, particularly given concomitant dysphagia.

Study Limitations

There are a few important limitations of this study to note. Firstly, a number of limitations arose related to the single-case data collection. It was not always possible to obtain consistent worsening, improving, or stabling data points for every participant within a group before the start of the intervention or the start of the next group intervention. This was likely due to the nature of COPD, where breathing status varies frequently across activities and across days. Additionally, even though the data collection times were individually discussed with each participant and agreed upon, sometimes participants had not eaten their evening dinner, ate earlier, or had other conflicts at the time of the planned phone call. Thus, while the team called the participants at these consistent times each day, the true reflection of breathing status immediately after oral intake was perhaps more confined. Also, retrospectively, it appeared that some participants comprehended the mealtime enjoyment question differently at times, focusing on their enjoyment of the specific food consumed during that meal versus the broader intention of exploring the mealtime process itself.

Secondly, there were a few needed restrictions related to the design and participants. In terms of the design of both portions of the study, most of the data collected was limited to within-a-month timeframe after the SKY intervention. The longer-term impacts of the intervention and maintenance of the intervention effects for individuals with COPD remains unexplored. Additionally, the makeup of the participants limits the generalizability of the findings. It would be beneficial for future studies to more closely mirror the demographics of the overall COPD population in terms of, for example, disease severity. As noted, those individuals with milder COPD may not yield the same immediate benefit from treatment. Further, all of our participants were in the age range of 61 to 74. Presbyphagia, or age-related changes in swallowing function, could potentially impact the influence of COPD on swallowing function and alter treatment effectiveness. Relatedly, no direct measures of swallowing status were collected, and dysphagia status was not used as inclusion/exclusion criteria. Although previous work has suggested that even participants without diagnosed dysphagia experience negative effects of COPD on the oral intake process, the current results cannot provide specific conclusions regarding the influence of SKY on dysphagia more specifically. Lastly, due to COVID-19, the study was limited to remote intervention presentation and data collection, relying on subjective experience/reporting rather than physiological measurements. The physiological aspects of breathing, oral intake, and the interactions of the two could not be collected as a result. Despite these limitations, the study's findings lay the foundation and invitation for further research directions.

Future Directions

This study forms the foundation for future investigations into the viability and effectiveness of SKY for individuals with COPD. Firstly, to promote the generalizability of the results, scaling up the study is needed. Increasing the sample size, recruiting a more heterogenous sample with respect to race and ethnicity and COPD status, involving multiple sites/regions, and including a control group will help strengthen the findings. Secondly, physiological measures like pre- and post- pulmonary functions (e.g., respiratory rate, FEV_1, FVC, FEV_1/FVC) 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. Similarly, swallowing physiology and its interaction with pulmonary status during oral intake should be explored to further the objective benefits of SKY and provide clear clinical implications for individuals with dysphagia. Thirdly, longer-term follow-up is warranted to investigate the true functional effects and maintenance of these effects over time. Also, longer-term follow-up would allow for additional outcome measures of relevance to be collected, such as nutritional status, which may be important for individuals with COPD experiencing dyspnea and dysphagia. Finally, the study results suggest the potential for benefit from SKY among other clinical populations with respiratory impairments (e.g., end-stage cancer, congestive heart failure, COVID-19). Thus, future work can expand to other populations who are affected by their breathing, in order to investigate the effectiveness of SKY in these different groups.

Conclusions

COPD is the third-leading cause of death and a major cause of disability worldwide. Its significant impacts are not limited to the physiological realm. COPD greatly 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 ultimately worsens health and quality of life. Therefore, it is crucial that COPD management more comprehensively targets the physiological and psycho-emotional consequences of the disease. This study is the first to explore the feasibility and acceptability of SKY among individuals with COPD as well as the relation between SKY and dyspnea perceptions in this population. Supported by our qualitative, single-case, and descriptive data, as well as the absence of any adverse events, the results suggest proof of concept that SKY can help alleviate aspects of COPD disease burden related to the mind, body, and breath more broadly as well as reduce the cyclical effect of the disease sequalae. 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, including following oral intake, an activity of daily life when these characteristics are known to be high. Importantly, 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, improvements in quality of life. This suggests that SKY may be a valuable supplement to more traditional therapeutic approaches for this population in order to address disease impacts comprehensively.

REFERENCES CITED

Allen, J., Greene, M., Sabido, I., Stretton, M., & Miles, A. (2019). Economic costs of dysphagia among hospitalized patients. *The Laryngoscope*. https://doi.org/10.1002/lary.28194

Ambrosino, N., & Fracchia, C. (2019). Strategies to relieve dyspnoea in patients with advanced chronic respiratory diseases. A narrative review. *Pulmonology*. https://doi.org/10.1016/j.pulmoe.2019.04.002

Anju, D., Anita, C., Raka, J., Deepak, Y., & Vedamurthachar. (2015). Effectiveness of yogic breathing intervention on quality of life of opioid dependent users. *International Journal of Yoga*, *8*(2), 144. https://doi.org/10.4103/0973-6131.154075

Arch, J. J., & Craske, M. G. (2006). Mechanisms of mindfulness: Emotion regulation following a focused breathing induction. *Behaviour Research and Therapy*, *44*(12), 1849–1858. https://doi.org/10.1016/j.brat.2005.12.007

Belafsky, P. C., Mouadeb, D. A., Rees, C. J., Pryor, J. C., Postma, G. N., Allen, J., & Leonard, R. J. (2008). Validity and Reliability of the Eating Assessment Tool (EAT-10). *Annals of Otology, Rhinology & Laryngology*, *117*(12), 919–924. https://doi.org/10.1177/000348940811701210

Bensliman, S., Ninane, V., & Mélot, C. (2020). Feasibility, compliance and effects of a Mindfulness program on COPD patients. *Airway Pharmacology and Treatment*, 645. https://doi.org/10.1183/13993003.congress-2020.645

Bentsen, S. B., Miaskowski, C., & Rustøen, T. (2014). Demographic and clinical characteristics associated with quality of life in patients with chronic obstructive pulmonary disease. *Quality of Life Research*, *23*(3), 991–998. https://doi.org/10.1007/s11136-013-0515-5

Berliner, D., Schneider, N., Welte, T., & Bauersachs, J. (2016). The Differential Diagnosis of Dyspnea. *Deutsches Aerzteblatt Online*. https://doi.org/10.3238/arztebl.2016.0834

Bodi, S. G., Sagar, R. N., Prasad, C. E., & Prasad, S. (2008). Improvement in lung function with a unique braething technique: Sudarshan Kriya Yoga. *Chest*, *134*(4), 144P. https://doi.org/10.1378/chest.134.4_MeetingAbstracts.p144003

Boiten, F. A., Frijda, N. H., & Wientjes, C. J. E. (1994). Emotions and respiratory patterns: Review and critical analysis. *International Journal of Psychophysiology*, *17*(2), 103–128. https://doi.org/10.1016/0167-8760(94)90027-2

Boone Jr., H. N., & Boone, D. A. (2017). Analyzing Likert data. *Russian Chemical Bulletin*, *66*(8), 1456–1466. https://doi.org/10.1007/s11172-017-1908-3

Borge, C. R., Hagen, K. B., Mengshoel, A. M., Omenaas, E., Moum, T., & Wahl, A. K. (2014). Effects of controlled breathing exercises and respiratory muscle training in people with chronic obstructive pulmonary disease: Results from evaluating the quality of evidence in systematic reviews. *BMC Pulmonary Medicine*, *14*(1). https://doi.org/10.1186/1471-2466-14-184

Brown, R. P., & Gerbarg, P. L. (2002). *Yogic Breathing and Meditation: When the Thalamus Quiets the Cortex and Rouses the Limbic System*. 9.

