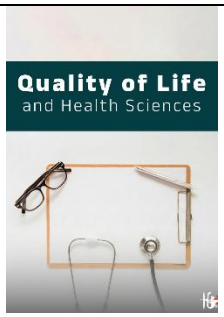
KMAN PUBLISHING INSTITUTE

Article history:
Received 15 March 2025
Revised 15 June 2025
Accepted 22 June 2025
Published online 01 July 2025

Quality of Life and Health Sciences

Volume 1, Issue 1, pp 1-15



Predicting Quality of Life Among Patients With Chronic Obstructive Pulmonary Disease Using Random Forest and Gradient Boosting Algorithms

Mansour. Abdi[1*], Nazanin Zahra. Asadi[2]

[1] Associate Professor, Department of Psychology, Faculty of Humanities, Arak University, Arak, Iran
[2] Master's Degree, Department of Psychology, Arak University, Arak, Iran

*** Corresponding author email address**: m-abdi@araku.ac.ir

A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Abdi, M. & Asadi, N. Z. (2025). Predicting Quality of Life Among Patients With Chronic Obstructive Pulmonary Disease Using Random Forest and Gradient Boosting Algorithms. *Quality of Life and Health Sciences*, *1*(1), 1-15.
http://dx.doi.org/10.61838/kman.qlhs.5753

A B S T R A C T

Objective: This study aimed to predict quality of life among patients with chronic obstructive pulmonary disease using Random Forest and Gradient Boosting algorithms and to identify the most important clinical, respiratory, psychological, and comorbidity-related predictors of health-related quality of life.

Methods and Materials: This descriptive, cross-sectional, predictive study was conducted among 342 patients with chronic obstructive pulmonary disease who were selected from pulmonary clinics and hospital-affiliated respiratory care units in Arak, Iran. Eligible participants had a confirmed diagnosis of chronic obstructive pulmonary disease and completed standardized clinical and patient-reported measures. Health-related quality of life was assessed using the St. George's Respiratory Questionnaire. Predictor variables included demographic characteristics, disease duration, spirometric indices, exacerbation and hospitalization history, COPD Assessment Test score, modified Medical Research Council dyspnea score, anxiety and depression scores, body mass index, and comorbidity burden. Data were analyzed using descriptive statistics, correlation analysis, and supervised machine learning regression. The dataset was divided into training and testing subsets, and Random Forest and Gradient Boosting models were developed using cross-validation and hyperparameter tuning.

Findings: Significant associations were found between poorer quality of life and higher COPD Assessment Test score, dyspnea severity, exacerbation frequency, hospitalization history, anxiety, depression, disease duration, body mass index, and comorbidity burden. Pulmonary function indices, including FEV1 percentage predicted, FVC percentage predicted, and FEV1/FVC ratio, were negatively associated with total quality-of-life score. In the independent testing set, the Random Forest model achieved a mean absolute error of 7.62, root mean square error of 9.81, and coefficient of determination of 0.64. The Gradient Boosting model demonstrated superior performance, with a mean absolute error of 6.93, root mean square error of 9.12, and coefficient of determination of 0.68. The most important predictors were COPD Assessment Test score, dyspnea severity, exacerbation frequency, depression, and FEV1 percentage predicted.

Conclusion: The findings indicate that machine learning algorithms, particularly Gradient Boosting, can predict quality of life among patients with chronic obstructive pulmonary disease with acceptable accuracy. Quality-of-life impairment was best predicted through a multidimensional profile combining symptom burden, dyspnea, exacerbation history, psychological distress, and pulmonary function.

Keywords: *Chronic obstructive pulmonary disease; Quality of life; Random Forest; Gradient Boosting; Machine learning; Dyspnea; St. George's Respiratory Questionnaire.*

1. Introduction

Chronic obstructive pulmonary disease is a progressive respiratory condition characterized by persistent airflow limitation, chronic respiratory symptoms, recurrent exacerbations, and increasing impairment in physical, psychological, and social functioning. Although spirometric indices remain central to diagnosis and clinical staging, the lived burden of chronic obstructive pulmonary disease extends beyond airflow obstruction and is reflected in patients' ability to walk, sleep, perform daily activities, maintain emotional well-being, adhere to treatment, and participate in social life. For this reason, health-related quality of life has become one of the most important patient-centered outcomes in chronic obstructive pulmonary disease research and care. Contemporary evidence indicates that patients with chronic obstructive pulmonary disease often experience substantial deterioration in quality of life due to dyspnea, fatigue, symptom burden, comorbidities, reduced activity tolerance, psychological distress, and repeated disease exacerbations (Jarab et al., 2023; Sabir et al., 2023; Tekobo et al., 2025; Wangsom et al., 2020).

Quality of life in chronic obstructive pulmonary disease is a multidimensional construct that reflects not only the physiological severity of pulmonary impairment but also the subjective consequences of the disease in everyday life. Patients may have similar spirometric classifications but very different levels of symptom burden, functional capacity, psychological adjustment, and perceived well-being. This discrepancy has encouraged researchers to move beyond a purely biomedical understanding of chronic obstructive pulmonary disease and to examine how clinical, behavioral, emotional, and contextual factors interact to shape health-related quality of life. Studies have shown that symptom experiences, disease outcomes, dyspnea, physical activity, and self-management behaviors are closely related to quality-of-life outcomes among patients with chronic obstructive pulmonary disease (Cherian et al., 2021; Lin et al., 2021; Lin et al., 2025; Moradkhani et al., 2021).

Dyspnea is one of the most clinically significant symptoms in chronic obstructive pulmonary disease and is strongly linked to reduced quality of life. Breathlessness limits physical activity, increases fear of exertion, contributes to avoidance behaviors, and may gradually reduce functional independence. Even in mild to moderate chronic obstructive pulmonary disease, dyspnea and symptom burden can substantially affect daily performance and perceived health status (Cherian et al., 2021). The modified Medical Research Council scale and the COPD Assessment Test have been widely used to capture dyspnea and disease impact, and their cutoff points have been examined in relation to clinical interpretation and disease burden (Munari et al., 2021). Evidence also suggests that dyspnea may mediate the relationship between multimorbidity and quality of life, highlighting the central position of respiratory discomfort in the broader burden of chronic disease (Alfano et al., 2022).

Functional limitation is another important determinant of quality of life among patients with chronic obstructive pulmonary disease. Reduced exercise tolerance, impaired mobility, and difficulty performing activities of daily living may directly decrease independence and indirectly increase psychological distress. Recent studies have emphasized the value of functional performance indicators such as sit-to-stand tests and real-world walking cadence for understanding disease severity and daily functioning in chronic obstructive pulmonary disease (Delgado-Ortiz et al., 2024; Machado et al., 2024). These findings are important because quality of life is often shaped by what patients can actually do in real life rather than by spirometric values alone. Functional impairment also interacts with symptom burden, exacerbation history, nutritional status, and comorbid conditions, producing heterogeneous quality-of-life profiles across patients.

Exacerbations represent a major clinical event in the progression of chronic obstructive pulmonary disease and are associated with worsening symptoms, accelerated functional decline, healthcare utilization, hospitalization, and impaired quality of life. During and after severe exacerbations, patients may experience persistent reductions in physical status, symptom control, and health-related quality of life, and these changes may also help discriminate

future risk (Quadflieg et al., 2023). Because exacerbations are often recurrent and may have cumulative effects on functioning, they are highly relevant for predictive modeling. The emergence of telemonitoring and algorithm-based exacerbation prediction has further demonstrated the importance of using longitudinal and multidimensional information to identify patients at risk of deterioration, hospitalization, and poor health-related quality of life (Kronborg et al., 2025).

