

Construction and Validation of a Prediction Model for Sustained Smoking Cessation in Patients with Chronic Obstructive Pulmonary Disease

Huimin Tong¹, Zheng Tian², Nan Zhang³, Xinyi Liu⁴, Hongyi Zhu⁴, Liwei Jing², Lan Wang⁴

¹Department of Respiratory and Critical Care Medicine, Tianjin Fourth Central Hospital, Tianjin, 300000, People's Republic of China; ²School of Nursing, Capital Medical University, Beijing, 100069, People's Republic of China; ³Department of Ophthalmology, Peking University People's Hospital, Beijing, 100044, People's Republic of China; ⁴School of Nursing, Tianjin Medical University, Tianjin, 300070, People's Republic of China

Correspondence: Liwei Jing, Capital Medical University, 10 Xitoutiao, You'anmenwai, Fengtai District, Beijing, 100069, People's Republic of China, Email lwjing2004@ccmu.edu.cn; Lan Wang, Tianjin Medical University, 22 Qixiangtai Road, Heping District, Tianjin, 300070, People's Republic of China, Email wangl0423@tmu.edu.cn

Objective: To identify factors associated with smoking relapse or non-attempt within one year in COPD patients and to develop a predictive model for early identification of high-risk individuals to guide targeted interventions.

Methods: Based on the health ecology model, a questionnaire integrating factors affecting smoking cessation was developed. We enrolled 221 COPD patients from a tertiary hospital in Tianjin and categorized them into smoking cessation success or failure groups. Mann–Whitney *U*-tests, χ^2 -tests, and logistic regression were used to identify predictors. A nomogram prediction model was developed using significant factors. Model performance was evaluated via calibration plot, Hosmer-Lemeshow test, concordance index (C-index), decision curve analysis (DCA), and clinical impact curve (CIC).

Results: Among 221 patients, 92 successfully quit smoking and 129 failed. Multivariate analysis identified age (OR = 0.922, $P < 0.001$), GOLD grade (OR = 0.257, $P < 0.001$), and death anxiety score (OR = 0.930, $P = 0.001$) as protective factors against cessation failure, while depression score (OR = 1.107, $P < 0.001$) and quit-smoking partner complaints score (OR = 1.075, $P < 0.001$) were risk factors. The prediction model demonstrated good discrimination (C-index = 0.876) and calibration (Hosmer-Lemeshow test $P = 0.350$). DCA and CIC confirmed the model's clinical utility.

Conclusion: Younger age, mild/moderate GOLD grade, higher depression score, lower death anxiety, and higher partner complaints increase the risk of smoking cessation failure in COPD patients. The developed model facilitates early identification of high-risk patients for targeted intervention to improve quit rates.

Keywords: chronic obstructive pulmonary disease, smoking cessation, prediction model, nomogram

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory respiratory disease characterized primarily by persistent airflow limitation.¹ In China, the prevalence of COPD is 13.7%,² with an annual mortality rate reaching 1.04 million, ranking highest globally.³ Smoking is a major risk factor for the development and progression of COPD. Smokers face a 10.62-fold higher risk of developing COPD compared to non-smokers.⁴ COPD patients who smoke experience more respiratory symptoms and a higher risk of systemic infections than their non-smoking counterparts.⁵ Smoking cessation is an effective measure for preventing and managing COPD, as it can reduce all-cause mortality, alleviate respiratory symptoms, and decrease the frequency of acute exacerbations in COPD patients.^{6,7}

However, compared to the general smoking population, COPD patients exhibit higher levels of nicotine dependence and encounter greater difficulty in quitting.⁸ Statistics indicate that only 19.1% of COPD patients successfully quit smoking, while 59.7% have never attempted cessation.⁹ Furthermore, 92.86% of COPD patients who attempt to quit experience relapse within one year.¹⁰ Significant differences exist in the clinical characteristics between COPD patients