Brown, R. P., & Gerbarg, P. L. (2005a). Sudarshan Kriya Yogic Breathing in the Treatment of Stress, Anxiety, and Depression: Part I—Neurophysiologic Model. *The Journal of Alternative and Complementary Medicine*, *11*(1), 189–201. https://doi.org/10.1089/acm.2005.11.189

Brown, R. P., & Gerbarg, P. L. (2005b). Sudarshan Kriya Yogic Breathing in the Treatment of Stress, Anxiety, and Depression: Part II—Clinical Applications and Guidelines. *The Journal of Alternative and Complementary Medicine*, *11*(4), 711–717. https://doi.org/10.1089/acm.2005.11.711

Byiers, B. J., Reichle, J., & Symons, F. J. (2012). Single-Subject Experimental Design for Evidence-Based Practice. *American Journal of Speech-Language Pathology*, *21*(4), 397–414. https://doi.org/10.1044/1058-0360(2012/11-0036)

Carrieri-Kohlman, V., Douglas, M. K., Gormley, J. M., & Stulbarg, M. S. (1993). Desensitization and guided mastery: treatment approaches for the management of dyspnea. Heart & lung: the journal of critical care, 22(3), 226-234.

Carrieri-Kohlman, V., Gormley, J. M., Douglas, M. K., Paul, S. M., & Stulbarg, M. S. (1996). Differentiation between Dyspnea and Its Affective Components. *Western Journal of Nursing Research*, *18*(6), 626–642. https://doi.org/10.1177/019394599601800602

Carrieri-Kohlman, V., Gormley, J. M., Eiser, S., Demir-Deviren, S., Nguyen, H., Paul, S. M., & Stulbarg, M. S. (2001). Dyspnea and the Affective Response During Exercise Training in Obstructive Pulmonary Disease: *Nursing Research*, *50*(3), 136–146. https://doi.org/10.1097/00006199-200105000-00002

Carter, J., Gerbarg, P. L., Brown, R. P., Ware, R. S., & D'ambrosio, C. (2013). Multi-component yoga breath program for Vietnam veteran post traumatic stress disorder: randomized controlled trial. *J Trauma Stress Disor Treat 2*, *3*(2).

Chan, R. R., & Lehto, R. H. (2016). The Experience of Learning Meditation and Mind/Body Practices in the COPD Population. *EXPLORE: The Journal of Science and Healing*, *12*(3), 171–179. https://doi.org/10.1016/j.explore.2016.02.004

Chavhan, D. B. (2013). The Effect Of Sudarshan Kriya and Bhastrika Pranayama on Endurance Capacity in Kho-Kho Players. *International Multidisciplinary Research Journal*, (6), 1.

Cheraghi, M. A., Esmaeili, M., & Salsali, M. (2017). Seeking Humanizing Care in Patient-Centered Care Process: A Grounded Theory Study. *Holistic Nursing Practice*, *31*(6), 359–368. https://doi.org/10.1097/HNP.0000000000000233

Chin, C., & Booth, S. (2016). Managing breathlessness: A palliative care approach. *Postgraduate Medical Journal*, *92*(1089), 393–400. https://doi.org/10.1136/postgradmedj-2015-133578

Coelho, C. A. (1987). Preliminary findings on the nature of dysphagia in patients with chronic obstructive pulmonary disease. *Dysphagia*, *2*(1), 28–31.

Constand, M. K., MacDermid, J. C., Dal Bello-Haas, V., & Law, M. (2014). Scoping review of patient-centered care approaches in healthcare. *BMC Health Services Research*, *14*(1). https://doi.org/10.1186/1472-6963-14-271

Cramer, H., Haller, H., Klose, P., Ward, L., Chung, V. C., & Lauche, R. (2019). The risks and benefits of yoga for patients with chronic obstructive pulmonary disease: A systematic review and meta-analysis. *Clinical Rehabilitation*, *33*(12), 1847–1862. https://doi.org/10.1177/0269215519860551

Croasmun, J. T., & Ostrom, L. (2011). Using Likert-type scales in the social sciences. *Journal of Adult Education*, *40*(1), 19–22.

Curtis, J. A., Seikaly, Z. N., & Troche, M. S. (2020). Respiratory–Swallow Coordination Training Improves Swallowing Safety and Efficiency in a Person With Anoxic Brain Injury. *American Journal of Speech-Language Pathology*, 1–11. https://doi.org/10.1044/2020_AJSLP-20-00095

Cvejic, L., Harding, R., Churchward, T., Turton, A., Finlay, P., Massey, D., Bardin, P. G., & Guy, P. (2011). Laryngeal penetration and aspiration in individuals with stable COPD: Aspiration in COPD. *Respirology*, *16*(2), 269–275. https://doi.org/10.1111/j.1440-1843.2010.01875.x

Dalal, A. A., Shah, M., Lunacsek, O., & Hanania, N. A. (2011). Clinical and Economic Burden of Depression/Anxiety in Chronic Obstructive Pulmonary Disease Patients within a Managed Care Population. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *8*(4), 293–299. https://doi.org/10.3109/15412555.2011.586659

Descilo, T., Vedamurtachar, A., Gerbarg, P. L., Nagaraja, D., Gangadhar, B. N., Damodaran, B., ... & Brown, R. P. (2010). Effects of a yoga breath intervention alone and in combination with an exposure therapy for post-traumatic stress disorder and depression in survivors of the 2004 South-East Asia tsunami. *Acta Psychiatrica Scandinavica*, *121*(4), 289-300.

de Visser, R. O., Graber, R., Hart, A., Abraham, C., Scanlon, T., Watten, P., & Memon, A. (2015). Using qualitative methods within a mixed-methods approach to developing and evaluating interventions to address harmful alcohol use among young people. *Health Psychology*, *34*(4), 349–360. https://doi.org/10.1037/hea0000163

Diaz-Guzman, E., & Mannino, D. M. (2014). Epidemiology and Prevalence of Chronic Obstructive Pulmonary Disease. *Clinics in Chest Medicine*, *35*(1), 7–16. https://doi.org/10.1016/j.ccm.2013.10.002

Disler, R. T., Green, A., Luckett, T., Newton, P. J., Inglis, S., Currow, D. C., & Davidson, P. M. (2014). Experience of Advanced Chronic Obstructive Pulmonary Disease: Metasynthesis of Qualitative Research. *Journal of Pain and Symptom Management*, *48*(6), 1182–1199. https://doi.org/10.1016/j.jpainsymman.2014.03.009

Divya, K., Bharathi, S., Somya, R., & Darshan, M. H. (2021). Impact of a Yogic Breathing Technique on the Well-Being of Healthcare Professionals During the COVID-19 Pandemic. *Global Advances in Health and Medicine*, *10*, 216495612098295. https://doi.org/10.1177/2164956120982956

Donesky-Cuenco, D., Nguyen, H. Q., Paul, S., & Carrieri-Kohlman, V. (2009). Yoga Therapy Decreases Dyspnea-Related Distress and Improves Functional Performance in People with Chronic Obstructive Pulmonary Disease: A Pilot Study. *The Journal of Alternative and Complementary Medicine*, *15*(3), 225–234. https://doi.org/10.1089/acm.2008.0389

Doria, S., de Vuono, A., Sanlorenzo, R., Irtelli, F., & Mencacci, C. (2015). Anti-anxiety efficacy of Sudarshan Kriya Yoga in general anxiety disorder: A multicomponent, yoga based, breath intervention program for patients suffering from generalized anxiety disorder with or without comorbidities. *Journal of Affective Disorders*, *184*, 310–317. https://doi.org/10.1016/j.jad.2015.06.011