Psychological factors also play a major role in the quality of life of patients with chronic obstructive pulmonary disease. Anxiety and depression are common in chronic respiratory disease and may amplify symptom perception, reduce self-efficacy, weaken treatment adherence, and increase avoidance of physical activity. In older adults, depression and physical activity have been shown to contribute to the association between sleep characteristics and health-related quality of life, demonstrating the complex relationship between emotional state, behavioral factors, and perceived health (Hu et al., 2022). In chronic obstructive pulmonary disease specifically, sleep duration has been associated with mortality and quality of life, suggesting that sleep is not merely a secondary complaint but a meaningful marker of disease burden and health status (Kim et al., 2021). Patient-reported outcome assessment is therefore essential in respiratory conditions, including chronic obstructive pulmonary disease and overlap syndromes such as chronic obstructive pulmonary disease with obstructive sleep apnea (Papaioannou et al., 2022).

Comorbidity is another key factor in the quality-of-life burden of chronic obstructive pulmonary disease. Many patients with chronic obstructive pulmonary disease are older adults and live with cardiovascular disease, metabolic conditions, musculoskeletal limitations, sleep disorders, or psychological symptoms. Multimorbidity can reduce physical functioning, increase medication burden, complicate disease management, and worsen perceived health. Studies in older populations have shown that multimorbidity can influence health-related quality of life directly and indirectly through functional status and cognitive function (Li et al., 2022). Other chronic disease studies have similarly shown that quality of life is predicted by a combination of disease-specific and general health factors, including functional limitation, comorbidity burden, treatment context, and patient-reported outcomes (Jia & Lubetkin, 2025; Qadire et al., 2023). These findings are relevant to chronic obstructive pulmonary disease because the condition rarely occurs in isolation and often requires integrated clinical assessment.

The importance of health-related quality of life is also evident across other chronic and high-risk clinical populations. In heart failure, changes in patient-reported outcomes over time provide meaningful information about disease burden and patient status (Jaarsma et al., 2023). Among women participating in cardiac rehabilitation, predictors of quality of life have been examined to better understand recovery and functioning in a structured care context (Wright et al., 2024). Quality of life has also been shown to have prognostic relevance after coronary artery bypass surgery and in postoperative recovery contexts, supporting the broader clinical importance of patient-reported health status (Bishawi et al., 2022; Mol et al., 2020). Although these studies are not limited to chronic obstructive pulmonary disease, they reinforce the value of quality of life as a clinically meaningful outcome that reflects survival, recovery, treatment response, and long-term disease burden.

Several studies have examined determinants of quality of life specifically in chronic obstructive pulmonary disease. Evidence from clinical practice settings has identified demographic, clinical, and symptom-related determinants of health-related quality of life among patients with chronic obstructive pulmonary disease (Tekobo et al., 2025). Other studies have reported associations between quality of life and factors such as disease severity, dyspnea, comorbidities, medication adherence, symptom burden, and healthcare access (Jarab et al., 2023; Moradkhani et al., 2021; Stöber et al., 2023). The role of specialty care is also important because access to appropriate respiratory services may influence the development of health-related quality of life over time (Stöber et al., 2023). In late-stage chronic obstructive pulmonary disease, specialized palliative care has been associated with benefits compared with hospital-based care, emphasizing the need to consider supportive and patient-centered outcomes in advanced disease (Henoch et al., 2021).

Objective pulmonary indicators remain important, but their relationship with quality of life is complex. Pulmonary function is associated with health status, but spirometry alone does not fully explain patient-reported impairment. Studies on pulmonary function and quality of life in aging men have shown that respiratory function is linked to quality-of-life outcomes in populations with and without major comorbid conditions (Abdo et al., 2023). In chronic obstructive pulmonary disease, mid-expiratory flow and other spirometric parameters may provide additional

information about clinical outcomes, particularly in patients with moderate disease (Aktan et al., 2021). Resting breathing instability has also been examined as a predictor of clinical outcomes in chronic obstructive pulmonary disease, indicating that physiological markers beyond conventional staging may contribute to risk assessment (Fujita et al., 2021). However, because quality of life is shaped by both objective disease severity and subjective illness experience, predictive models must integrate multiple domains of information.

Nutritional and body composition factors are also relevant to quality of life in chronic obstructive pulmonary disease. Malnutrition and related physiological changes can reduce muscle strength, impair functional capacity, increase vulnerability to exacerbations, and worsen clinical outcomes (Srigiripura et al., 2023). Conversely, excessive weight gain among obese patients with chronic obstructive pulmonary disease may also represent a risk factor for reduced health-related quality of life, particularly when weight change contributes to reduced mobility and cardiometabolic burden (Huber et al., 2021). Upper airway and comorbid respiratory conditions may further influence quality of life, as rhinosinusitis without nasal polyps has been associated with poorer health-related quality of life in patients with chronic obstructive pulmonary disease (Øie et al., 2021). These findings support a broad and multidimensional approach to identifying risk factors for poor quality of life.

Given the complexity of chronic obstructive pulmonary disease, conventional linear statistical models may not fully capture nonlinear relationships, interactions among predictors, or heterogeneous patient profiles. Machine learning methods offer an alternative approach by identifying complex patterns in structured clinical data and improving prediction of patient-centered outcomes. Random Forest and Gradient Boosting are particularly suitable for clinical prediction because they can handle multiple predictors, model nonlinear associations, evaluate variable importance, and maintain robust performance in datasets that include demographic, clinical, physiological, psychological, and patient-reported variables. Related analytic approaches, including latent health risk classification, structural equation modeling, and algorithm-based prediction, have already demonstrated the value of advanced modeling for understanding physical and mental outcomes, quality of life, and healthcare use in chronic disease populations (Kronborg et al., 2025; Peepratoom et al., 2020; Stellefson et al., 2020). Moreover, the broader literature on chronic obstructive pulmonary disease emphasizes the need for more personalized and predictive approaches to disease management, especially as the field moves toward integrated assessment and individualized intervention (Krishnan & Turner, 2022).

Despite the growing body of evidence on quality of life in chronic obstructive pulmonary disease, important gaps remain. Many studies have examined individual predictors such as dyspnea, pulmonary function, exacerbations, depression, sleep, comorbidity, physical activity, or medication adherence, but fewer studies have integrated these variables within machine learning models to predict quality of life as a multidimensional outcome. In addition, evidence from different clinical settings suggests that predictors may vary according to healthcare context, population characteristics, disease severity distribution, and access to respiratory care. Therefore, developing predictive models in local clinical populations can support early identification of patients at high risk for poor quality of life and guide more targeted interventions. Such models may assist clinicians in prioritizing patients for pulmonary rehabilitation, psychological support, medication review, exacerbation prevention, self-management training, nutritional assessment, and specialized care.

The aim of this study was to predict quality of life among patients with chronic obstructive pulmonary disease in Arak using Random Forest and Gradient Boosting algorithms and to identify the most important demographic, clinical, respiratory, psychological, and comorbidity-related predictors of health-related quality of life.

2. Methods and Materials

2.1. Study Design and Participants

This study was conducted using a descriptive, cross-sectional, and predictive research design with a machine learning approach. The statistical population consisted of patients diagnosed with chronic obstructive pulmonary disease who were receiving outpatient or follow-up respiratory care in pulmonary clinics and hospital-affiliated respiratory units in Arak, Iran. Data collection was carried out among patients who had a confirmed medical diagnosis of chronic obstructive pulmonary disease based on pulmonologist assessment, clinical history, and spirometric evidence of persistent airflow limitation. A total of 342 patients with chronic obstructive pulmonary disease were included in the final analysis. Participants were selected through convenience sampling from eligible patients who attended respiratory clinics and internal medicine

departments in Arak during the study period. Inclusion criteria were age 40 years or older, confirmed diagnosis of chronic obstructive pulmonary disease for at least six months, clinical stability during the data collection period, ability to understand and complete the questionnaires, and willingness to participate in the study. Patients were excluded if they had an acute exacerbation at the time of assessment, severe cognitive impairment, active psychiatric disorder that interfered with questionnaire completion, diagnosis of other advanced respiratory diseases such as pulmonary fibrosis or lung cancer, or incomplete clinical or questionnaire data. Before participation, the purpose of the study was explained to all eligible patients, and written informed consent was obtained. Participants were assured that their information would remain confidential and that their participation was voluntary. The study protocol was designed in accordance with ethical principles for research involving human participants.