who succeed and those who fail in quitting.¹¹ Cavusoglu et al found that COPD patients with higher nicotine dependence, low motivation to quit, high stress levels, insufficient social support, and lack of hobbies/interests are more prone to relapse after cessation.¹² Schiller et al observed that COPD patients who consume alcohol, are older, and have no comorbidities are less likely to attempt quitting.¹³ A qualitative study found that the sequelae of COVID-19 infection effectively enhance the willingness to quit smoking among COPD patients and promote smoking cessation.¹⁴ Hassan demonstrated that COVID-19 significantly exacerbates the health burden in COPD patients, leading to higher mortality risk, more severe clinical symptoms, and prolonged recovery.^{15,16} COVID-19 infection fosters a more concrete and profound awareness of the disease risks and health threats associated with COPD among patients. The resulting sense of health crisis serves as a critical factor motivating them to quit smoking.¹⁴ Research demonstrates that intensifying cessation interventions for smokers facing greater quitting difficulties and higher relapse risks can promote successful cessation,¹⁷ and timely implementation of cessation interventions helps improve quit rates.¹⁸ Shiffman et al described relapse as an acute event occurring when the propensity to relapse exceeds a certain threshold, emphasizing that comprehensively understanding the influencing factors of relapse and determining overall relapse susceptibility are key to intervening and enhancing cessation success rates.¹⁹ Currently, research exploring smokers' relapse probabilities guided by influencing factors remains scarce. For COPD patients, both the low rate of cessation attempts and the high relapse rate are significant contributors to the overall low success rate of quitting.^{9,10} Therefore, comprehensively analyzing the factors influencing relapse/non-attempt within one year of cessation, quantifying the probability of relapse/non-attempt, and guiding nursing staff to prioritize interventions for high-risk patients are of critical importance.

Predictive models can comprehensively analyze influencing factors, quantify the risk of adverse events, and guide healthcare professionals in implementing targeted interventions for high-risk patients.²⁰ A nomogram, a visual representation of a predictive model, uses a cluster of non-overlapping line segments on a plane coordinate to illustrate the functional relationships between multiple variables, providing an intuitive display of event risk probability.²¹ Although COPD patients have stronger tobacco dependence and a lower likelihood of successful cessation compared to the general smoking population,⁸ those who maintain abstinence for one year experience significantly reduced future relapse rates, markedly alleviated respiratory symptoms, and substantially improved quality of life.^{22,23} Additionally, strengthening interventions for patients with low cessation motivation or no prior quit attempts can effectively promote smoking cessation among COPD patients.²⁴ Recent research has further illuminated key factors influencing smoking among COPD patients. For example, Ukey found that COPD patients with current psychiatric disorders, particularly current depression, faced a significantly increased likelihood of continued smoking.²⁵ In another study, Pant identified gender, age, weight control status, and weekly walking frequency as key predictors of current smoking in this population, providing a quantitative basis for risk stratification.²⁶ Nevertheless, research quantifying the probability of relapse/non-attempt in COPD patients based on influencing factors remains inadequate, hindering the precision of clinical interventions.

In recent years, the Health Ecology Model (HEM), recognized for its hierarchical structure and systematic comprehensiveness, has been widely applied in chronic disease management and proven effective in comprehensively integrating factors influencing health-related behaviors.²⁷ Scholars have successfully used the HEM to investigate factors influencing physical activity in stroke survivors,²⁸ breast cancer screening behaviors,²⁹ and medication adherence in hypertensive patients,³⁰ yielding systematic and reliable findings. The HEM posits that individual and population health results from the interaction of biological factors, behavioral and lifestyle factors, psychological factors, healthcare service factors, and social and environmental factors.³¹ Based on the HEM, Qin Tingting analyzed factors influencing tobacco use among cancer patients, providing a scientific basis for developing cessation intervention strategies and further confirming the effectiveness and scientific validity of cessation management guided by this theory.³² Consequently, integrating factors influencing sustained smoking cessation in COPD patients based on the HEM will offer a more holistic perspective for formulating cessation intervention strategies.

Based on the above background, this study aims to construct a predictive model for smoking cessation behavior in COPD patients based on the HEM, develop a corresponding nomogram, comprehensively analyze the influencing factors of cessation behavior, and quantify the probability of relapse/non-attempt within one year after cessation. This will facilitate the early identification of COPD patients prone to relapse or non-attempt, guiding targeted intensification of interventions for high-risk patients to improve smoking cessation success rates.

