

# A randomized controlled study on assessment of health status, depression, and anxiety in coal miners with chronic obstructive pulmonary disease following yoga training

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## ABSTRACT

**Context:** Psychological comorbidities are prevalent in coal miners with chronic obstructive pulmonary disease (COPD) and contribute to the severity of the disease reducing their health status. Yoga has been shown to alleviate depression and anxiety associated with other chronic diseases but in COPD not been fully investigated.

**Aim:** This study aimed to evaluate the role of yoga on health status, depression, and anxiety in coal miners with COPD.

**Materials and Methods:** This was a randomized trial with two study arms (yoga and control), which enrolled 81 coal miners, ranging from 36 to 60 years with stage II and III stable COPD. Both groups were either on conventional treatment or combination of conventional care with yoga program for 12 weeks.

**Results:** Data were collected through standardized questionnaires; COPD Assessment Test, Beck Depression Inventory and State and Trait Anxiety Inventory at the beginning and the end of the intervention. The yoga group showed statistically significant ( $P < 0.001$ ) improvements on all scales within the group, all significantly different ( $P < 0.001$ ) from changes observed in the controls. No significant prepost changes were observed in the control group ( $P > 0.05$ ).

**Conclusion:** Yoga program led to greater improvement in physical and mental health status than did conventional care. Yoga seems to be a safe, feasible, and effective treatment for patients with COPD. There is a need to conduct more comprehensive, high-quality, evidence-based studies to shed light on the current understanding of the efficacy of yoga in these chronic conditions and identify unanswered questions.

**Key words:** Anxiety; COPD assessment test; chronic obstructive pulmonary disease; depression; yoga.

## INTRODUCTION


Chronic obstructive pulmonary disease (COPD) is a complex, treatment-resistant disease with multiple comorbidities, depression, and anxiety being the two of the most important and least treated among them.<sup>[1]</sup> Other than cigarette smoking, there is an increasing evidence of occupational exposures as a major risk factor for COPD<sup>[2,3]</sup> found the prevalence of COPD in nonsmoking coal miners was 19% in a study. Depression and anxiety

increasingly affect the psychological well-being of working populations,<sup>[4]</sup> coal miners being more susceptible due to highly risky and stressful working environments.<sup>[5]</sup> Prior studies have documented association of depression and anxiety among COPD patients<sup>[6-9]</sup> more than non-COPD individuals.<sup>[10]</sup> Clinically significant symptoms of depression were found in around half COPD patients<sup>[11,12]</sup> while the prevalence of anxiety has been estimated at

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40%.<sup>[13-15]</sup> About one-third of COPD sufferers is afflicted by both.<sup>[16]</sup> The presence of these comorbid symptoms significantly contributes to the impaired health status in patients with COPD<sup>[17,18]</sup> irrespective of the degree of airflow limitation.<sup>[19]</sup> Therefore, optimizing the health status is an important goal in COPD management.<sup>[20]</sup> In a systematic review, it has been reported that comprehensive pulmonary rehabilitation benefits in a reduction in short-term depression and anxiety.<sup>[21]</sup> Limited evidence is available on the effect of mindfulness-based treatments such as yoga for the management of depression and anxiety in COPD patients.

Yoga is a way of life, mainly has four primary components: Physical postures to develop strength and flexibility, breathing exercises to enhance respiratory functioning, deep relaxation techniques to cultivate the ability to release anxiety, and meditation/mindfulness practices to promote emotion and stress regulation skills.<sup>[22]</sup> Psychosomatic ailments arise due to a disturbance in the mind.<sup>[23]</sup> The level of documented evidence of yoga's psychophysiological benefits for depression and anxiety is progressively increasing.<sup>[24-32]</sup> Similarly, some research has been conducted on yoga's application to COPD<sup>[33-37]</sup> but no study has been published assessing the effect of yoga on coal miners, for whom the condition is a major work-related health hazard. Hence, this study was aimed to evaluate the effects of a 12 weeks program of the Integrated Approach of Yoga Therapy (IAYT) on health status, depression, and anxiety of COPD in coal miners compared to controls on conventional care, based on the hypothesis that it would improve the health status by decreasing depression and anxiety symptoms. IAYT is a combination of breathing practices, physical postures, *pranayama*, *kriya*, meditation, relaxation techniques, and lectures.<sup>[22]</sup> Its therapeutic applications as a supplementary therapy for chronic health conditions in asthma,<sup>[38]</sup> cancer,<sup>[39]</sup> diabetes,<sup>[40]</sup> schizophrenia,<sup>[41]</sup> and low back pain<sup>[42]</sup> are well established.