2.2. Measures

Data were collected using a demographic and clinical information form, standardized respiratory health questionnaires, and a disease-specific quality of life instrument. The demographic and clinical information form was prepared by the researchers to record age, sex, marital status, educational level, occupational status, body mass index, smoking status, duration of chronic obstructive pulmonary disease, number of exacerbations during the previous year, history of hospitalization due to respiratory problems, use of long-term oxygen therapy, medication use, and presence of comorbid diseases. Clinical indicators related to chronic obstructive pulmonary disease severity were also recorded from patients' medical files, including forced expiratory volume in one second, forced vital capacity, forced expiratory volume in one second to forced vital capacity ratio, and disease severity classification based on spirometric findings. These variables were considered potential predictors because quality of life in patients with chronic obstructive pulmonary disease is influenced not only by respiratory function but also by symptom burden, disease duration, exacerbation history, functional limitation, smoking exposure, and comorbid conditions.

Health-related quality of life was assessed using the St. George's Respiratory Questionnaire. This instrument is one of the most widely used disease-specific tools for evaluating quality of life among patients with chronic respiratory diseases, particularly chronic obstructive pulmonary disease. The questionnaire evaluates the impact of respiratory disease on different aspects of daily life and includes domains related to symptoms, activity limitation, and psychosocial impacts. Scores are calculated for each domain and as a total score, ranging from 0 to 100, with higher scores indicating poorer health-related quality of life. In the present study, the total score of the St. George's Respiratory Questionnaire was used as the main outcome variable for machine learning prediction. The questionnaire was completed by the participants under the supervision of trained research assistants, and in cases where patients had difficulty reading or completing the forms independently, items were read aloud in a neutral manner without influencing their responses.

Respiratory symptom burden was assessed using the COPD Assessment Test. This questionnaire consists of eight items that measure the perceived impact of chronic obstructive pulmonary disease on cough, sputum production, chest tightness, breathlessness, activity limitation, confidence in leaving home, sleep, and energy. Each item is scored from 0 to 5, and the total score ranges from 0 to 40, with higher scores indicating greater disease impact and symptom burden. Dyspnea severity was also assessed using the modified Medical Research Council Dyspnea Scale, which grades breathlessness from 0 to 4 according to the degree of functional limitation experienced during daily activities. These measures were included because symptom severity and dyspnea are clinically important determinants of quality of life in patients with chronic obstructive pulmonary disease and may improve the predictive performance of machine learning models.

Psychological status was assessed using the Hospital Anxiety and Depression Scale. This scale includes 14 items divided into two subscales, anxiety and depression, with seven items for each subscale. Each item is scored from 0 to 3, and higher scores indicate greater anxiety or depressive symptoms. Psychological symptoms were included as predictor variables because emotional distress is common among patients with chronic obstructive pulmonary disease and may substantially affect perceived quality of life, functional capacity, treatment adherence, and disease burden. Comorbidity burden was assessed using the Charlson Comorbidity Index based on information obtained from medical records and patient self-report. This index provides a structured estimate of comorbidity load and was used to represent the influence of coexisting chronic conditions on quality of life prediction.

2.3. Data Analysis

Data analysis was performed using both conventional statistical procedures and supervised machine learning methods. Initially, all data were screened for accuracy, missing values, outliers, and distributional characteristics. Cases with substantial incomplete information on the main outcome variable were removed from the dataset, while limited missing values in predictor variables were handled using appropriate imputation procedures based on the type and distribution of the variable. Continuous variables were described using mean and standard deviation, and categorical variables were described using frequency and percentage. Before model development, categorical variables were coded numerically, and continuous clinical and questionnaire variables were inspected for unrealistic values. Because tree-based machine learning algorithms are relatively robust to non-normal distributions and multicollinearity, no strict normality assumption was imposed for predictive modeling. However, correlation patterns and variable distributions were examined to understand the structure of the dataset and to identify redundant or clinically irrelevant variables.

The primary outcome variable was the total score of the St. George's Respiratory Questionnaire, representing health-related quality of life among patients with chronic obstructive pulmonary disease. Higher scores indicated poorer quality of life. Predictor variables entered into the models included demographic characteristics, smoking status, body mass index, disease duration, spirometric indicators, disease severity classification, exacerbation history, hospitalization history, dyspnea severity, COPD Assessment Test score, anxiety and depression scores, comorbidity burden, and treatment-related clinical variables. Two supervised machine learning regression algorithms were developed and compared: Random Forest and Gradient Boosting. Random Forest was selected because it combines multiple decision trees and reduces prediction error through bootstrap aggregation, making it suitable for complex nonlinear relationships and interactions among clinical variables. Gradient Boosting was selected because it sequentially builds decision trees in a way that corrects previous prediction errors and can provide strong predictive performance in structured clinical datasets.

The dataset was randomly divided into training and testing subsets, with 80% of the data used for model training and 20% reserved for final model evaluation. To reduce the risk of overfitting and improve model stability, k-fold cross-validation was applied within the training set. Hyperparameters were tuned using cross-validation procedures, including the number of trees, maximum tree depth, minimum number of samples required for node splitting, learning rate, and number of boosting estimators where appropriate. Model performance was evaluated on the independent testing set using mean absolute error, root mean square error, and coefficient of determination. Lower mean absolute error and root mean square error values indicated better predictive accuracy, while a higher coefficient of determination indicated a greater proportion of variance in quality of life explained by the model. Feature importance analysis was conducted to identify the most influential predictors of quality of life in each algorithm. The relative importance of variables was interpreted in relation to clinical relevance, with particular attention to dyspnea severity, symptom burden, exacerbation history, psychological distress, lung function, and comorbidity burden. All statistical and machine learning analyses were conducted using standard statistical software and machine learning packages, and the level of statistical significance for descriptive and comparative analyses was set at 0.05.

3. Findings and Results

A total of 342 patients with chronic obstructive pulmonary disease were included in the final analysis. The mean age of the participants was 64.73 years with a standard deviation of 8.91 years, and the age range was from 42 to 84 years. Of the total sample, 213 participants were men, representing 62.3% of the sample, and 129 participants were women, representing 37.7%. Most participants were married, with 271 patients reporting married status, equivalent to 79.2% of the sample, while 71 patients, equivalent to 20.8%, were single, widowed, or divorced. Regarding educational level, 94 participants, or 27.5%, were illiterate or had only basic literacy, 128 participants, or 37.4%, had primary or middle school education, 83 participants, or 24.3%, had completed high school or held a diploma, and 37 participants, or 10.8%, had university education. In terms of occupational status, 156 participants, or 45.6%, were retired, 74 participants, or 21.6%, were unemployed or homemakers, 69 participants, or 20.2%, were self-employed, and 43 participants, or 12.6%, were employed in formal or part-time occupations. With respect to smoking status, 63 patients, or 18.4%, were current smokers, 181 patients, or 52.9%, were former smokers, and 98 patients, or 28.7%, had never smoked. Based on

spirometric classification of disease severity, 46 patients, or 13.5%, were classified as having mild disease, 121 patients, or 35.4%, had moderate disease, 119 patients, or 34.8%, had severe disease, and 56 patients, or 16.4%, had very severe chronic obstructive pulmonary disease. These findings indicate that the sample consisted mainly of older adults with moderate to severe disease, substantial smoking history, and clinically meaningful respiratory limitation.