Methods

Study Subjects

Convenience sampling was employed between October 2023 to October 2024 to recruit COPD patients from a tertiary hospital in Tianjin, China. The inclusion criteria were: ① Patients diagnosed with COPD upon admission; ② Patients who had not quit smoking before their initial COPD diagnosis and had smoked ≥ 100 cigarettes in their lifetime (either continuously or cumulatively);³³ ③ Age ≥ 18 years; ④ Normal mental status and memory, absence of hearing impairment, intact verbal communication skills, and voluntary participation in this study. The exclusion criteria were: ① COPD patients who were attempting cessation for the first time and had been abstinent for less than one year; ② COPD patients who had quit for over one year but subsequently relapsed.

In this study, successful smoking cessation was defined as patients having achieved sustained abstinence (without using any tobacco products) for at least one year at the time of enrollment. Smoking cessation failure was defined as either never having attempted to quit or having relapsed after a cessation attempt lasting less than one year.

Study Tools/Variables

This study, guided by the HEM as the theoretical framework,²⁷ integrated findings from a prior scoping review³⁴ and a qualitative study¹⁴ to identify the factors influencing sustained smoking cessation in COPD patients. The HEM is divided into five levels: the individual characteristics level includes age, gender, disease susceptibility, etc.; the behavioral patterns level includes lifestyle habits, mental health, etc.; the interpersonal networks level includes interpersonal interactions within family, community, and society, etc.; the living and working conditions level includes occupation, socioeconomic status, etc.; the policy environment level includes local, national, and even global political, economic, and cultural policies, and the social environment, etc.³¹

In this study, “Married” in marital status includes first marriage with spouse, remarriage with spouse, and reconciliation with spouse; “Other” includes divorced, widowed, and unmarried. In education level, high school, college, university undergraduate, master’s degree, and doctoral degree are defined as “High school or above”; no formal education, primary school, and junior high school are defined as “Below high school”. “Other” in employment status includes unemployed/jobless, retired, and unemployed. The influencing factors integrated based on the HEM theoretical framework are detailed as follows:

Individual Characteristics Level

Includes basic personal information and disease-related information such as age, education level, place of residence, marital status, employment status, economic status, ethnicity, gender, Chronic Obstructive Pulmonary Disease Assessment Test (CAT), Modified Medical Research Council Dyspnea Questionnaire (mMRC), Global Initiative for Chronic Obstructive Lung Disease Classification (GOLD), whether hospitalized/visited a doctor for acute exacerbation in the previous year, history of surgery, presence of comorbidities, whether experienced worsening COPD symptoms after SARS-CoV-2 infection, etc.

Chronic Obstructive Pulmonary Disease Assessment Test (CAT)

The CAT scale includes a comprehensive symptom score covering aspects like dyspnea and can assess the patient’s condition multidimensionally. When the CAT score is < 10 , it indicates mild disease; the patient is mostly normal most of the time, but COPD has caused some symptoms, such as coughing on a few days per week, feeling short of breath after physical exertion, and often feeling easily exhausted, etc. When $10 < \text{CAT score} \leq 20$, it indicates moderate disease; the patient coughs and produces sputum most of the time, experiences 1 to 2 acute exacerbations per year, frequently experiences shortness of breath, and can only climb a few flights of stairs slowly, etc. When $20 < \text{CAT score} \leq 30$, it indicates severe disease; the patient cannot engage in most activities, lung symptoms interfere with sleep most nights, and doing everything is very strenuous, etc. When the CAT score is > 30 , it indicates very severe disease; the patient cannot engage in any activities, life is very difficult, and quality of life is extremely low.³⁵

Modified Medical Research Council Dyspnea Questionnaire (mMRC)

The mMRC questionnaire is primarily used to assess the degree of dyspnea in patients with chronic obstructive pulmonary disease. This questionnaire categorizes patients based on their dyspnea symptoms into the following 5 grades: Grade 0: Dyspnea only during strenuous exercise; Grade 1: Dyspnea when walking briskly on level ground or walking up a slight incline; Grade 2: Due to dyspnea, walks slower than peers of the same age on level ground or needs to stop for breath; Grade 3: Stops for breath after walking about 100 meters on level ground or after a few minutes; Grade 4: Too dyspneic to leave the house or experiences dyspnea when dressing or undressing.³⁶

Global Initiative for Chronic Obstructive Lung Disease Classification (GOLD)

The GOLD grade evaluates the patient's lung function indicators. Mild COPD: (FEV1/FVC) <70%, FEV1 ≥80% predicted; Moderate COPD: (FEV1/FVC) <70%, 50% ≤ FEV1 <80% predicted; Severe COPD: (FEV1/FVC) <70%, 30% ≤ FEV1 <50% predicted; Very Severe COPD: (FEV1/FVC) <70%, FEV1 <30% predicted or FEV1 <50% predicted plus chronic respiratory failure (PaCO₂ >50mmHg).