Dudley, D. L., Glaser, E. M., Jorgenson, B. N., & Logan, D. L. (1980). Psychosocial Concomitants to Rehabilitation in Chronic Obstructive Pulmonary Disease Pt. 1. *Chest*, *77*(3), 413–420. https://doi.org/10.1378/chest.77.3.413

Ekberg, O., Hamdy, S., Woisard, V., Wuttge-Hannig, A., & Ortega, P. (2002). Social and Psychological Burden of Dysphagia: Its Impact on Diagnosis and Treatment. *Dysphagia*, *17*(2), 139–146. https://doi.org/10.1007/s00455-001-0113-5

Eslick, G. D., & Talley, N. J. (2008). Dysphagia: Epidemiology, risk factors and impact on quality of life - a population-based study: DYSPHAGIA - A POPULATION-BASED STUDY. *Alimentary Pharmacology & Therapeutics*, *27*(10), 971–979. https://doi.org/10.1111/j.1365-2036.2008.03664.x

Esser, R. W., Stoeckel, M. C., Kirsten, A., Watz, H., Taube, K., Lehmann, K., Petersen, S., Magnussen, H., & von Leupoldt, A. (2016). Structural Brain Changes in Patients With COPD. *Chest*, *149*(2), 426–434. https://doi.org/10.1378/chest.15-0027

Farquhar, M. C., Prevost, A. T., McCrone, P., Brafman-Price, B., Bentley, A., Higginson, I. J., Todd, C. J., & Booth, S. (2016). The clinical and cost effectiveness of a Breathlessness Intervention Service for patients with advanced non-malignant disease and their informal carers: Mixed findings of a mixed method randomised controlled trial. *Trials*, *17*(1), 185. https://doi.org/10.1186/s13063-016-1304-6

Farver-Vestergaard, I., O’Toole, M. S., O’Connor, M., Løkke, A., Bendstrup, E., Basdeo, S. A., Cox, D. J., Dunne, P. J., Ruggeri, K., Early, F., & Zachariae, R. (2018). Mindfulness-based cognitive therapy in COPD: A cluster randomised controlled trial. *European Respiratory Journal*, *51*(2), 1702082. https://doi.org/10.1183/13993003.02082-2017

Fischer, M. J., Scharloo, M., Abbink, J. J., van ‘t Hul, A. J., van Ranst, D., Rudolphus, A., Weinman, J., Rabe, K. F., & Kaptein, A. A. (2009). Drop-out and attendance in pulmonary rehabilitation: The role of clinical and psychosocial variables. *Respiratory Medicine*, *103*(10), 1564–1571. https://doi.org/10.1016/j.rmed.2008.11.020

Ford, E. S., Murphy, L. B., Khavjou, O., Giles, W. H., Holt, J. B., & Croft, J. B. (2015). Total and State-Specific Medical and Absenteeism Costs of COPD Among Adults Aged 18 Years in the United States for 2010 and Projections Through 2020. *Chest*, *147*(1), 31–45. https://doi.org/10.1378/chest.14-0972

Garand, K. L., Strange, C., Paoletti, L., Hopkins-Rossabi, T., & Martin-Harris, B. (2018). Oropharyngeal swallow physiology and swallowing-related quality of life in underweight patients with concomitant advanced chronic obstructive pulmonary disease. *International Journal of Chronic Obstructive Pulmonary Disease*, *Volume 13*, 2663–2671. https://doi.org/10.2147/COPD.S165657

Garrod, R., Ford, K., Daly, C., Hoareau, C., Howard, M., & Simmonds, C. (2004). Pulmonary rehabilitation: Analysis of a clinical service. *Physiotherapy Research International*, *9*(3), 111–120. https://doi.org/10.1002/pri.311

Ghahremani, D. G., Oh, E. Y., Dean, A. C., Mouzakis, K., Wilson, K. D., & London, E. D. (2013). Effects of the Youth Empowerment Seminar on Impulsive Behavior in Adolescents. *Journal of Adolescent Health*, *53*(1), 139–141. https://doi.org/10.1016/j.jadohealth.2013.02.010

Goldstein, M., Lewis, G., Newman, R., Brown, J., Bobashev, G., Kilpatrick, L., Seppälä, E., Fishbein, D., & Meleth, S. (2016). Improvements in well-being and vagal tone following a yogic breathing-based life skills workshop in young adults: Two open-trial pilot studies. *International Journal of Yoga*, *9*(1), 20. https://doi.org/10.4103/0973-6131.171718

Goldstein, M. R., Lewin, R. K., & Allen, J. J. B. (2020). Improvements in well-being and cardiac metrics of stress following a yogic breathing workshop: Randomized controlled trial with active comparison. *Journal of American College Health*, 1–11. https://doi.org/10.1080/07448481.2020.1781867

Good-Fratturelli, M. D., Curlee, R. F., & Holle, J. L. (2000). Prevalence and nature of dysphagia in va patients with copd referred for videofluoroscopic swallow examination. *Journal of Communication Disorders*, *33*(2), 93–110. https://doi.org/10.1016/S0021-9924(99)00026-X

Groenewald, T. (2004). A Phenomenological Research Design Illustrated. *International Journal of Qualitative Methods*, *3*(1), 42–55. https://doi.org/10.1177/160940690400300104

Gross, R. D., Atwood, C. W., Ross, S. B., Olszewski, J. W., & Eichhorn, K. A. (2009). The Coordination of Breathing and Swallowing in Chronic Obstructive Pulmonary Disease. *American Journal of Respiratory and Critical Care Medicine*, *179*(7), 559–565. https://doi.org/10.1164/rccm.200807-1139OC

Harrison, S. L., Robertson, N., Apps, L., C. Steiner, M., Morgan, M. D. L., & Singh, S. J. (2015). “We are not worthy” – understanding why patients decline pulmonary rehabilitation following an acute exacerbation of COPD. *Disability and Rehabilitation*, *37*(9), 750–756. https://doi.org/10.3109/09638288.2014.939770

Hess, J. S., & Straub, D. M. (2011). Brief Report: Preliminary Findings from a Pilot Health Care Transition Education Intervention for Adolescents and Young Adults with Special Health Care Needs. *Journal of Pediatric Psychology*, *36*(2), 172–178. https://doi.org/10.1093/jpepsy/jsq091

Higginson, I. J., Bausewein, C., Reilly, C. C., Gao, W., Gysels, M., Dzingina, M., McCrone, P., Booth, S., Jolley, C. J., & Moxham, J. (2014). An integrated palliative and respiratory care service for patients with advanced disease and refractory breathlessness: A randomised controlled trial. *The Lancet Respiratory Medicine*, *2*(12), 979–987. https://doi.org/10.1016/S2213-2600(14)70226-7

Hillemacher, T., Gräßel, E., Tigges, S., Bleich, S., Neundörfer, B., Kornhuber, J., & Hecht, M. (2004). Depression and bulbar involvement in amyotrophic lateral sclerosis. *Amyotrophic Lateral Sclerosis and Other Motor Neuron Disorders*, *5*(4), 245–249. https://doi.org/10.1080/14660820410021294

Hodson, M. (2016). *Integrating nutrition into pathways for patients with COPD*. *21*(11), 6.