Table 1

Descriptive Statistics of Clinical, Symptom, Psychological, and Quality-of-Life Variables Among Patients With Chronic Obstructive Pulmonary Disease

Variable	Mean	Standard Deviation	Minimum	Maximum
Body mass index	26.18	4.37	17.90	38.60
Duration of COPD, years	8.42	5.16	1.00	27.00
FEV1 percentage predicted	51.76	17.83	18.00	89.00
FVC percentage predicted	68.29	15.94	31.00	98.00
FEV1/FVC ratio	58.41	9.87	34.00	69.00
Number of exacerbations in previous year	1.86	1.21	0.00	6.00
Number of hospitalizations in previous year	0.74	0.91	0.00	4.00
COPD Assessment Test score	21.67	7.34	5.00	39.00
Modified Medical Research Council dyspnea score	2.14	1.03	0.00	4.00
Hospital Anxiety and Depression Scale, anxiety	8.93	4.21	0.00	20.00
Hospital Anxiety and Depression Scale, depression	9.48	4.36	0.00	21.00
Charlson Comorbidity Index	2.31	1.42	0.00	7.00
St. George's Respiratory Questionnaire, symptoms	58.42	18.76	12.20	94.80
St. George's Respiratory Questionnaire, activity	64.85	19.43	15.40	100.00
St. George's Respiratory Questionnaire, impact	49.37	17.92	8.60	91.30
St. George's Respiratory Questionnaire, total score	56.91	16.84	11.70	93.60

As shown in Table 1, the participants demonstrated a clinically notable level of respiratory impairment and reduced health-related quality of life. The mean FEV1 percentage predicted was 51.76, indicating that a considerable proportion of the sample had moderate to severe airflow limitation. The mean FEV1/FVC ratio was 58.41, which is consistent with persistent obstructive ventilatory impairment. The mean number of exacerbations during the previous year was 1.86, showing that acute worsening of respiratory symptoms was a common clinical experience in the sample. The mean COPD Assessment Test score was 21.67, which reflects a high perceived burden of disease on daily functioning, energy, sleep, respiratory comfort, and activity tolerance. The mean modified Medical Research Council dyspnea score was 2.14, indicating that many patients experienced breathlessness during ordinary physical activities. The psychological variables also showed clinically meaningful values, with mean anxiety and depression scores of 8.93 and 9.48, respectively, suggesting that emotional distress was present in a considerable proportion of patients. The mean total St. George's Respiratory Questionnaire score was 56.91, with the highest domain score observed in the activity domain, indicating that activity limitation was the most affected dimension of quality of life. Overall, these descriptive findings show that the study sample had substantial symptom burden, functional restriction, psychological distress, and impaired respiratory-specific quality of life.

Table 2

Bivariate Associations Between Main Predictors and Total Quality-of-Life Score

Predictor Variable	Correlation With SGRQ Total Score	95% Confidence Interval	p-value
Body mass index	0.18	0.08 to 0.28	0.001
Duration of COPD	0.31	0.21 to 0.40	<0.001
FEV1 percentage predicted	-0.46	-0.54 to -0.37	<0.001
FVC percentage predicted	-0.34	-0.43 to -0.24	<0.001
FEV1/FVC ratio	-0.29	-0.38 to -0.19	<0.001
Number of exacerbations in previous year	0.52	0.44 to 0.59	<0.001

Number of hospitalizations in previous year	0.41	0.32 to 0.49	<0.001
COPD Assessment Test score	0.71	0.65 to 0.76	<0.001
Modified Medical Research Council dyspnea score	0.64	0.57 to 0.70	<0.001
Anxiety score	0.49	0.40 to 0.57	<0.001
Depression score	0.55	0.47 to 0.62	<0.001
Charlson Comorbidity Index	0.37	0.27 to 0.46	<0.001

The results presented in Table 2 show that quality of life among patients with chronic obstructive pulmonary disease was significantly associated with clinical severity, symptom burden, psychological status, and comorbidity. Because higher St. George's Respiratory Questionnaire scores indicate poorer quality of life, positive correlations show that higher predictor scores were associated with worse quality of life, while negative correlations show that better pulmonary function was associated with better quality of life. The strongest association was observed between COPD Assessment Test score and total quality-of-life score, indicating that patients who reported greater disease impact also experienced substantially poorer quality of life. Dyspnea severity also had a strong positive association with impaired quality of life, showing that breathlessness during daily activities was one of the most important clinical correlates of reduced functioning and well-being. Exacerbation frequency was another important factor, suggesting that patients who experienced more frequent symptom worsening during the previous year had poorer perceived health status. Among psychological variables, depression and anxiety were both significantly associated with poorer quality of life, with depression showing a slightly stronger relationship than anxiety. Pulmonary function indicators, including FEV1 percentage predicted, FVC percentage predicted, and FEV1/FVC ratio, were negatively correlated with total quality-of-life score, showing that lower lung function was associated with poorer health-related quality of life. These findings support the inclusion of respiratory, psychological, and comorbidity-related variables in the machine learning models.

Table 3

Predictive Performance of Random Forest and Gradient Boosting Models for Total Quality-of-Life Score

Model	Dataset	Mean Absolute Error	Root Mean Square Error	Coefficient of Determination
Random Forest	Cross-validation training estimate	7.14	9.32	0.66
Random Forest	Independent testing set	7.62	9.81	0.64
Gradient Boosting	Cross-validation training estimate	6.51	8.74	0.71
Gradient Boosting	Independent testing set	6.93	9.12	0.68

Table 3 presents the predictive accuracy of the Random Forest and Gradient Boosting algorithms in estimating total quality-of-life score among patients with chronic obstructive pulmonary disease. Both models demonstrated acceptable predictive performance, indicating that the selected demographic, clinical, symptom-related, psychological, and comorbidity variables were able to explain a meaningful proportion of variation in health-related quality of life. In the independent testing set, the Random Forest model produced a mean absolute error of 7.62 and a root mean square error of 9.81, with a coefficient of determination of 0.64. This indicates that the Random Forest model explained 64% of the variance in total quality-of-life score among patients not used during model training. The Gradient Boosting model showed stronger predictive performance, with a lower mean absolute error of 6.93, a lower root mean square error of 9.12, and a higher coefficient of determination of 0.68 in the testing set. These results indicate that Gradient Boosting provided more accurate predictions than Random Forest and captured a greater proportion of variance in quality of life. The relatively close performance between cross-validation and testing results also suggests that neither model showed substantial overfitting. However, the Gradient Boosting model showed better generalizability and was therefore considered the superior predictive model in this study.

Table 4

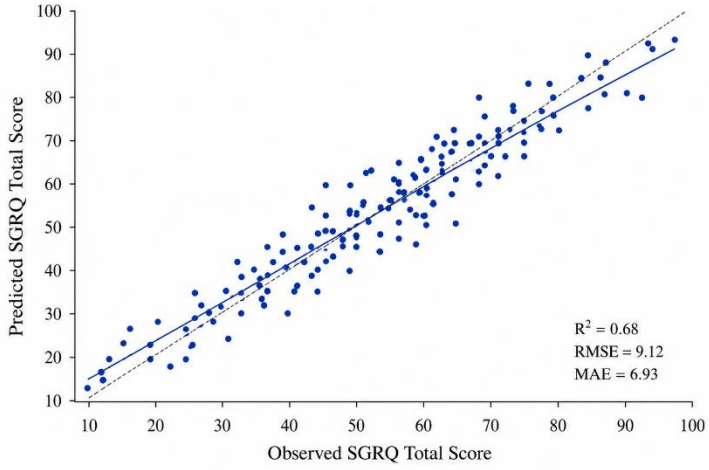
Relative Importance of Predictors in the Random Forest and Gradient Boosting Models