## MATERIALS AND METHODS

### Participants

Eighty-one male nonsmoking coal miners with ages ranging from 36 years to 60 years were recruited for the study. They were all present coal miners of Rampur Colliery, Odisha. A total of 279 coal miners were screened, of whom 36 declined to sign the informed consent form. Rest 243 underwent clinical examination, of these 162 met any one of exclusion criteria and finally 81 registered for the trial and were randomized into two groups, yoga and waitlist controls. Figure 1 depicts the flow diagram of the study, showing screening, enrollment, intervention, assessments, and analysis.

### Inclusion criteria

The inclusion criteria were as follows: Physician diagnosed COPD with spirometric evidence of chronic airflow limitation (forced expiratory volume in 1 s/forced vital capacity, post bronchodilator <0.70), Global initiative for Obstructive Lung Disease (GOLD) stage I and II COPD;<sup>[1]</sup> clinically stable for at least 3 months; literate to complete the questionnaires.

### Exclusion criteria

Exclusion criteria were: Prior experience of yoga; recent COPD exacerbation; cognitive impairment; myocardial infarction or recurrent angina within the previous 6 months; hospitalization within 3 months; and respiratory tract infection within 1 month of enrollment.

### Informed consent

The aim of the study was conveyed to those agreeing to participate in the study; signed informed consent was obtained from all participants prior to baseline assessment.

### Design

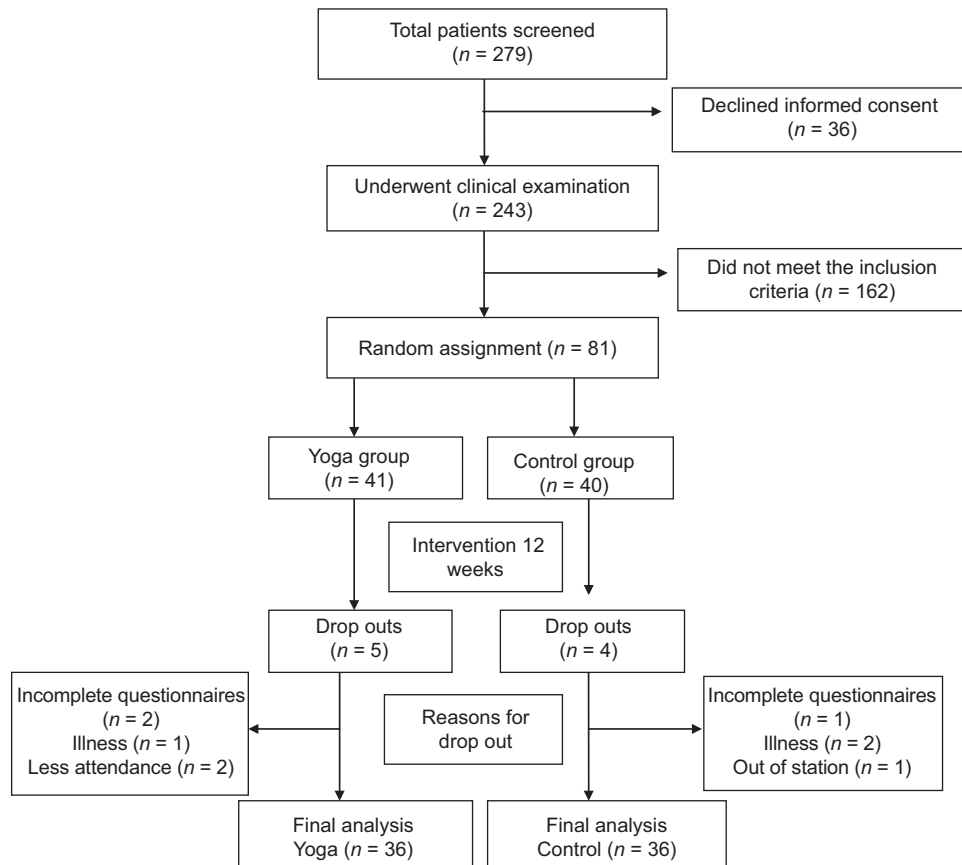
This is a randomized, waitlist control, single-blind clinical trial in which 81 participants were assigned to two groups (yoga and control) using a computer generated random number table obtained from <http://www.randomizer.org>. Numbered opaque envelopes were used to implement the random allocation to conceal the sequence until interventions were assigned.