Hoong, J. M., Ferguson, M., Hukins, C., & Collins, P. F. (2017). Economic and operational burden associated with malnutrition in chronic obstructive pulmonary disease. *Clinical Nutrition*, *36*(4), 1105–1109. https://doi.org/10.1016/j.clnu.2016.07.008

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The Use of Single-Subject Research to Identify Evidence-Based Practice in Special Education. *Exceptional Children*, *71*(2), 165–179. https://doi.org/10.1177/001440290507100203

Hynninen, K. M. J., Breitve, M. H., Wiborg, A. B., Pallesen, S., & Nordhus, I. H. (2005). Psychological characteristics of patients with chronic obstructive pulmonary disease: A review. *Journal of Psychosomatic Research*, *59*(6), 429–443. https://doi.org/10.1016/j.jpsychores.2005.04.007

Iyer, A. S., Bhatt, S. P., Garner, J. J., Wells, J. M., Trevor, J. L., Patel, N. M., Kirkpatrick, deNay, Williams, J. C., & Dransfield, M. T. (2015). Depression is Associated with Readmission Due To Acute Exacerbation Of Chronic Obstructive Pulmonary Disease. *Annals of the American Thoracic Society*. https://doi.org/10.1513/AnnalsATS.201507-439OC

Janssens, T., Van de Moortel, Z., Geidl, W., Carl, J., Pfeifer, K., Lehbert, N., Wittmann, M., Schultz, K., & von Leupoldt, A. (2019). Impact of Disease-Specific Fears on Pulmonary Rehabilitation Trajectories in Patients with COPD. *Journal of Clinical Medicine*, *8*(9), 1460. https://doi.org/10.3390/jcm8091460

Johnson, J. D., & Theurer, W. M. (2014). *A Stepwise Approach to the Interpretation of Pulmonary Function Tests*. *89*(5), 8.

Jones, E., Speyer, R., Kertscher, B., Denman, D., Swan, K., & Cordier, R. (2018). Health-Related Quality of Life and Oropharyngeal Dysphagia: A Systematic Review. *Dysphagia*, *33*(2), 141–172. https://doi.org/10.1007/s00455-017-9844-9

Jones, Harding, G., Berry, P., Wiklund, I., Chen, W.-H., & Kline Leidy, N. (2009). Development and first validation of the COPD Assessment Test. *European Respiratory Journal*, *34*(3), 648–654. https://doi.org/10.1183/09031936.00102509

Jones, P. W., Tabberer, M., & Chen, W.-H. (2011). Creating scenarios of the impact of copd and their relationship to copd assessment test (CAT^{TM}) scores. *BMC Pulmonary Medicine*, *11*(1), 42. https://doi.org/10.1186/1471-2466-11-42

Jyotsna, V. P., Joshi, A., Ambekar, S., Kumar, N., Dhawan, A., & Sreenivas, V. (2012). Comprehensive yogic breathing program improves quality of life in patients with diabetes. *Indian journal of endocrinology and metabolism*, *16*(3), 423.

Kale, J., Deshpande, R., & Katole, N. (2016). The effect of Sudarshan Kriya Yoga (SKY) on cardiovascular and respiratory parameters. *International Journal of Medical Science and Public Health*, *5*(10), 2091. https://doi.org/10.5455/ijmsph.2016.23022016430

Kaminsky, D. A., Guntupalli, K. K., Lippmann, J., Burns, S. M., Brock, M. A., Skelly, J., DeSarno, M., Pecott-Grimm, H., Mohsin, A., LaRock-McMahon, C., Warren, P., Whitney, M. C., & Hanania, N. A. (2017). Effect of Yoga Breathing (Pranayama) on Exercise Tolerance in Patients with Chronic Obstructive Pulmonary Disease: A Randomized, Controlled Trial. *The Journal of Alternative and Complementary Medicine*, *23*(9), 696–704. https://doi.org/10.1089/acm.2017.0102

Kaptein, A. A., Scharloo, M., Fischer, M. J., Snoei, L., Hughes, B. M., Weinman, J., Kaplan, R. M., & Rabe, K. F. (2009). 50 Years of psychological research on patients with COPD – Road to ruin or highway to heaven? *Respiratory Medicine*, *103*(1), 3–11. https://doi.org/10.1016/j.rmed.2008.08.019

Karloh, M., Fleig Mayer, A., Maurici, R., Pizzichini, M. M. M., Jones, P. W., & Pizzichini, E. (2016). The COPD Assessment Test: What Do We Know So Far? *Chest*, *149*(2), 413–425. https://doi.org/10.1378/chest.15-1752

Karvonen-Gutierrez, C. A., Ronis, D. L., Fowler, K. E., Terrell, J. E., Gruber, S. B., & Duffy, S. A. (2008). Quality of Life Scores Predict Survival Among Patients With Head and Neck Cancer. *Journal of Clinical Oncology*, *26*(16), 2754–2760. https://doi.org/10.1200/JCO.2007.12.9510

Katzman, M., Gerbarg, P., Iorio, C., Cameron, C., Vermani, M., Brown, R., Davis, M., & Tsirgielis, D. (2012). A multicomponent yoga-based, breath intervention program as an adjunctive treatment in patients suffering from generalized anxiety disorder with or without comorbidities. *International Journal of Yoga*, *5*(1), 57. https://doi.org/10.4103/0973-6131.91716

Kaushik, R. M., Kaushik, R., Mahajan, S. K., & Rajesh, V. (2006). Effects of mental relaxation and slow breathing in essential hypertension. *Complementary Therapies in Medicine*, *14*(2), 120–126. https://doi.org/10.1016/j.ctim.2005.11.007

Kharya, C., Gupta, V., Deepak, K. K., Sagar, R., Upadhyav, A., Kochupillai, V., & Anand, S. (2014). Effect of controlled breathing exercises on the psychological status and the cardiac autonomic tone: Sudarshan Kriya and Prana-Yoga. *Indian J Physiol Pharmacol*, *58*(3), 210-220.

Kjellgren, A., Bood, S. Å., Axelsson, K., Norlander, T., & Saatcioglu, F. (2007). Wellness through a comprehensive Yogic breathing program – A controlled pilot trial. *BMC Complementary and Alternative Medicine*, *7*(1), 43. https://doi.org/10.1186/1472-6882-7-43

Klinke, M. E., Wilson, M. E., Hafsteinsdóttir, T. B., & Jónsdóttir, H. (2013). Recognizing new perspectives in eating difficulties following stroke: A concept analysis. *Disability and Rehabilitation*, *35*(17), 1491–1500. https://doi.org/10.3109/09638288.2012.736012

Kobayashi, S., Kubo, H., & Yanai, M. (2007). Impairment of the swallowing reflex in exacerbations of COPD. *Thorax*, *62*(11), 1017–1017. https://doi.org/10.1136/thx.2007.084715

Kochupillai, V., Kumar, P., Singh, D., Aggarwal, D., Bhardwaj, N., Bhutani, M., & Das, S. N. (2005). Effect of rhythmic breathing (Sudarshan Kriya and Pranayam) on immune functions and tobacco addiction. *Annals of the New York Academy of Sciences*, *1056*(1), 242-252.