Predictor Variable	Random Forest Importance Percentage	Gradient Boosting Importance Percentage	Mean Rank
COPD Assessment Test score	21.40	24.80	1
Modified Medical Research Council dyspnea score	17.60	18.90	2
Number of exacerbations in previous year	13.20	12.70	3
Depression score	10.80	11.60	4
FEV1 percentage predicted	9.70	8.40	5
Anxiety score	7.90	7.20	6
Charlson Comorbidity Index	6.40	5.80	7
Number of hospitalizations in previous year	5.10	4.60	8
Duration of COPD	3.90	3.10	9
Body mass index	2.40	1.80	10
FEV1/FVC ratio	1.60	1.10	11

As shown in Table 4, the most important predictor of quality of life in both machine learning models was the COPD Assessment Test score. This finding indicates that the overall perceived impact of chronic obstructive pulmonary disease on daily life was the strongest contributor to predicted quality-of-life impairment. The modified Medical Research Council dyspnea score was the second most important variable in both models, confirming the central role of breathlessness and activity-related respiratory limitation in determining quality of life. The number of exacerbations in the previous year ranked third, showing that repeated episodes of symptom worsening had a strong influence on predicted quality-of-life outcomes. Psychological factors were also important, particularly depression, which ranked fourth in both models and contributed more strongly than anxiety. This suggests that emotional and motivational symptoms associated with depression may have a particularly important role in the patient's perception of disease burden, daily functioning, and overall well-being. FEV1 percentage predicted was also among the five most important variables, confirming that objective pulmonary function remains clinically relevant, although its importance was lower than subjective symptom burden and dyspnea severity. Comorbidity burden, hospitalization history, disease duration, body mass index, and FEV1/FVC ratio contributed less strongly to model prediction but still added incremental information. Overall, the feature-importance findings indicate that quality of life in chronic obstructive pulmonary disease is best predicted through a multidimensional profile that includes symptom burden, dyspnea, exacerbation history, psychological distress, and pulmonary function rather than spirometric indicators alone.

Figure 1

Observed and Predicted Total Quality-of-Life Scores in the Independent Testing Set Using the Gradient Boosting Model



The pattern illustrated in Figure 1 shows that the predicted total quality-of-life scores generated by the Gradient Boosting model were closely aligned with the observed St. George's Respiratory Questionnaire total scores in the independent testing set. The distribution of predicted values followed the general trend of the actual

scores, indicating that the model was able to distinguish between patients with relatively better and poorer quality of life. The prediction pattern was strongest among patients with moderate to high impairment, where most observed and predicted values were concentrated. Some deviation was observed at the extreme ends of the quality-of-life distribution, particularly among patients with very low or very high St. George's Respiratory Questionnaire scores. This suggests that although the Gradient Boosting model had strong overall predictive accuracy, it was somewhat less precise in estimating extreme quality-of-life values. Nevertheless, the close agreement between observed and predicted scores supports the practical value of the Gradient Boosting model as a predictive approach for identifying patients with chronic obstructive pulmonary disease who are at greater risk of poor quality of life. The figure further confirms the numerical results reported in Table 3, in which the Gradient Boosting model achieved the lowest prediction error and the highest explained variance.

Overall, the findings of this study indicate that machine learning algorithms can predict health-related quality of life among patients with chronic obstructive pulmonary disease with acceptable accuracy. The Gradient Boosting algorithm outperformed the Random Forest algorithm across all evaluation indices, showing lower prediction error and greater explained variance. The most influential predictors were not limited to objective pulmonary function measures but included symptom burden, dyspnea severity, exacerbation frequency, depression, anxiety, and comorbidity. These findings suggest that quality of life in chronic obstructive pulmonary disease is a complex and multidimensional outcome that can be more accurately predicted when clinical, functional, psychological, and disease-impact variables are considered simultaneously.

4. Discussion

The present study aimed to predict quality of life among patients with chronic obstructive pulmonary disease using Random Forest and Gradient Boosting algorithms and to identify the most influential demographic, clinical, respiratory, psychological, and comorbidity-related predictors of health-related quality of life. The findings showed that patients with chronic obstructive pulmonary disease experienced substantial impairment in quality of life, with the activity domain of the St. George's Respiratory Questionnaire showing the highest level of impairment. The results also indicated that the Gradient Boosting model outperformed the Random Forest model, explaining 68% of the variance in total quality-of-life score in the independent testing set, compared with 64% explained variance by the Random Forest model. In addition, the Gradient Boosting model produced lower prediction error, with a mean absolute error of 6.93 and a root mean square error of 9.12. These findings suggest that machine learning algorithms, particularly Gradient Boosting, can provide clinically useful prediction of quality of life in patients with chronic obstructive pulmonary disease by integrating symptom burden, dyspnea severity, exacerbation history, psychological distress, pulmonary function, and comorbidity indicators.

The finding that quality of life was considerably impaired among patients with chronic obstructive pulmonary disease is consistent with previous studies showing that chronic obstructive pulmonary disease affects multiple dimensions of daily living, including physical functioning, emotional well-being, independence, sleep, and social participation. Similar to the present findings, previous studies have reported that patients with chronic obstructive pulmonary disease often experience poor health-related quality of life due to respiratory symptoms, reduced functional capacity, repeated exacerbations, and comorbid health conditions (Jarab et al., 2023; Sabir et al., 2023; Tekobo et al., 2025; Wangsom et al., 2020). The high score observed in the activity domain is also theoretically and clinically expected because chronic obstructive pulmonary disease directly restricts physical exertion through airflow limitation, dynamic hyperinflation, breathlessness, fatigue, and fear of symptom aggravation. This result aligns with evidence emphasizing that functional capacity, real-world walking behavior, and sit-to-stand performance are strongly related to disease severity and functional burden in chronic obstructive pulmonary disease (Delgado-Ortiz et al., 2024; Machado et al., 2024). Therefore, the present results reinforce the view that quality of life in chronic obstructive pulmonary disease should not be interpreted only as a psychological or subjective construct, but as a patient-centered reflection of functional limitation, symptom perception, and respiratory disability.

The most important predictor of quality of life in both machine learning models was the COPD Assessment Test score. This result indicates that the overall perceived impact of chronic obstructive pulmonary disease on daily life is the strongest indicator of quality-of-life impairment. The COPD Assessment Test covers cough, sputum, chest tightness, breathlessness, activity limitation, confidence, sleep, and

energy; therefore, it captures a broad patient-reported disease-impact profile. The strong predictive role of this variable is consistent with studies showing that symptom experiences and disease impact are closely associated with outcomes in chronic obstructive pulmonary disease (Lin et al., 2021; Munari et al., 2021). It is also supported by findings that health-related quality of life among patients with chronic obstructive pulmonary disease is strongly associated with clinical symptoms, perceived health, disease burden, and patient-reported disease consequences (Jarab et al., 2023; Tekobo et al., 2025). This finding suggests that patient-reported symptom burden may have greater predictive value for quality of life than some objective clinical variables because it reflects the direct experience of living with chronic respiratory disease.

Dyspnea severity was the second most important predictor in both models, and it also showed a strong positive association with poorer quality of life. This finding is highly consistent with the chronic obstructive pulmonary disease literature, in which dyspnea is one of the most disabling and distressing symptoms. Breathlessness restricts mobility, increases dependence on others, reduces confidence in leaving home, and contributes to inactivity and social withdrawal. Previous studies have shown that dyspnea and symptom burden are strongly associated with quality of life even in mild to moderate chronic obstructive pulmonary disease (Cherian et al., 2021). The mediating role of dyspnea between multimorbidity and quality of life has also been reported, suggesting that breathlessness is a central pathway through which broader health problems are translated into poorer perceived well-being (Alfano et al., 2022). In the present study, the high importance of dyspnea confirms that quality-of-life prediction should include subjective respiratory limitation, because airflow obstruction alone may not adequately represent the functional and emotional consequences of chronic obstructive pulmonary disease.