### Study protocol

At enrollment, medical, exposure histories, pulmonary symptoms, and information about current pharmacological treatments were obtained, and clinical examinations performed by a specialist physician. Comorbid diagnoses were established from clinical histories and examination findings, supported by reviews of available medical records. The yoga group practiced a set of integrated yoga practices specially designed for COPD for 90 min daily, 6 days/week for 12 weeks. Participants of control group continued conventional therapy, completing all assessments at the same times as the yoga group; they were offered yoga at the end of the study. All participants were asked to refrain from participating in any other yoga classes during the study period.

### Blinding and masking

Double blinding is not considered possible for yoga interventions, where participants and trainer can recognize group assignment. However, giving and scoring



**Figure 1:** Flow of participants over study period

the assessments were masked wherever feasible. The statistician responsible for randomization, and subsequent data analysis was not involved in administering the intervention and was thus blind to the source of the data. The clinical psychologist who administered and scored the psychological questionnaires and the staff, who carried out assessments, were blind to membership of the intervention groups. Coded answer sheets were analyzed only after the study's completion.

### Study approval

The study was approved by the Institution Ethics Committee (Swami Vivekananda Yoga University, Bangalore) through RES/IEC/28/2014 in accordance with the Helsinki Declaration.

### Intervention

The IAYT module was developed by Swami Vivekananda Yoga Anusandhana Samasthana specifically for COPD. It included simple and safe practices at physical, mental, emotional, and intellectual levels. The yoga practice protocol was designed in consultation with S-VYASA's Medical Director. The daily schedule is detailed in Table 1.

### Assessments

Assessments were made on both groups before and after the 12 weeks of intervention. The following questionnaires were completed by all participants.

#### COPD assessment test

COPD Assessment Test (CAT) is a short questionnaire developed for assessing and monitoring COPD in routine clinical practice. It provides a valid, reliable, and standardized measure of the impact of COPD on a patient's health and well-being.<sup>[43,44]</sup> It consists of 8 items rated using a Likert-type scale of 0–5, providing a score out of 40, higher scores representing the poorer quality of life (QoL). Despite the small number of items, it covers a broad range of effects on patients' health. It takes less time to complete than other health-related QoL questionnaires.<sup>[45]</sup> CAT is sensitive to changes in disease progression over time and to the effectiveness of treatments.<sup>[46,47]</sup> Internal consistency is excellent with Cronbach's  $\alpha = 0.88$  and test-retest reliability good in stable patients (ICCC = 0.8).<sup>[43]</sup>

#### Beck depression inventory

All participants completed the Beck Depression Inventory (BDI), 2<sup>nd</sup> edition.<sup>[48]</sup> BDI-II is a self-report

**Table 1: Integrated approach of yoga therapy for chronic obstructive pulmonary disease used in this study**

Name of the practices	Duration (min)
Breathing practices	10
Standing	
Hands in and out breathing	1
Hands stretch breathing	1
Ankle stretch breathing	1
Sitting	
Dog breathing	1
Rabbit breathing	1
Tiger breathing	1
Sasāikāsana breathing (moon pose)	1
Prone	
Bhujāgāsana breathing	1
Śalabhāsana breathing	1
Supine	
Straight leg raising breathing	1
Loosening practices	10
Forward and backward bending	1
Side bending	1
Twisting	1
Pawanmuktāsana kriyā (alternate leg)	1×2
Rocking and rolling	1×2
Surya Namaskāra × 3 rounds	1×3
Yogāsanas (physical postures)	20
Standing	
Ardhakati cakrāsana (lateral arc pose)	2
Pādahastāsana (forward bend pose)	2
Ardha cakrāsana (half wheel pose)	2
Sitting	
Vakrāsana (twisting posture)	2
Ardhamatsyendrāsana (half spinal twist posture)	2
Paścimottānāsana (sleeping thunderbolt posture)	2
Prone	
Bhujāgāsana (serpent pose)	2
Śalabhāsana (locust pose)	2
Supine	
Sarvāgāsana (shoulder stand pose)	2
Matsyāsana (fish pose)	2
Yogā chair breathing	10
Instant relaxation technique	1
Neck muscle relaxation with chair support	1
Neck movements in Vajrāsana	1
Sasāikāsana movement	1
Relaxation in Tadāsana	1
Neck movements in Tadāsana	1
Ardha cakrāsana - Pādahastāsana	1
Quick relaxation technique	3
Prāëyāma	10
Kapālabhāti (frontal brain cleansing)	2
Vibhāgiya prāëyāma (sectional breathing)	2
Nādēśodhana prāëyāma (alternate nostril breathing)	2
Ujjayi prāëyāma (diaphragmatic breathing)	2
Bhrāmaré prāëyāma (bee breathing)	2
Meditation	10
Nādānusandhāna (alternate day)	10
Om Meditation (alternate day)	10
DRT in Çavāsana (corpse pose)	10
Yogic counseling/lectures	10
Yoga philosophy and health, basis and applications of yoga, Pancakoña viveka (five layers of existence), COPD causes, complications and relation to stress, Stress reaction and its management. Lifestyle modification, diet and exercise, emotion and coping	