Kumar, N., Bhatnagar, S., Kashyap, K., Surajpal, Velpandian, T., Patnaik, S., Menon, G., Mehta, M., & Singh, V. (2013). Randomized controlled trial in advance stage breast cancer patients for the effectiveness on stress marker and pain through Sudarshan Kriya and Pranayam. *Indian Journal of Palliative Care*, *19*(3), 180. https://doi.org/10.4103/0973-1075.121537

Langmore, S. E. (1999). Risk Factors for Aspiration Pneumonia. *Nutrition in Clinical Practice*, *14*(5_suppl), S41–S46. https://doi.org/10.1177/0884533699014005S09

Langmore, S. E., Skarupski, K. A., Park, P. S., & Fries, B. E. (2002). Predictors of Aspiration Pneumonia in Nursing Home Residents. *Dysphagia*, *17*(4), 298–307. https://doi.org/10.1007/s00455-002-0072-5

Laurin, C., Moullec, G., Bacon, S. L., & Lavoie, K. L. (2012). Impact of Anxiety and Depression on Chronic Obstructive Pulmonary Disease Exacerbation Risk. *American Journal of Respiratory and Critical Care Medicine*, *185*(9), 918–923. https://doi.org/10.1164/rccm.201105-0939PP

Leder, S. B., Suiter, D. M., Agogo, G. O., & Cooney, L. M. (2016). An Epidemiologic Study on Ageing and Dysphagia in the Acute Care Geriatric-Hospitalized Population: A Replication and Continuation Study. *Dysphagia*, *31*(5), 619–625. https://doi.org/10.1007/s00455-016-9714-x

Leventhal, H., Diefenbach, M., & Leventhal, E. A. (1992). *Illness Cognition: Using Common Sense to Understand Treatment Adherence and Affect Cognition Interactionsl*. 22.

Ley, R. (1999). The Modification of Breathing Behavior. *Behavior Modification*, *23*(3), 441–479.

Li, C., Liu, Y., Ji, Y., Xie, L., & Hou, Z. (2018). Efficacy of yoga training in chronic obstructive pulmonary disease patients: A systematic review and meta-analysis. *Complementary Therapies in Clinical Practice*, *30*, 33–37. https://doi.org/10.1016/j.ctcp.2017.11.006

Lin, T., & Shune, S. (2019). Eating-Related Difficulties in Individuals with COPD (abstract). *Dysphagia*, *34*(6), 946. https://doi.org/10.1007/s00455-019-10022-z

Lin, T., & Shune, S. (2020). Chronic Obstructive Pulmonary Disease and Dysphagia: A Synergistic Review. *Geriatrics*, *5*(3), 45. https://doi.org/10.3390/geriatrics5030045

Linville, D., Savercool, V., Barrera, S., Mintz, B., & Shune, S. (2018). Qualitative perspectives on a family group intervention program for improving physical wellness. *Journal of Family Psychotherapy*, *29*(3), 252–273. https://doi.org/10.1080/08975353.2018.1440098

Lobo, M. A., Moeyaert, M., Baraldi Cunha, A., & Babik, I. (2017). Single-Case Design, Analysis, and Quality Assessment for Intervention Research. *Journal of Neurologic Physical Therapy*, *41*(3), 187–197. https://doi.org/10.1097/NPT.0000000000000187

Lun Chow, E. S., Hei Kong, B. M., Po Wong, M. T., Draper, B., Lin, K. L., Sabrina Ho, S. K., & Por Wong, C. (2004). The prevalence of depressive symptoms among elderly Chinese private nursing home residents in Hong Kong. *International Journal of Geriatric Psychiatry*, *19*(8), 734–740. https://doi.org/10.1002/gps.1158

Maddocks, M., Lovell, N., Booth, S., Man, W. D.-C., & Higginson, I. J. (2017). Palliative care and management of troublesome symptoms for people with chronic obstructive pulmonary disease. *The Lancet*, *390*(10098), 988–1002. https://doi.org/10.1016/S0140-6736(17)32127-X

Mancopes, R., Peladeau-Pigeon, M., Barrett, E., Guran, A., Smaoui, S., Pasqualoto, A. S., & Steele, C. M. (2020). Quantitative Videofluoroscopic Analysis of Swallowing Physiology and Function in Individuals With Chronic Obstructive Pulmonary Disease. *Journal of Speech, Language, and Hearing Research*, *63*(11), 3643–3658. https://doi.org/10.1044/2020_JSLHR-20-00154

Marik, P. E. (2001). Aspiration Pneumonitis and Aspiration Pneumonia. *Primary Care*, *344*(9), 665–671.

Martin-Harris, B., Brodsky, M. B., Michel, Y., Ford, C. L., Walters, B., & Heffner, J. (2005). Breathing and swallowing dynamics across the adult lifespan. *Archives of Otolaryngology–Head & Neck Surgery*, *131*(9), 762–770.

Martin-Harris, B., Brodsky, M. B., Price, C. C., Michel, Y., & Walters, B. (2003). Temporal coordination of pharyngeal and laryngeal dynamics with breathing during swallowing: Single liquid swallows. *Journal of Applied Physiology*, *94*(5), 1735–1743. https://doi.org/10.1152/japplphysiol.00806.2002

Martin-Harris, B., McFarland, D., Hill, E. G., Strange, C. B., Focht, K. L., Wan, Z., Blair, J., & McGrattan, K. (2015). Respiratory-Swallow Training in Patients With Head and Neck Cancer. *Archives of Physical Medicine and Rehabilitation*, *96*(5), 885–893. https://doi.org/10.1016/j.apmr.2014.11.022

Mathers, C. D., & Loncar, D. (2006). Projections of Global Mortality and Burden of Disease from 2002 to 2030. *PLoS Medicine*, *3*(11), e442. https://doi.org/10.1371/journal.pmed.0030442

Mauch, A. D., & Day, A. (2008). The effects of a two week yoga program on pulmonary functions. *BIO*, *493*, 1-9.

McHorney, C. A., Bricker, D. E., Kramer, A. E., Rosenbek, J. C., Robbins, J., Chignell, K. A., Logemann, J. A., & Clarke, C. (2000). The SWAL-QOL Outcomes Tool for Oropharyngeal Dysphagia in Adults: I. Conceptual Foundation and Item Development. *Dysphagia*, *15*(3), 115–121. https://doi.org/10.1007/s004550010012

Mintz, S. W., & Du Bois, C. M. (2002). The Anthropology of Food and Eating. *Annual Review of Anthropology*, *31*(1), 99–119. https://doi.org/10.1146/annurev.anthro.32.032702.131011

Miravitlles, M. (2004). Effect of exacerbations on quality of life in patients with chronic obstructive pulmonary disease: A 2 year follow up study. *Thorax*, *59*(5), 387–395. https://doi.org/10.1136/thx.2003.008730

Mokhlesi, B., Logemann, J. A., Rademaker, A. W., Stangl, C. A., & Corbridge, T. C. (2002). Oropharyngeal deglutition in stable COPD. *Chest*, *121*(2), 361–369.

Montserrat-Capdevila, J., Godoy, P., Marsal, J. R., Barbé, F., Pifarré, J., Alsedà, M., & Ortega, M. (2017). Overview of the Impact of Depression and Anxiety in Chronic Obstructive Pulmonary Disease. *Lung*, *195*(1), 77–85. https://doi.org/10.1007/s00408-016-9966-0

Mularski, R. A., Munjas, B. A., Lorenz, K. A., Sun, S., Robertson, S. J., Schmelzer, W., Kim, A. C., & Shekelle, P. G. (2009). Randomized controlled trial of mindfulness-based therapy for dyspnea in chronic obstructive lung disease. *The Journal of Alternative and Complementary Medicine*, *15*(10), 1083–1090.

Mulla, Z. R. & Vedamuthachar. (2014). Impact of a Sudarshan Kriya-based Occupational Stress Management Intervention on Physiological and Psychological Outcomes. *Management and Labour Studies*, *39*(4), 381–395. https://doi.org/10.1177/0258042X15578024

Namasivayam-MacDonald, A., & Shune, S. (2018). The Burden of Dysphagia on Family Caregivers of the Elderly: A Systematic Review. *Geriatrics*, *3*(2), 30. https://doi.org/10.3390/geriatrics3020030

Newman, R. I., Yim, O., & Shaenfield, D. E. (2020). Gender and ethnicity: Are they associated with differential outcomes of a biopsychosocial social-emotional learning program?. *International journal of yoga*, *13*(1), 18.