Exacerbation frequency was the third most important variable in predicting quality of life. This finding indicates that patients who experienced more frequent exacerbations during the previous year were more likely to report poorer quality of life. Exacerbations often produce acute worsening of respiratory symptoms, increased healthcare use, hospital admission, reduced physical capacity, fear of recurrence, and delayed recovery. The present finding is consistent with previous evidence showing that severe exacerbations of chronic obstructive pulmonary disease are associated with changes in physical status, symptoms, and health-related quality of life, and that recovery patterns may help discriminate future risk (Quadflieg et al., 2023). It also aligns with the growing interest in telemonitoring and exacerbation prediction algorithms, which seek to reduce hospitalizations and improve health-related quality of life through earlier detection of deterioration (Kronborg et al., 2025). In the context of the present study, the predictive value of exacerbation history suggests that quality of life is shaped not only by current symptom severity but also by the cumulative burden of repeated acute clinical events.

Psychological factors, particularly depression and anxiety, were also important predictors of quality of life. Depression ranked fourth in the feature-importance analysis and was more influential than anxiety, although both variables were significantly associated with poorer quality of life. This finding supports the multidimensional nature of chronic obstructive pulmonary disease and indicates that emotional distress may intensify perceived symptom burden, reduce motivation for physical activity, impair self-management, and weaken coping capacity. Previous studies have shown that depression and physical activity play meaningful roles in the association between sleep characteristics and health-related quality of life among older adults (Hu et al., 2022). Sleep duration has also been associated with mortality and quality of life among patients with chronic obstructive pulmonary disease, emphasizing that psychological and behavioral factors are clinically meaningful in this population (Kim et al., 2021). In addition, patient-reported outcomes in chronic obstructive pulmonary disease and obstructive sleep apnea overlap syndrome highlight the importance of assessing subjective health status, sleep-related symptoms, and functional burden in respiratory disease (Papaioannou et al., 2022). The present findings therefore suggest that quality-of-life prediction should integrate psychological assessment rather than relying exclusively on pulmonary function or exacerbation history.

Pulmonary function, particularly FEV1 percentage predicted, was among the five most important predictors, but its importance was lower than symptom burden, dyspnea, exacerbation frequency, and depression. This finding is clinically important because it supports the argument that spirometric impairment contributes to quality of life but does not fully explain the patient's lived experience of chronic obstructive pulmonary disease. Previous studies have shown that pulmonary function is associated with quality of life and clinical outcomes, including among aging adults with and without major comorbid conditions (Abdo et al., 2023). Other evidence suggests that additional physiological

markers, such as maximum mid-expiratory flow and resting breathing instability, may provide useful clinical information in chronic obstructive pulmonary disease (Aktan et al., 2021; Fujita et al., 2021). However, the present results indicate that patient-centered indicators may outperform spirometric variables in predicting health-related quality of life. This pattern reinforces the need for integrated clinical assessment in which lung function is considered alongside symptom burden, dyspnea, psychological distress, and functional limitation.

Comorbidity burden and body mass index also contributed to the prediction of quality of life, although their relative importance was lower than the strongest symptom-related variables. This finding is consistent with evidence showing that multimorbidity and functional status are closely linked to health-related quality of life in older adults and chronic disease populations (Jia & Lubetkin, 2025; Li et al., 2022). In chronic obstructive pulmonary disease, comorbid conditions may worsen breathlessness, reduce mobility, complicate medication use, increase hospitalization risk, and intensify psychological distress. Nutritional status is also relevant because malnutrition can reduce muscle strength and functional capacity, while excessive weight gain may worsen mobility and health-related quality of life among obese patients with chronic obstructive pulmonary disease (Huber et al., 2021; Srigiripura et al., 2023). The association between rhinosinusitis and poorer quality of life in chronic obstructive pulmonary disease further demonstrates that comorbid respiratory and upper-airway conditions can intensify disease burden (Øie et al., 2021). These findings support the inclusion of comorbidity and nutritional variables in predictive models, even when their independent contribution is smaller than that of dyspnea and symptom burden.

The superior performance of the Gradient Boosting model compared with the Random Forest model may be explained by the capacity of boosting methods to sequentially correct prediction errors and capture complex nonlinear relationships among clinical predictors. In chronic obstructive pulmonary disease, quality of life is rarely determined by a single factor. Instead, it is produced by interactions among respiratory symptoms, pulmonary function, exacerbation history, functional limitation, psychological status, comorbidities, sleep, and treatment-related variables. Advanced analytic approaches are increasingly relevant in chronic disease research because they can detect heterogeneous risk profiles and improve individualized prediction. This interpretation is consistent with studies using latent health-risk classification, structural equation modeling, and predictive algorithms to examine physical and mental outcomes, quality of life, and disease burden (Kronborg et al., 2025; Peepratoom et al., 2020; Stellefson et al., 2020). The present findings also align with broader evidence that patient-reported outcomes are clinically meaningful across chronic conditions, including heart failure, cardiac rehabilitation, coronary artery bypass surgery, and postoperative recovery (Bishawi et al., 2022; Jaarsma et al., 2023; Mol et al., 2020; Wright et al., 2024). Although these conditions differ from chronic obstructive pulmonary disease, they support the broader clinical value of quality-of-life prediction as part of patient-centered care.

5. Conclusion

The findings have implications for chronic obstructive pulmonary disease management and personalized care. The importance of symptom burden, dyspnea, exacerbation history, depression, anxiety, pulmonary function, and comorbidity suggests that quality-of-life risk cannot be accurately understood through spirometry alone. Studies have emphasized the importance of medication adherence, self-management behaviors, breathlessness beliefs, self-efficacy, and access to specialty care in shaping quality-of-life outcomes among patients with chronic obstructive pulmonary disease (Lin et al., 2025; Moradkhani et al., 2021; Stöber et al., 2023). The benefit of specialized palliative care in late-stage chronic obstructive pulmonary disease also indicates that patients with advanced disease may require supportive models of care that address symptom relief, psychosocial needs, and quality of life rather than focusing only on disease control (Henoch et al., 2021). More broadly, the present results are compatible with the current direction of chronic obstructive pulmonary disease research, which emphasizes personalized assessment, integrated disease management, and future-oriented predictive approaches (Krishnan & Turner, 2022). Therefore, machine learning models may assist clinicians in identifying patients who need more intensive monitoring, pulmonary rehabilitation, psychological intervention, exacerbation prevention, nutritional support, and self-management education.

6. Limitations & Suggestions

This study had several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to make causal conclusions

about the relationships between predictors and quality of life. Although the machine learning models showed acceptable predictive accuracy, the findings do not prove that the identified predictors directly caused poorer quality of life. Second, the sample was recruited from clinical settings in Arak, which may limit the generalizability of the findings to patients in other regions, rural settings, or healthcare systems with different patterns of access to respiratory care. Third, some variables were based on self-report questionnaires, which may be affected by recall bias, response tendencies, literacy level, and current emotional state. Fourth, although important demographic, clinical, respiratory, psychological, and comorbidity-related variables were included, other potentially relevant predictors such as inflammatory biomarkers, detailed medication regimens, pulmonary rehabilitation history, environmental exposure, socioeconomic status, and longitudinal exacerbation trajectories were not fully examined. Finally, external validation was not conducted in an independent clinical sample, and therefore the stability of the predictive models should be confirmed in future studies.

Future studies should use longitudinal designs to examine how quality of life changes over time and whether machine learning models can predict future deterioration, exacerbation risk, hospitalization, treatment response, and survival. It is recommended that future research validate the present models in larger and more diverse samples from different cities, clinical centers, and healthcare systems. Future studies should also compare additional machine learning algorithms, such as extreme gradient boosting, support vector regression, artificial neural networks, elastic net regression, and ensemble stacking methods, to determine whether prediction accuracy can be improved. Incorporating additional data sources, including physical activity monitoring, sleep measures, biomarkers, medication adherence records, pulmonary rehabilitation participation, air pollution exposure, and longitudinal electronic health record data, may enhance model performance. Future research should also examine model interpretability more deeply by using explainable artificial intelligence methods to clarify how specific predictors influence risk at the individual patient level. Finally, intervention studies are needed to determine whether using predictive models in clinical decision-making can improve quality of life and reduce preventable complications in patients with chronic obstructive pulmonary disease.