Contd...

**Table 1: Contd...**

Name of the practices	Duration (min)
Kriyā (once a week)	90
Theory on kriyā	10
Jala Neti	20
Sutra Neti	20
Vamana Dhouti	25
DRT	15

DRT = Deep relaxation technique, COPD = Chronic obstructive pulmonary disease

questionnaire of 21 items scored from 0 to 3. It is designed to assess depressive symptoms experienced within the previous 2 weeks. It has high internal consistency (Cronbach's  $\alpha = 0.92$ ); mean test-retest reliability is 0.72.<sup>[49]</sup> BDI-II scores range from 0 to 63, with categorical depression ratings of "minimal" (0–13), "mild" (14–19), "moderate" (20–28), and "severe" (29–63). BDI is considered a valid measure of depressed mood for diverse populations.

### State trait anxiety inventory

State and Trait Anxiety Inventory (STAI) is a reliable, valid, and widely used measure of anxiety for clinical practice and research, with a high degree of internal consistency.<sup>[50]</sup> Cronbach's  $\alpha$  is 0.85 for the total scores.<sup>[51]</sup> It includes separate measures of state anxiety and trait anxiety each comprising 20 items rated on a 4 point scale from 0 to 3 which range from 20, minimum, to 80, maximum. Form S evaluates state anxiety, how subjects, feel "at this moment;" while Form T assesses trait anxiety, how the respondent feels "most of the time." In India, its reliability and validity are well established following extensive use in adult populations. State anxiety reflects subjective and transitory emotional states characterized by consciously perceived feelings of nervousness, tension, worries, and apprehension, and heightened autonomic nervous system activity. In contrast, trait anxiety refers to relatively stable individual differences in anxiety proneness as a personality attribute that denotes general tendency to respond with anxiety to perceived threats in the environment.

### Data collection

Clinical and demographic information were collected using medical records and study-specific forms. Adherence and compliance were monitored through the use of daily patient diaries and attendance records kept by the yoga instructors. No make-up sessions were provided for missed classes. All participants were instructed to continue their routine daily activities during the 12-week intervention period but were asked not to start a new yoga or exercise regimen on their own during that time. A feedback form was used to assess enjoyment and helpfulness of the yoga intervention, and to ask whether participants would recommend it to others.

## Statistical analysis

Data were analyzed using SPSS version 18.0 (IBM Corporation, USA). Within group changes and between group treatment effects associated with participation in the yoga intervention were evaluated using Chi-square tests for categorical data and paired *t*-tests and independent sample *t*-tests for continuous data.  $P < 0.05$  was considered significant.

## RESULTS

### Descriptive features

The study population initially consisted of 81 coal miners with COPD. Five and four participants dropped out of yoga and control group, respectively, for personal reasons unrelated to the study, giving a final sample size of 72 (36 in each group). Total participants in GOLD stage II category were 52.8% in yoga and 58.3% in controls, and in GOLD stage III 47.2% in yoga and 41.7% in controls. Demographic variables of patient's average age, duration of employment in coal mines, and duration of disease since diagnosis were comparable as were initial test scores at baseline (all  $P > 0.05$ ) [Table 2].

### COPD assessment test

The practice of yoga for 12 weeks has significantly lowered the CAT scores ( $P < 0.001$ ) in the yoga group, indicating better health status, whereas no significant difference was observed in the control group ( $P = 0.294$ ). The results further revealed that the change occurred in the yoga group was 23.05% and in the control group was  $-2.52\%$ . Between-group differences were statistically significant ( $P < 0.001$ , independent *t*-test) [Table 3].