Behavioral Patterns Level

Smoking duration (years), daily cigarette consumption (cigarettes), nicotine dependence level, whether uses smoking to expectorate phlegm, smoking cessation health beliefs, smoking cessation self-efficacy, alcohol consumption, presence of regular physical exercise habit, presence of hobbies/interests besides smoking, presence of depression, perceived stress, death anxiety.

Fagerström Test for Nicotine Dependence (FTND)

This study used the FTND as the assessment standard. It is a 10-point scale comprising 6 questions. The answers to each question correspond to 1 point, or 2 points, or 3 points. The level of nicotine dependence is determined based on the total final score. Among them, the time to the first cigarette after waking up in the morning and the number of cigarettes smoked per day reflect the smoking intensity of the smoker. The dependence levels represented by the total score are: Mild dependence 0~3 points, Moderate dependence 4~6 points, High dependence 7~10 points.³⁷ The FTND has high test-retest reliability and internal consistency, with a Cronbach's alpha value of 0.64.³⁸

Smoking Self-Efficacy Questionnaire (SEQ-12)

The SEQ-12 is used to evaluate the size of smokers' confidence in controlling smoking urges in two types of situations: physiological (internal stimuli) and social (external stimuli). It consists of 12 items, using a Likert 5-point scoring method (1=Absolutely not confident, 2=Not confident, 3=Probably confident, 4=Confident, 5=Absolutely confident). The higher the degree of confidence, the higher the score, the greater the confidence in smoking cessation, and the higher the self-efficacy for smoking cessation. Its Cronbach's alpha value is 0.88.³⁹

Smoking Cessation Health Belief Scale (SCHBS)

The SCHBS comprises 18 items. The scale includes: Perceived susceptibility to disease (6 items, items 1–6), Perceived severity of disease (4 items, items 7–10), Perceived benefits of smoking cessation (4 items, items 11–14), Perceived barriers to smoking cessation (4 items, items 15–18). Scoring method: Strongly agree = 5 points, Agree = 4 points, No opinion = 3 points, Disagree = 2 points, Strongly disagree = 1 point. The higher the total score, the more positive the health beliefs. Its Cronbach's alpha value is 0.84.⁴⁰

Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 was used to measure the patient's level of depression. This is a single-dimension scale consisting of 9 items, used to assess the presence and frequency of situations described in the items over the past two weeks. A Likert 4-point scoring method was used, with options ranging from Not at all (0 points) to Nearly every day (3 points). Scores 0–4 indicate no depression, 5–9 indicate mild depression, 10–14 indicate moderate depression, 15–19 indicate moderately severe depression, and 20–27 indicate severe depression. The total score ranges from 0 to 27. Its Cronbach's alpha value is 0.76.⁴¹

Chinese Perceived Stress Scale (CPSS)

The CPSS was used to assess the patient's perceived stress. This scale is divided into two dimensions: tension and loss of control, totaling 14 items. It is evaluated based on the patient's personal feelings over the past month. Among them, 7 items are reverse-scored. The total score ranges from 14 to 70 points. A higher score indicates that the individual feels greater stress. Its Cronbach's alpha value is 0.78.⁴²

Threat-Oriented Death Anxiety Scale (T-DAS)

The T-DAS was used. This scale is used to reflect an individual's level of death anxiety. The scale consists of 15 items, scored using a Likert 5-point scoring method (1=Strongly disagree, 5=Strongly agree). Among them, 6 items are reverse-scored. The total score ranges from 15 to 75 points. A higher total score indicates a higher level of death anxiety in the individual. Its Cronbach's alpha value is 0.71.⁴³

Interpersonal Networks Level

Includes marital status, whether received smoking cessation education from healthcare professionals, satisfaction with smoking cessation education implemented by healthcare professionals, negative interactions (criticism/complaints), and social support received during the cessation process.