Nguyen, N. P., Frank, C., Moltz, C. C., Vos, P., Smith, H. J., Karlsson, U., Dutta, S., Midyett, A., Barloon, J., & Sallah, S. (2005). Impact of dysphagia on quality of life after treatment of head-and-neck cancer. *International Journal of Radiation Oncology*Biology*Physics*, *61*(3), 772–778. https://doi.org/10.1016/j.ijrobp.2004.06.017

Nici, L., Donner, C., Wouters, E., Zuwallack, R., Ambrosino, N., Bourbeau, J., Carone, M., Celli, B., Engelen, M., Fahy, B., Garvey, C., Goldstein, R., Gosselink, R., Lareau, S., MacIntyre, N., Maltais, F., Morgan, M., O'Donnell, D., Prefault, C., … Troosters, T. (2006). American Thoracic Society/European Respiratory Society Statement on Pulmonary Rehabilitation. *American Journal of Respiratory and Critical Care Medicine*, *173*(12), 1390–1413. https://doi.org/10.1164/rccm.200508-1211ST

Nund, R. L., Scarinci, N. A., Cartmill, B., Ward, E. C., Kuipers, P., & Porceddu, S. V. (2016). Third-party disability in carers of people with dysphagia following non-surgical management for head and neck cancer. *Disability and Rehabilitation*, *38*(5), 462–471. https://doi.org/10.3109/09638288.2015.1046563

O'Driscoll, Corner, & Bailey. (1999). The experience of breathlessness in lung cancer. *European Journal of Cancer Care*, *8*(1), 37–43. https://doi.org/10.1046/j.1365-2354.1999.00129.x

Ohta, K., Murata, K., Takahashi, T., Minatani, S., Sako, S., & Kanada, Y. (2009). Evaluation of swallowing function by two screening tests in primary COPD. *European Respiratory Journal*, *34*(1), 280–281. https://doi.org/10.1183/09031936.00016909

O’Kane, L., & Groher, M. (2009). Oropharyngeal dysphagia in patients with chronic obstructive pulmonary disease: A systematic review. *Revista CEFAC*, *11*(3), 449–506.

Parker, R. I., Vannest, K. J., Davis, J. L., & Sauber, S. B. (2011). Combining Nonoverlap and Trend for Single-Case Research: Tau-U. *Behavior Therapy*, *42*(2), 284–299. https://doi.org/10.1016/j.beth.2010.08.006

Patel, D., Krishnaswami, S., Steger, E., Conover, E., Vaezi, M. F., Ciucci, M. R., & Francis, D. O. (2018). Economic and survival burden of dysphagia among inpatients in the United States. *Diseases of the Esophagus*, *31*(1), 1–7. https://doi.org/10.1093/dote/dox131

Patel, N. K., Newstead, A. H., & Ferrer, R. L. (2012). The Effects of Yoga on Physical Functioning and Health Related Quality of Life in Older Adults: A Systematic Review and Meta-Analysis. *The Journal of Alternative and Complementary Medicine*, *18*(10), 902–917. https://doi.org/10.1089/acm.2011.0473

Patterson, J. M., McColl, E., Carding, P. N., Hildreth, A. J., Kelly, C., & Wilson, J. A. (2014). Swallowing in the first year after chemoradiotherapy for head and neck cancer: Clinician-and patient-reported outcomes: Swallowing Outcomes after Chemoradiotherapy for Head and Neck Cancer. *Head & Neck*, *36*(3), 352–358. https://doi.org/10.1002/hed.23306

Perry, L., & McLaren, S. (2003). Coping and adaptation at six months after stroke: Experiences with eating disabilities. *International Journal of Nursing Studies*, 11.

Philippot, P., Chapelle, G., & Blairy, S. (2002). Respiratory feedback in the generation of emotion. *Cognition & Emotion*, *16*(5), 605–627. https://doi.org/10.1080/02699930143000392

Plastow, N. A., Atwal, A., & Gilhooly, M. (2015). Food activities and identity maintenance in old age: A systematic review and meta-synthesis. *Aging & Mental Health*, *19*(8), 667–678. https://doi.org/10.1080/13607863.2014.971707

Plowman-Prine, E. K., Sapienza, C. M., Okun, M. S., Pollock, S. L., Jacobson, C., Wu, S. S., & Rosenbek, J. C. (2009). The relationship between quality of life and swallowing in Parkinson’s disease. *Movement Disorders*, *24*(9), 1352–1358. https://doi.org/10.1002/mds.22617

Pooler, A., & Beech, R. (2014). Examining the relationship between anxiety and depression and exacerbations of COPD which result in hospital admission: A systematic review. *International Journal of Chronic Obstructive Pulmonary Disease*, 315. https://doi.org/10.2147/COPD.S53255

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology*, *74*(2), 116–143. https://doi.org/10.1016/j.biopsycho.2006.06.009

Puhan, M. A., Frey, M., Büchi, S., & Schünemann, H. J. (2008). The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease. *Health and Quality of Life Outcomes*, *6*(1), 46. https://doi.org/10.1186/1477-7525-6-46

Pustejovsky, J. E. (2018). Using response ratios for meta-analyzing single-case designs with behavioral outcomes. *Journal of School Psychology*, *68*, 99–112. https://doi.org/10.1016/j.jsp.2018.02.003

Qian, J., Simoni-Wastila, L., Rattinger, G. B., Zuckerman, I. H., Lehmann, S., Wei, Y.-J. J., & Stuart, B. (2014). Association between depression and maintenance medication adherence among Medicare beneficiaries with chronic obstructive pulmonary disease: Depression and COPD maintenance medication adherence. *International Journal of Geriatric Psychiatry*, *29*(1), 49–57. https://doi.org/10.1002/gps.3968

Rasam, S., Vanjare, N., Katkar, S., Nirmal, P., Das, V., Kale, N., Madas, S., Sahasrabudhe, S., Dalal, A., & Salvi, S. (2019). Yoga and meditation improve quality of life in subjects with moderate-to-very severe COPD without any effect on lung function. *Clinical Respiratory Physiology, Exercise and Functional Imaging*, PA769. https://doi.org/10.1183/13993003.congress-2019.PA769

Ratarasarn, K., & Kundu, A. (2020). Yoga and Tai Chi: A mind–body approach in managing respiratory symptoms in obstructive lung diseases. *Current Opinion in Pulmonary Medicine*, *26*(2), 186–192. https://doi.org/10.1097/MCP.0000000000000654

Rathert, C., Wyrwich, M. D., & Boren, S. A. (2013). Patient-Centered Care and Outcomes: A Systematic Review of the Literature. *Medical Care Research and Review*, *70*(4), 351–379. https://doi.org/10.1177/1077558712465774

Reaves, C., & Angosta, A. D. (2021). The relaxation response: Influence on psychological and physiological responses in patients with COPD. *Applied Nursing Research*, *57*, 151351. https://doi.org/10.1016/j.apnr.2020.151351

Regan, J., Lawson, S., & De Aguiar, V. (2017). The Eating Assessment Tool-10 Predicts Aspiration in Adults with Stable Chronic Obstructive Pulmonary Disease. *Dysphagia*, *32*(5), 714–720. https://doi.org/10.1007/s00455-017-9822-2

Resnick, B. (2017). Patient centered care: We are definitely not there yet! *Geriatric Nursing*, *38*(1), 7–8. https://doi.org/10.1016/j.gerinurse.2016.12.011

Ries, A. L., Bauldoff, G. S., Carlin, B. W., Casaburi, R., Emery, C. F., Mahler, D. A., Make, B., Rochester, C. L., ZuWallack, R., & Herrerias, C. (2007). Pulmonary Rehabilitation. *Chest*, *131*(5), 4S-42S. https://doi.org/10.1378/chest.06-2418

Sahasrabudhe, S., Bodi, S., Ingole, S., Michalickova, M., Deokar, Y., Kulkarni, P., Ghare, A., Lendghar, N., Chaudhari, A., Vincent, V., Rasam, S., Vanjare, N., Jadhav, S., Madas, S., Kanchibhotla, D., & Salvi, S. (2019). Effects of Yogic breathing exercise on lung function among adolescent children in India. *Clinical Respiratory Physiology, Exercise and Functional Imaging*, PA4133. https://doi.org/10.1183/13993003.congress-2019.PA4133

Sakakibara, M., & Hayano, J. (1996). Effect of slowed respiration on cardiac parasympathetic response to threat. *Psychosomatic Medicine*, *58*(1), 32–37.