### Beck depression inventory

In both the groups, mean depression scores were reduced,

**Table 2: Baseline characteristics of participants in both yoga and control group**

Variables	Mean±SD		P (independent sample t-test)
	Yoga (n=36)	Control (n=36)	
Age	53.69±5.66	54.36±5.40	0.611*
Duration of employment in coal mines	28.36±4.62	27.72±4.23	0.543*
Duration of disease since diagnosis	9.92±3.25	10.69±2.54	0.262*
CAT	20.69±5.53	21.81±5.48	0.395*
BDI	22.25±8.47	24.14±9.21	0.368*
STAI (S)	39.61±8.73	37.92±10.92	0.469*
STAI (T)	41.06±7.82	39.86±8.88	0.547*
STAI (total)	80.67±16.06	77.78±19.27	0.492*

\*Not significant. CAT = COPD assessment test, BDI = Beck depression inventory, STAI = State-trait anxiety inventory, STAI (S) = State anxiety, STAI (T) = Trait anxiety, SD = Standard deviation, COPD = Chronic obstructive pulmonary disease

but the magnitude of change is statistically significant and higher ( $P < 0.001$ , 25.53%) in the yoga group as compared to the control group ( $P = 0.095$ , 3.23%). In addition, significant group mean differences were observed between yoga and control group's post intervention scores ( $P = 0.002$ ) [Table 3].

### State and trait anxiety inventory

The yoga group showed significantly lower scores in both state and trait anxiety ( $P < 0.001$ ), but controls showed no significant change ( $P = 0.192$  and  $P = 0.383$ , respectively). State anxiety decreased by 15.98% in yoga and increased by 1.98% in controls. A similar trend was observed in trait anxiety also. It decreased by 13.35% in yoga and increased by 1.46% in controls. Independent *t*-tests gave statistically significant differences between groups at posttest,  $P = 0.032$  and  $P = 0.034$ , respectively. Overall anxiety score was significantly reduced by 14.64% within the yoga group ( $P < 0.001$ ), whereas and there was slight increase by 1.71% ( $P = 0.054$ ) reported in the control group [Table 3].

## DISCUSSION

To the best of our knowledge, this is the first randomized-controlled study investigating physical and psychological health benefits associated with yoga practice on coal miners with COPD. The study evaluated the impact of yoga on their disease-specific health status, depression, and anxiety levels. Results suggested that IAYT practice facilitates improvements in health status and reduces self-reported depression and anxiety levels after 12 weeks of practice.

The results are consistent with previously reported interventions based on yoga, which demonstrated positive, beneficial effects on psychological and psychosocial factors in diverse conditions such as diabetes,<sup>[40]</sup> cancer,<sup>[52]</sup> CAD,<sup>[53]</sup> low back pain,<sup>[54]</sup> osteoarthritis of the knee,<sup>[55]</sup> and pregnancy.<sup>[56,57]</sup> It is reported in a study that *pranayama* (yogic breathing) mitigates posttraumatic stress disorder and depression.<sup>[58]</sup> Another study on patients who participated in education and stress management in addition to exercise training during a 12-week intervention reported reductions in depression and anxiety.<sup>[59]</sup>

A study reported that changes in depression and state and trait anxiety did not significantly differ between the two interventions (6 weeks of weekly yoga classes together with exercise, compared to a 6 weeks weekly group exercise) (GDS15,  $P = 0.749$ , STAI-S,  $P = 0.595$ , STAI-T,  $P = 0.407$ ).<sup>[60]</sup> Another study has similarly obtained unclear effects following yoga intervention.<sup>[61]</sup>

The pathophysiology of depression and anxiety among COPD patient is complex and poorly understood. The



**Table 3: Change scores within yoga and control, and difference between groups with 95% CI**

Variables	Yoga (n=36)				Control (n=36)				Between group	
	Pre <sup>s</sup>		Post <sup>s</sup>		Pre <sup>s</sup>		Post <sup>s</sup>		Post	Group ×
	Mean±SD	CI (LB-UB)	Mean±SD	CI (LB-UB)	Mean±SD	CI (LB-UB)	Mean±SD	CI (LB-UB)	versus post <sup>#</sup>	time interaction
									P	P
CAT	20.69±5.53	18.82-22.56	15.92±6.51***	13.71-18.12	21.81±5.48	19.95-23.66	22.36±5.65	20.45-24.27	0.001	<0.001
BDI II	22.25±8.47	19.38-25.12	16.56±7.03***	14.18-18.93	24.14±9.21	21.02-27.25	23.36±10.49	19.81-26.91	0.002	<0.001
STAI (S)	39.61±8.73	36.66-42.56	33.28±9.92***	29.92-36.63	37.92±10.92	34.22-41.61	38.67±10.92	34.97-42.36	0.032	<0.001
STAI (T)	41.06±7.82	38.41-43.70	35.58±9.14***	32.49-38.67	39.86±8.88	32.49-38.67	40.44±9.89	37.10-43.79	0.034	<0.001
STAI total	80.67±16.06	75.23-86.10	68.86±17.96***	62.79-74.94	77.78±19.27	71.26-84.30	79.11±19.77	72.42-85.80	0.024	<0.001