Partner Interaction Questionnaire (PIQ)

The PIQ developed by Burns et al was selected to reflect the negative interactions (criticism/complaints) and social support received by quitters during the cessation process. The scale consists of 19 items, divided into two subscales: social support and negative interactions. Participants report the degree of perceived social support and negative interactions from family/friends using a 5-point scale (1=Never, 5=Always). The scale has good reliability and validity, with a Cronbach's alpha value of 0.85.⁴⁴

Living and Working Conditions Level

Includes place of residence, education level, employment status, per capita monthly household income.

Policy Environment Level

Includes whether offered cigarettes in social situations and urged to smoke, whether consciously complies with smoke-free environment policies in hospitals.

Statistical Analysis

Data processing and analysis were performed using SPSS software (version 26.0). Nomograms, calibration plots, decision curve analysis (DCA), and clinical impact curve (CIC) analyses were generated using R software (version 4.3.1).

Continuous data not conforming to a normal distribution are presented as the median (M) with interquartile range (IQR; P25–P75), and comparisons between groups were performed using the Mann–Whitney *U*-test. Categorical data are presented as frequency or percentage (%), and comparisons between groups were performed using the χ^2 test. Multivariate logistic regression analysis was employed to identify factors associated with relapse/non-attempt within one year among COPD patients. Variables with a P-value < 0.05 in the univariate analysis were included as candidates for the multivariate logistic regression. The final prediction model was constructed using the forward selection method based on conditional parameter estimates, with the criteria for variable entry and removal both set at P < 0.05. Based on the results of the multivariate logistic regression analysis, variables for inclusion in the prediction model were identified, and the prediction model was developed and validated. To verify the robustness of the variable selection results, we additionally employed LASSO regression as a sensitivity analysis. LASSO regression is particularly suitable for handling high-dimensional datasets containing a large number of predictors. By imposing constraints on the coefficients, it automatically performs variable selection to identify the predictors most relevant to the outcome, thereby constructing a more parsimonious and robust model while effectively preventing overfitting.⁴⁵ The model's discriminative ability was assessed using the concordance index (C-index) and calibration plots. The model's calibration was evaluated using the Hosmer-Lemeshow goodness-of-fit test. The clinical utility of the model was evaluated using DCA and CIC analysis.

All tests were two-sided, and a P-value < 0.05 was considered statistically significant.

Results

Univariate Analysis of Factors Influencing Sustained Smoking Cessation in COPD Patients

This study included 221 COPD patients. Among them, 92 patients successfully quit smoking, while 129 failed to quit. The median age of the patients was 67 years (interquartile range [IQR]: 62–74 years). A total of 183 patients (82.8%) were male and 38 (17.2%) were female. Regarding marital status, 179 patients (81.0%) were married and 42 (19.0%) had other marital statuses.

Prior to the univariate analysis, multicollinearity was assessed for all independent variables. The variance inflation factor (VIF) for each variable was below 5, with all tolerance values exceeding 0.2, indicating the absence of significant multicollinearity. Details are presented in [eTable 1](#) in supplemental content.

Statistically significant differences ($P < 0.05$) were observed between the smoking cessation success and failure groups in the following factors: age, GOLD grade, presence of post-COVID sequelae, presence of regular physical exercise habit, daily cigarette consumption, smoking cessation self-efficacy score, death anxiety score, and quit-smoking partner complaints score. Detailed results are presented in [Table 1](#).

Development of a Predictive Model for Sustained Smoking Cessation in COPD Patients

Using smoking cessation status as the dependent variable, variables demonstrating statistically significant differences in univariate analysis were selected as independent variables for multivariate logistic regression analysis. Factors identified as significant in the multivariate logistic regression were then used to construct a predictive model for smoking cessation behavior in COPD patients. Prior to analysis, categorical variables were assigned numerical values as detailed in [Table 2](#).

Before performing the multivariate logistic regression analysis, we assessed multicollinearity among all candidate independent variables. The variance inflation factor (VIF) for each variable was below the threshold of 5, with all tolerance values greater than 0.2, confirming the absence of significant multicollinearity. Details are presented in [eTable 2](#) in supplemental content.