Santo et al. (2021). Interventions to Prevent Aspiration Pneumonia in Older Adults: An Updated Systematic Review. *Journal of Speech, Language, and Hearing Research*, 1–17.

Santos, M., Steven Richards, C., & Kathryn Bleckley, M. (2007). Comorbidity between depression and disordered eating in adolescents. *Eating Behaviors*, *8*(4), 440–449. https://doi.org/10.1016/j.eatbeh.2007.03.005

Schane, R. E., Woodruff, P. G., Dinno, A., Covinsky, K. E., & Walter, L. C. (2008). Prevalence and Risk Factors for Depressive Symptoms in Persons with Chronic Obstructive Pulmonary Disease. *Journal of General Internal Medicine*, *23*(11), 1757–1762. https://doi.org/10.1007/s11606-008-0749-z

Schneider, C., Jick, S. S., Bothner, U., & Meier, C. R. (2010). COPD and the Risk of Depression. *Chest*, *137*(2), 341–347. https://doi.org/10.1378/chest.09-0614

Selzler, A.-M., Simmonds, L., Rodgers, W. M., Wong, E. Y. L., & Stickland, M. K. (2012). Pulmonary Rehabilitation in Chronic Obstructive Pulmonary Disease: Predictors of Program Completion and Success. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *9*(5), 538–545. https://doi.org/10.3109/15412555.2012.705365

Seppälä, E. M., Bradley, C., Moeller, J., Harouni, L., Nandamudi, D., & Brackett, M. A. (2020). Promoting Mental Health and Psychological Thriving in University Students: A Randomized Controlled Trial of Three Well-Being Interventions. *Frontiers in Psychiatry*, *11*. https://doi.org/10.3389/fpsyt.2020.00590

Seppälä, E. M., Nitschke, J. B., Tudorascu, D. L., Hayes, A., Goldstein, M. R., Nguyen, D. T. H., Perlman, D., & Davidson, R. J. (2014). Breathing-Based Meditation Decreases Posttraumatic Stress Disorder Symptoms in U.S. Military Veterans: A Randomized Controlled Longitudinal Study: Breathing Meditation for PTSD. *Journal of Traumatic Stress*, *27*(4), 397–405. https://doi.org/10.1002/jts.21936

Shaker, R., Li, Q., Ren, J., Townsend, W. F., Dodds, W. J., Martin, B. J., Kern, M. K., & Rynders, A. (1992). Coordination of deglutition and phases of respiration: Effect of aging, tachypnea, bolus volume, and chronic obstructive pulmonary disease. *American Journal of Physiology-Gastrointestinal and Liver Physiology*, *263*(5), G750–G755. https://doi.org/10.1152/ajpgi.1992.263.5.G750

Sharma, A., Barrett, M. S., Cucchiara, A. J., Gooneratne, N. S., & Thase, M. E. (2017). A Breathing-Based Meditation Intervention for Patients With Major Depressive Disorder Following Inadequate Response to Antidepressants: A Randomized Pilot Study. *The Journal of Clinical Psychiatry*, *78*(01), e59–e63. https://doi.org/10.4088/JCP.16m10819

Sharma, P., Thapliyal, A., Chandra, T., Singh, S., Baduni, H., & Waheed, S. M. (2015). Rhythmic breathing: Immunological, biochemical, and physiological effects on health. *Adv Mind Body Med*, *29*(1), 18–25.

Sharma, H., Sen, S., Singh, A., Bhardwaj, N. K., Kochupillai, V., & Singh, N. (2003). Sudarshan Kriya practitioners exhibit better antioxidant status and lower blood lactate levels. *Biological psychology*, *63*(3), 281-291.

Shetty, K. T., Subbakrishna, D. K., Meti, B. L., & Raju, T. R. (1998). Therapeutic Efficacy of Sudarshan Kriya Yoga (SKK) in Dysthymic Disorder.-. *Nimhans Journal*, 21-28.

Shune, S. E., Karnell, L. H., Karnell, M. P., Van Daele, D. J., & Funk, G. F. (2012). Association between severity of dysphagia and survival in patients with head and neck cancer. *Head & Neck*, *34*(6), 776–784. https://doi.org/10.1002/hed.21819

Silbergleit, A. K., Schultz, L., Jacobson, B. H., Beardsley, T., & Johnson, A. F. (2012). The Dysphagia Handicap Index: Development and Validation. *Dysphagia*, *27*(1), 46–52. https://doi.org/10.1007/s00455-011-9336-2

Singleton, O., Hölzel, B. K., Vangel, M., Brach, N., Carmody, J., & Lazar, S. W. (2014). Change in Brainstem Gray Matter Concentration Following a Mindfulness-Based Intervention is Correlated with Improvement in Psychological Well-Being. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00033

Smallwood, N., Currow, D., Booth, S., Spathis, A., Irving, L., & Philip, J. (2018). Differing Approaches to Managing the Chronic Breathlessness Syndrome in Advanced COPD: A Multi-National Survey of Specialists. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *15*(3), 294–302. https://doi.org/10.1080/15412555.2018.1502264

Snaith, R. P. (2003). The Hospital Anxiety And Depression Scale. *Health and Quality of Life Outcomes*, 4.

Somwanshi, S. D., HSM, A. B., & Kolpe, D. V. (2013). Effect of sudarshankriya yoga on cardiorespiratory parameters. *Int J Recent Trends in Science and Technology*, *8*(1), 62-66.

Sovik, R. (2000). The science of breathing—The yogic view. In *Progress in Brain Research* (Vol. 122, pp. 491–505). Elsevier. https://doi.org/10.1016/S0079-6123(08)62159-7

Steele, B., & Shaver, J. (1992). The dyspnea experience: Nociceptive properties and a model for research and practice. *Advances in Nursing Science*, *15*(1), 64–76. https://doi.org/10.1097/00012272-199209000-00009

Steele, C. M., & Cichero, J. A. Y. (2014). Physiological Factors Related to Aspiration Risk: A Systematic Review. *Dysphagia*, *29*(3), 295–304. https://doi.org/10.1007/s00455-014-9516-y

Steidl, E., Ribeiro, C., Gonçalves, B., Fernandes, N., Antunes, V., & Mancopes, R. (2014). Relationship between Dysphagia and Exacerbations in Chronic Obstructive Pulmonary Disease: A Literature Review. *International Archives of Otorhinolaryngology*, *19*(01), 074–079. https://doi.org/10.1055/s-0034-1376430

Stein, M., Williams, A. J., Grossman, F., Weinberg, A. S., & Zuckerbraun, L. (1990). Cricopharyngeal dysfunction in chronic obstructive pulmonary disease. *Chest*, *97*(2), 347–352.