<sup>s</sup>Paired t-test; <sup>#</sup>Independent t-test. BDI = Beck depression inventory, STAI = State-trait anxiety inventory, STAI (S) = State anxiety, STAI (T) = Trait anxiety, SD = Standard deviation, CI = Confidence interval, LB = Lower bound, UB = Upper bound, CAT = COPD assessment test, COPD = Chronic obstructive pulmonary disease.

\*\*\*Highly significant

physical, emotional, and social impact of COPD may cause a self-perpetuating cycle that has a severe impact on a patient's physical and mental health status.<sup>[21]</sup> It has been shown that high scores on perceived stress and anxiety are related to increase in hypothalamic-pituitary-adrenal (HPA) axis activity.<sup>[62]</sup> The effects of yoga in our results can be explained by reduction in levels of psychophysiological arousal via triggering neurohormonal mechanisms that suppress sympathetic activity,<sup>[63,64]</sup> balance in the autonomic nervous system responses,<sup>[65]</sup> alterations in neuroendocrine arousal<sup>[66,67]</sup> through better regulation of the HPA axis<sup>[68]</sup> resulting in reductions in stress and anxiety.<sup>[32]</sup> Better psychological health resulting from stress reduction might be due to relaxation techniques<sup>[69]</sup> which contribute to the observed improvements in CAT scores in our study. Thus, these psychological changes may explain the physiological changes observed as better outcomes seen in previous studies on integrated yoga in asthma.<sup>[38]</sup> Yoga unites body, mind, and spirit; and enhances attention by calming down the restless mind.<sup>[22]</sup> Thus, the deep physiological rest that is achieved by the components of *pranayama*, meditation, and other mindfulness practices incorporated in the integrated yoga program could be the major factors explaining observed benefits. Overall, antidepressant effects of yoga programs can be attributed to stress reduction.<sup>[70]</sup> Another study concluded the practice of meditation strengthens the mental resolve and hence decreases anxiety.<sup>[71]</sup> Yoga practices decrease parasympathetic nervous system and GABAergic activity that underlies stress-related disorders which result in amelioration of disease symptoms.<sup>[72]</sup> Reductions in psychological hyper-reactivity and emotional instability achieved by yoga may be due to reduced efferent vagal reactivity<sup>[73]</sup> already recognized as a main psychosomatic factor in asthma,<sup>[74]</sup> might have similar physiology in COPD also.

This study is the first of its kind to conclude that integrated yoga can act as an imperative line of therapy in the management of COPD in coal miners. The novel aspects of this study were (a) the randomized control design, (b) good sample size, (c) incorporation of integrated yoga

approach, and (d) good compliance. A major constraint of the study is the lack of an active control group. It would have been valuable to include physiological measures of stress such as Galvanic Skin Response and Heart Rate Variability to overcome the subjectivity of self-report and to throw light on the mechanisms. In spite of the aforementioned limitations, significant results were manifested in a short time suggesting yoga therapy could be a non-pharmacological alternative for the management of COPD. The current state of understanding necessitates further assessment to evaluate benefits of yoga for COPD in diverse populations, especially associated with depression and anxiety followed over longer time periods. Robust effectiveness and implementation studies are required to determine whether yoga therapy can decrease medical utilization. In addition, the findings of this study may also provide evidence supporting the incorporation of yoga into standardized pulmonary rehabilitation programs as a practical adjunct to improve the management of psychosocial symptoms associated with COPD.

## CONCLUSION

In this study, 12 weeks of integrated yoga enhanced health status and reduced depression and anxiety in coal miners with COPD. Any system that can bring symptomatic relief and improve different aspects of QoL of COPD patients merits incorporation into standard COPD treatments. Further research is warranted to confirm these preliminary findings and facilitate implementation in clinical settings.

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## Conflicts of interest

There are no conflicts of interest.

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