Multivariate logistic regression analysis was performed using the forward selection method based on conditional parameter estimates. The results revealed that age (OR = 0.922, $P < 0.001$), GOLD grade (OR = 0.257, $P < 0.001$), and death anxiety score (OR = 0.930, $P = 0.001$) were protective factors against smoking cessation failure. Conversely, depression score (OR = 1.107, $P < 0.001$) and quit-smoking partner complaints score from quitting companions (OR = 1.075, $P < 0.001$) were identified as risk factors for smoking cessation failure. These five factors were incorporated into the final predictive model. Details are presented in [Table 3](#). The variables selected by LASSO regression are exactly the same as the five predictors obtained through stepwise regression described above. For details, see [eTable 3](#) and [eFigure 1](#) in the Supplemental content.

Construction of the Sustained Smoking Cessation Nomogram for COPD Patients

Based on the results of the predictive model, a nomogram was constructed, shown in [Figure 1](#). The nomogram indicates that lower age, mild or moderate GOLD grade, higher depression score, lower death anxiety score, and higher quit-smoking partner complaints score are associated with an increased risk of smoking cessation failure in COPD patients.

Validation of the Sustained Smoking Cessation Prediction Model in COPD Patients

The calibration plot and the Hosmer-Lemeshow test were employed to evaluate the agreement of the prediction model, while the concordance index (C-index) was used to assess its discrimination. The calibration curve demonstrated a high degree of alignment with the ideal line, shown in [Figure 2](#). The Hosmer-Lemeshow test yielded a χ^2 statistic of 8.907 ($P = 0.350$). Following internal validation using repeated bootstrap resampling with 1000 iterations, the C-index was 0.876 (95% CI: 0.833–0.920). These results indicate that the prediction model possesses excellent discrimination and calibration.

Table 1 Comparison of Baseline Characteristics Between COPD Patients with Successful Smoking Cessation and Those with Failed Smoking Cessation

Characteristic	Category	Total (n=221)	Successful Cessation (n=92)	Failed Cessation (n=129)	Z/ χ^2 Value	P value
Age (years)		67.00(62.00,74.00)	70.00(64.00,76.00)	63.00(59.00,69.25)	-4.981	<0.001
Sex, n (%)	Male	183(82.8)	74(80.4)	109(84.5)	0.622	0.430
	Female	38(17.2)	18(19.6)	20(15.5)		
Marital Status, n (%)	Married	179(81.0)	77(83.7)	102(79.1)	0.747	0.388
	Other	42(19.0)	15(16.3)	27(20.9)		
Education Level, n (%)	High school or above	85(38.5)	39(42.4)	46(35.7)	1.038	0.311
	Below high school	136(61.5)	53(57.6)	83(64.3)		
Residence, n (%)	Urban	188(85.1)	76(82.6)	112(86.8)	0.750	0.386
	Rural	33(14.9)	16(17.4)	17(13.2)		
Monthly Income per Capita (¥), n (%)	≤3000	64(29.0)	28(30.4)	36(27.9)	0.167	0.683
	>3000	157(71.0)	64(69.6)	93(72.1)		
Employment Status, n (%)	Employed	54(24.4)	26(28.3)	28(21.7)	1.125	0.264
	Other	167(75.6)	66(71.7)	101(78.3)		
CAT Score, n (%)	≤20	139(62.9)	58(63.0)	81(62.8)	0.001	0.969
	>20	82(37.1)	34(37.0)	48(37.2)		
mMRC Grade, n (%)	≤ Grade 2	105 (47.5)	47 (51.1)	58 (45.0)	0.808	0.369
	> Grade 2	116 (52.5)	45 (48.9)	71 (55.0)		
GOLD Grade, n (%)	Mild/Moderate	114 (51.6)	84 (65.1)	30 (32.6)	22.722	<0.001
	Severe/Very Severe	107 (48.4)	45 (34.9)	62 (67.4)		
Comorbidities, n (%)	Yes	120(54.3)	50(54.3)	70(54.3)	0.001	0.990
	No	101(45.7)	42(45.7)	59(45.7)		
Prior Surgery, n (%)	Yes	25(11.3)	8(8.7)	17(13.2)	1.676	0.195
	No	196(88.7)	84(91.3)	84(86.8)		
Post-COVID Sequelae, n (%)	Yes	65(29.4)	18(19.6)	47(36.4)	7.360	0.007
	No	156(70.6)	74(80.4)	82(63.6)		
Hospitalization for Acute Exacerbation, n (%)	Yes	177(80.1)	72(78.3)	105(81.4)	0.331	0.565
	No	44(19.9)	20(21.7)	24(18.6)		
Non - Smoking Hobbies/Activities, n (%)	Yes	134(60.6)	55(59.8)	79(61.2)	0.048	0.827
	No	87(39.4)	37(40.2)	50(38.8)		
Alcohol Consumption, n (%)	Yes	106(48.0)	48(52.2)	58(45.0)	1.119	0.290
	No	115(52.0)	44(47.8)	71(55.0)		
Regular Physical Exercise, n (%)	Yes	93(42.1)	31(33.7)	62(48.1)	4.547	0.033
	No	128(57.9)	61(66.3)	67(51.9)		
Smoking Duration, n (%)	≤40 years	148(67.0)	65(70.7)	83(64.3)	0.967	0.325
	>40 years	73(33.0)	27(29.3)	46(35.7)		
Daily Cigarette Consumption, n (%)	≤20 cigarettes	150(67.9)	70(76.1)	80(62.0)	0.432	0.027
	>20 cigarettes	71(32.1)	22(23.9)	49(38.0)		
Nicotine Dependence Level, n (%)	Mild/Moderate Dependence	101(45.7)	41(44.6)	60(46.5)	0.082	0.775
	Severe Dependence	120(54.3)	51(55.4)	69(53.5)		
Smoking to Expel Phlegm, n (%)	Yes	118(53.4)	52(56.5)	66(51.2)	0.620	0.431
	No	103(46.6)	40(43.5)	63(48.8)		