Sulekha, S., Thennarasu, K., Vedamurthachar, A., Raju, T. R., & Kutty, B. M. (2006). Evaluation of sleep architecture in practitioners of Sudarshan Kriya yoga and Vipassana meditation. *Sleep and Biological Rhythms*, *4*(3), 207-214.

Sureka, P., Govil, S., Dash, D., Dash, C., Kumar, M., & Singhal, V. (2014). Effect of Sudarshan Kriya on male prisoners with non psychotic psychiatric disorders: A randomized control trial. *Asian journal of psychiatry*, *12*, 43-49.

Swan, F., Newey, A., Bland, M., Allgar, V., Booth, S., Bausewein, C., Yorke, J., & Johnson, M. (2019). Airflow relieves chronic breathlessness in people with advanced disease: An exploratory systematic review and meta-analyses. *Palliative Medicine*, *33*(6), 618–633. https://doi.org/10.1177/0269216319835393

Terada, K., Muro, S., Ohara, T., Kudo, M., Ogawa, E., Hoshino, Y., Hirai, T., Niimi, A., Chin, K., & Mishima, M. (2010). Abnormal Swallowing Reflex and COPD Exacerbations. *Chest*, *137*(2), 326–332. https://doi.org/10.1378/chest.09-0482

The American Geriatrics Society Expert Panel on Person-Centered Care. (2016). Person-Centered Care: A Definition and Essential Elements. *Journal of the American Geriatrics Society*, *64*(1), 15–18. https://doi.org/10.1111/jgs.13866

Tsiligianni, I., Alma, H., de Jong, C., Jelusic, D., Wittmann, M., Schuler, M., Schultz, K., Kollen, B., van der Molen, T., & Kocks, J. W. (2016). Investigating sensitivity, specificity, and area under the curve of the Clinical COPD Questionnaire, COPD Assessment Test, and Modified Medical Research Council scale according to GOLD using St George's Respiratory Questionnaire cutoff 25 (and 20) as reference. *International Journal of Chronic Obstructive Pulmonary Disease*, 1045. https://doi.org/10.2147/COPD.S99793

Tulloch, A., Bombell, H., Dean, C., & Tiedemann, A. (2018). Yoga-based exercise improves health-related quality of life and mental well-being in older people: A systematic review of randomised controlled trials. *Age and Ageing*, *47*(4), 537–544. https://doi.org/10.1093/ageing/afy044

Ubolnuar, N., Tantisuwat, A., Thaveeratitham, P., Lertmaharit, S., Kruapanich, C., & Mathiyakom, W. (2019). Effects of Breathing Exercises in Patients With Chronic Obstructive Pulmonary Disease: Systematic Review and Meta-Analysis. *Annals of Rehabilitation Medicine*, *43*(4), 509–523. https://doi.org/10.5535/arm.2019.43.4.509

Vedamurthachar, A., Janakiramaiah, N., Hegde, J. M., Shetty, T. K., Subbakrishna, D. K., Sureshbabu, S. V., & Gangadhar, B. N. (2006). Antidepressant efficacy and hormonal effects of Sudarshana Kriya Yoga (SKY) in alcohol dependent individuals. *Journal of affective disorders*, *94*(1-3), 249-253.

Vempati, P., & Telles, S. (2002). Yoga-based guided relaxation reduces sympathetic activity judged from baseline levels*’*. 9.

Verdonschot, R. J. C. G., Baijens, L. W. J., Serroyen, J. L., Leue, C., & Kremer, B. (2013). Symptoms of anxiety and depression assessed with the Hospital Anxiety and Depression Scale in patients with oropharyngeal dysphagia. *Journal of Psychosomatic Research*, *75*(5), 451–455. https://doi.org/10.1016/j.jpsychores.2013.08.021

Verdonschot, R. J. C. G., Baijens, L. W. J., Vanbelle, S., van de Kolk, I., Kremer, B., & Leue, C. (2017). Affective symptoms in patients with oropharyngeal dysphagia: A systematic review. *Journal of Psychosomatic Research*, *97*, 102–110. https://doi.org/10.1016/j.jpsychores.2017.04.006

Vögele, C., & von Leupoldt, A. (2008). Mental disorders in chronic obstructive pulmonary disease (COPD). *Respiratory Medicine*, *102*(5), 764–773. https://doi.org/10.1016/j.rmed.2007.12.006

von Leupoldt, A., Taube, K., Henkhus, M., Dahme, B., & Magnussen, H. (2010). The impact of affective states on the perception of dyspnea in patients with chronic obstructive pulmonary disease. *Biological Psychology*, *84*(1), 129–134. https://doi.org/10.1016/j.biopsycho.2009.07.010

Vyas, R., & Dikshit, N. (2002). Effect of meditation on respiratory system, cardiovascular system and lipid profile. *Indian journal of physiology and pharmacology*, *46*(4), 487-491.

Ward, E. C., Bishop, B., Frisby, J., & Stevens, M. (2002). Swallowing Outcomes Following Laryngectomy and Pharyngolaryngectomy. *Archives of Otolaryngology–Head & Neck Surgery*, *128*(2), 181. https://doi.org/10.1001/archotol.128.2.181

Warner, A., & Hall, K. (2012). Psychological and spiritual well-being of women with breast cancer participating in the art of living program. *Psychology of Cancer, NL Hicks and RE Warren, Editors*.

Watson, D., Anna, L., & Tellegen, A. (n.d.). Development and validation of brief measures of positive and negative affect: The PANAS Scales. 8.

Wenger, D. (1961). Studies of autonomic functions in practitioners of yoga in india'. 13.

Wielgosz, J., Goldberg, S. B., Kral, T. R. A., Dunne, J. D., & Davidson, R. J. (2019). Mindfulness Meditation and Psychopathology. *Annual Review of Clinical Psychology*, *15*(1), 285–316. https://doi.org/10.1146/annurev-clinpsy-021815-093423

Wu, Y. P., Thompson, D., Aroian, K. J., McQuaid, E. L., & Deatrick, J. A. (2016). Commentary: Writing and Evaluating Qualitative Research Reports. *Journal of Pediatric Psychology*, *41*(5), 493–505. https://doi.org/10.1093/jpepsy/jsw032

Yohannes, A. M., Willgoss, T. G., Baldwin, R. C., & Connolly, M. J. (2010). Depression and anxiety in chronic heart failure and chronic obstructive pulmonary disease: Prevalence, relevance, clinical implications and management principles. *International Journal of Geriatric Psychiatry*, *25*(12), 1209–1221. https://doi.org/10.1002/gps.2463

Yohannes, Abebaw M., Müllerová, H., Hanania, N. A., Lavoie, K., Tal-Singer, R., Vestbo, J., Rennard, S. I., & Wouters, E. F. (2016). Long-term course of depression trajectories in patients with COPD: A 3-year follow-up analysis of the evaluation of COPD longitudinally to identify predictive surrogate endpoints cohort. *Chest*, *149*(4), 916–926.

Yohannes, Abebaw Mengistu, Junkes-Cunha, M., Smith, J., & Vestbo, J. (2017). Management of Dyspnea and Anxiety in Chronic Obstructive Pulmonary Disease: A Critical Review. *Journal of the American Medical Directors Association*, *18*(12), 1096.e1-1096.e17. https://doi.org/10.1016/j.jamda.2017.09.007

Yudhawati, R., & Hs, M. R. (2019). Effect of yoga on FEV1, 6-minute walk distance (6-MWD) and quality of life in patients with COPD group B. *Advances in respiratory medicine*, *87*(5), 261-268.