The findings suggest that clinicians should assess quality of life in patients with chronic obstructive pulmonary disease through a multidimensional framework that includes symptom burden, dyspnea severity, exacerbation history, depression, anxiety, pulmonary function, comorbidity, and functional limitation. Routine use of patient-reported measures such as the COPD Assessment Test and St. George's Respiratory Questionnaire can help identify patients whose daily life is strongly affected by the disease, even when spirometric findings alone do not fully explain their impairment. Patients with high symptom burden, frequent exacerbations, severe dyspnea, or psychological distress should be prioritized for comprehensive care plans that may include pulmonary rehabilitation, psychological support, medication review, smoking cessation, self-management education, nutritional assessment, and follow-up monitoring. Machine learning models such as Gradient Boosting may be used as clinical decision-support tools to identify high-risk patients and guide targeted interventions. However, such models should complement, not replace, clinical judgment, patient preferences, and individualized assessment.

Acknowledgments

We would like to express our appreciation and gratitude to all those who cooperated in carrying out this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

Authors' Contributions

All authors equally contributed to this article.

References

Abdo, M., Kunisaki, K. M., Morris, A., Stosor, V., Chang, D., D'Souza, G., Crothers, K., Abdel-Maksoud, M., DiGuiseppi, C., Brown, T. T., Erlandson, K. M., & MaWhinney, S. (2023). Pulmonary Function and Quality of Life in Aging Men With and Without HIV From the Multicenter AIDS Cohort Study. *AIDS Research and Human Retroviruses*, *39*(12), 621-632. https://doi.org/10.1089/aid.2023.0001

Aktan, R., Özalevli, S., & Alpaydın, A. Ö. (2021). Clinical Outcomes of Male Subjects With Moderate COPD Based on Maximum Mid-Expiratory Flow. *Respiratory Care*, *66*(3), 442-448. https://doi.org/10.4187/respcare.07794

Alfano, P., Cuttitta, G., Audino, P., Fazio, G., Grutta, S. L., & Marcantonio, S. (2022). Relationship Between Multimorbidity and Quality of Life in a Primary Care Setting: The Mediating Role of Dyspnea. *Journal of clinical medicine*, *11*(3), 656. https://doi.org/10.3390/jcm11030656

Bishawi, M., Hattler, B., Almassi, G. H., Quin, J. A., Grover, F. L., Collins, J. F., Ebrahimi, R., Wolbrom, D. H., & Shroyer, A. L. (2022). Health-related Quality of Life Impacts Upon 5-year Survival After Coronary Artery Bypass Surgery. *Journal of Cardiac Surgery*, *37*(12), 4899-4905. https://doi.org/10.1111/jocs.17165

Cherian, M., Jensen, D., Tan, W. C., Mursleen, S., Goodall, E. C., Nadeau, G., Awan, A. M., Marciniuk, D. D., Walker, B., Aaron, S. D., O'Donnell, D. E., Chapman, K. R., Maltais, F., Hernandez, P., Sin, D. D., Benedetti, A., & Bourbeau, J. (2021). Dyspnoea and Symptom Burden in Mild–moderate COPD: The Canadian Cohort Obstructive Lung Disease Study. *Erj Open Research*, *7*(2), 00960-02020. https://doi.org/10.1183/23120541.00960-2020

Delgado-Ortiz, L., Ranciati, S., Arbillaga-Etxarri, A., Balcells, E., Buekers, J., Demeyer, H., Frei, A., Gimeno-Santos, E., Hopkinson, N. S., Jong, C. d., Karlsson, N., Louvaris, Z., Palmerini, L., Polkey, M. I., Puhan, M. A., Rabinovich, R., Rodríguez, D. A., Rodriguez-Roisín, R., Torán-Monserrat, P., . . . García-Aymerich, J. (2024). Real-World Walking Cadence in People With COPD. *Erj Open Research*, *10*(2), 00673-02023. https://doi.org/10.1183/23120541.00673-2023

Fujita, Y., Yamauchi, M., Yoshikawa, M., Yamamoto, Y., Sakaguchi, K., Fujioka, N., Ibaraki, T., & Muro, S. (2021). Resting Breathing Instability During Wakefulness as a Predictor of Clinical Outcome in COPD. *Respiratory Care*, *66*(9), 1477-1484. https://doi.org/10.4187/respcare.08877

Henoch, I., Ekberg-Jansson, A., Löfdahl, C. G., & Strang, P. (2021). Benefits, for Patients With Late Stage Chronic Obstructive Pulmonary Disease, of Being Cared for in Specialized Palliative Care Compared to Hospital. A Nationwide Register Study. *BMC Palliative Care*, *20*(1). https://doi.org/10.1186/s12904-021-00826-y

Hu, W., Chu, J., Chen, X., Liu, S., Sun, N., Han, Q., Li, T., Feng, Z., He, Q., & Shen, Y. (2022). The Role of Depression and Physical Activity in the Association of Between Sleep Quality, and Duration With and Health-Related Quality of Life Among the Elderly: A UK Biobank Cross-Sectional Study. *BMC Geriatrics*, *22*(1). https://doi.org/10.1186/s12877-022-03047-x

Huber, M., Schneider, N. A., Kirsch, F. W., Schwarzkopf, L., Schramm, A., & Leidl, R. (2021). Long-Term Weight Gain in Obese COPD Patients Participating in a Disease Management Program: A Risk Factor for Reduced Health-Related Quality of Life. *Respiratory Research*, *22*(1). https://doi.org/10.1186/s12931-021-01787-9

Jaarsma, T., Kato, N., Klompstra, L., Gal, T. B., Boyne, J., Hägglund, E., Vellone, E., Hagenow, A., Evangelista, L. S., Mårtensson, J., & Strömberg, A. (2023). Changes Over Time in Patient-Reported Outcomes in Patients With Heart Failure. *ESC Heart Failure*, *11*(2), 811-818. https://doi.org/10.1002/ehf2.14648

Jarab, A. S., Al-Qerem, W., Alzoubi, K. H., Heshmeh, S. A., Mukattash, T. L., Naser, A. Y., & Hamarneh, Y. N. A. (2023). Health-Related Quality of Life and Its Associated Factors in Patients With Chronic Obstructive Pulmonary Disease. *PLoS One*, *18*(10), e0293342. https://doi.org/10.1371/journal.pone.0293342

Jia, H., & Lubetkin, E. I. (2025). Comparing Potential Contributors of Health-Related Quality of Life and Mortality Among US Older Adults. *Medical Decision Making*, *45*(6), 675-689. https://doi.org/10.1177/0272989x251340709

Kim, S. J., Kwak, N., Choi, S. M., Lee, J., Park, Y. S., Lee, C. H., Lee, S. M., Yoo, C. G., & Cho, J. (2021). Sleep Duration and Its Associations With Mortality and Quality of Life in Chronic Obstructive Pulmonary Disease: Results From the 2007–2015 KNAHNES. *Respiration*, *100*(11), 1043-1049. https://doi.org/10.1159/000516381

Krishnan, A., & Turner, A. (2022). Chronic Obstructive Pulmonary Disease: The Present and Future. *Biomedicines*, *10*(2), 499. https://doi.org/10.3390/biomedicines10020499

Kronborg, T., Hangaard, S., Laursen, S. H., Hæsum, L. K. E., Egmose, J., Bender, C., Secher, P. H., Hejlesen, O., & Udsen, F. W. (2025). Impact of Telemonitoring With Exacerbation Prediction Algorithm Versus Telemonitoring Alone on Hospitalizations and Health-Related Quality of Life in Patients With COPD. *Respiratory Care*, *70*(8), 954-961. https://doi.org/10.1089/respcare.12611

Li, T., Hu, W., Zhou, L., Peng, L., Cao, L., Feng, Z., He, Q., Chu, J., Chen, X., Liu, S., Han, Q., Sun, N., & Shen, Y. (2022). Moderated-Mediation Analysis of Multimorbidity and Health-Related Quality of Life Among the Chinese Elderly: The Role of Functional Status and Cognitive Function. *Frontiers in psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.978488

Lin, W.-C., Huang, T. Y., Liu, C. Y., Yeh, M. L., Tsao, C.-Y., Chen, S.-M., & Hwang, S. L. (2021). The Effect of Different Symptom Experiences on Disease Outcome in Patients With Chronic Obstructive Pulmonary Disease: A Cluster Analysis. *Journal of Comprehensive Nursing Research and Care*, *6*(1). https://doi.org/10.33790/jcnrc1100172

Lin, W., Li, Q., & Jiang, N. (2025). Effect of Breathlessness Beliefs on Quality of Life in Chronic Obstructive Pulmonary Disease: Chain-Mediating Role of Self-Efficacy and Self-Management Behaviors. *Journal of Health Psychology*, *30*(12), 3397-3416. https://doi.org/10.1177/13591053251331940

Machado, A., Rebelo, P., Souto-Miranda, S., Mendes, M. A., Ferreira, D., Martins, V., Simão, P., Burtin, C., & Marques, A. (2024). Functional Capacity Using Sit-to-Stand Tests in People With Chronic Obstructive Pulmonary Disease and Its Relationship With Disease Severity–a Cross-Sectional Study With Matched Controls. *Brazilian Journal of Physical Therapy*, *28*(4), 101090. https://doi.org/10.1016/j.bjpt.2024.101090

Mol, K. H., Lier, F. v., Liem, V. G., Stolker, R. J., & Hoeks, S. E. (2020). Immediate Postoperative High-Sensitivity Troponin T Concentrations and Long-Term Patient-Reported Health-Related Quality of Life. *European Journal of Anaesthesiology*, *37*(8), 680-687. https://doi.org/10.1097/eja.0000000000001234

Moradkhani, B., Mollazadeh, S., Niloofar, P., Bashiri, A., & Oghazian, M. B. (2021). Association Between Medication Adherence and Health-Related Quality of Life in Patients With Chronic Obstructive Pulmonary Disease. *Journal of*

Pharmaceutical Health Care and Sciences, *7*(1). https://doi.org/10.1186/s40780-021-00222-x

Munari, A. B., Gulart, A. A., Araújo, J., Zanotto, J., Sagrillo, L. M., Karloh, M., & Mayer, A. F. (2021). Modified Medical Research Council and COPD Assessment Test Cutoff Points. *Respiratory Care*, *66*(12), 1876-1884. https://doi.org/10.4187/respcare.08889

Øie, M. R., Sue-Chu, M., Helvik, A. S., Steinsvåg, S., Steinsbekk, S., & Thorstensen, W. M. (2021). Rhinosinusitis Without Nasal Polyps Is Associated With Poorer Health-Related Quality of Life in COPD. *Respiratory Medicine*, *189*, 106661. https://doi.org/10.1016/j.rmed.2021.106661

Papaioannou, A. I., Fouka, E., Nena, E., Bakakos, P., & Steiropoulos, P. (2022). Patient-Reported Outcome Measurements in Patients With COPD-Obstructive Sleep Apnea Overlap Syndrome: Time for Action? *Journal of Personalized Medicine*, *12*(12), 1951. https://doi.org/10.3390/jpm12121951

Peepratoom, B., Low, G., Malathum, P., Chai-Aroon, T., Chuchottaworn, C., & Arpanantikul, M. (2020). A Structural Equation Model of Health-related Quality of Life Among Thai Men With Chronic Obstructive Pulmonary Disease. *Journal of clinical nursing*, *29*(13-14), 2638-2651. https://doi.org/10.1111/jocn.15286

Qadire, M. A., Alhosni, F., Al-Daken, L., Aljezawi, M. e., Omari, O. A., & Khalaf, A. (2023). Quality of Life and Its Predictors Among Patients With Selected Chronic Diseases. *Nursing Forum*, *2023*, 1-9. https://doi.org/10.1155/2023/6657164

Quadflieg, K., Machado, A., Lima, F. F. d., Daenen, M., Ruttens, D., Thomeer, M., Spruit, M. A., & Burtin, C. (2023). Physical Status, Symptoms and Health-Related Quality of Life During a Severe Exacerbation of COPD: Recovery and Discriminative Capacity for Future Events. *Respiratory Medicine*, *220*, 107437. https://doi.org/10.1016/j.rmed.2023.107437

Sabir, A., Nisar, S., Raja, K. M., Anwer, A., Awan, M. H., & Tariq, M. (2023). Health Related Quality of Life in Chronic Obstructive Pulmonary Disease Patients. *Pakistan Armed Forces Medical Journal*, *73*(SUPPL-1), S205-208. https://doi.org/10.51253/pafmj.v73isuppl-1.4685

Srigiripura, C. V., Chaya, S. K., Siddaiah, J. B., Mahesh, P. A., & Urooj, A. (2023). Determinants of Malnutrition and Associated Parameters in Subjects With Stable Chronic Obstructive Pulmonary Disease: A Cross Sectional Study. *The North African Journal of Food and Nutrition Research*, *7*(16), 85-100. https://doi.org/10.51745/najfnr.7.16.85-100

Stellefson, M., Wang, M. Q., Balanay, J. A. G., Wu, R., & Paige, S. R. (2020). Latent Health Risk Classes Associated With Poor Physical and Mental Outcomes in Workers With COPD From Central Appalachian U.S. States. *International journal of environmental research and public health*, *17*(18), 6798. https://doi.org/10.3390/ijerph17186798

Stöber, A., Marijic, P., Kurz, C., Schwarzkopf, L., Kirsch, F. W., Schramm, A., & Leidl, R. (2023). Does Uptake of Specialty Care Affect HRQoL Development in COPD Patients Beneficially? A Difference-in-Difference Analysis Linking Claims and Survey Data. *The European Journal of Health Economics*, *24*(9), 1561-1573. https://doi.org/10.1007/s10198-022-01562-7

Tekobo, A., Ayo-Olagunju, T. T. R., Ogundare, A., Dania, M. G., Oloyede, T., Olaniyan, A. T., Fapohunda, T., Ekete, O. A., Adeyeye, O. O., & Ozoh, O. B. (2025). Determinants of Health-Related Quality of Life Among COPD Patients From a Clinical Practice Setting in Nigeria. *Journal of Evaluation in Clinical Practice*, *31*(4). https://doi.org/10.1111/jep.70178

Wangsom, A., Othaganont, P., & Ladores, S. (2020). The Factors Predicting the Health-Related Quality of Life Among Persons With Chronic Obstructive Pulmonary Disease in Public Health Region 4, Thailand: A Mixed-Methods Study. *The Open Public Health Journal*, *13*(1), 105-113. https://doi.org/10.2174/1874944502013010105

Wright, C. X., Fournier, S., Deng, Y., Meng, C., Tucker, K. L., Spatz, E. S., Lichtman, J. H., Zhu, C., Dreyer, R. P., & Oen-Hsiao, J. (2024). Predictors of Health-Related Quality of Life Among Women Participating in an Appointment-Based Cardiac Rehabilitation Program. *The Journal of Cardiovascular Nursing*, *40*(1), 64-73. https://doi.org/10.1097/jcn.0000000000001096