(Continued)

Table I (Continued).

Characteristic	Category	Total (n=221)	Successful Cessation (n=92)	Failed Cessation (n=129)	Z/ χ^2 Value	P value
Smoking Cessation Self-Efficacy Cessation (points)		38.00(24.00,43.00)	42.00(25.00,44.25)	36.00(23.00,42.00)	-0.768	0.043
Health Belief Score for Smoking Cessation (points)		57.00(46.00,62.00)	55.50(47.00,62.25)	57.00(43.00,61.00)	-1.074	0.283
Depression Score (points)		7.00(4.00,21.00)	5.00(3.00,7.00)	17.00(15.00,24.25)	-5.956	<0.001
Stress Score (points)		45.00(37.00,50.00)	43.00(34.75,50.00)	45.00(38.00,50.00)	-1.310	0.190
Death Anxiety Score (points)		30.00(25.00,36.00)	31.00(27.00,41.00)	29.00(25.00,32.25)	-3.157	0.002
Peer Support Score (points)		26.00(22.00,29.00)	26.00(22.00,29.00)	26.00(22.00,30.00)	-0.757	0.449
Peer Quit-Smoking Partner Complaints Score (points)		25.00(17.00,33.00)	22.00(14.00,28.00)	32.00(21.00,38.00)	-5.560	<0.001
Received Smoking Cessation Education from Healthcare Providers, n (%)	Yes	204(92.3)	87(94.6)	117(90.7)	1.131	0.288
	No	17(7.7)	5(5.4)	12(9.3)		
Satisfied with Smoking Cessation Guidance from Healthcare Providers, n (%)	Yes	185(83.7)	74(80.4)	111(86.0)	1.240	0.265
	No	36(16.3)	18(19.6)	18(14.0)		
Offered or Urged to Smoke in Social Settings, n (%)	Yes	142(64.3)	57(62.0)	85(65.9)	0.362	0.547
	No	79(35.7)	35(38.0)	44(34.1)		
Voluntary Compliance with Hospital Smoking Control Policy, n (%)	Yes	155(70.1)	62(67.4)	93(72.1)	0.567	0.452
	No	66(29.9)	30(32.6)	36(27.9)		

Table 2 Assignment of Categorical Variables for Logistic Regression Analysis

Variable	Coding
Smoking Cessation Status	0 = Success, 1 = Failure
GOLD Grade	0 = Mild/Moderate, 1 = Severe/Very severe
Marital status	0 = Other, 1 = Married
Post-COVID Sequelae	0 = No, 1 = Yes
Regular Physical Exercise	0 = No, 1 = Yes
Daily Cigarette Consumption	0 = ≤20 cigarettes, 1 = >20 cigarettes

Table 3 Multivariate Logistic Regression Analysis of Factors Associated with Sustained Smoking Cessation in COPD Patients

Indicator	Regression Coefficient	Standard Error	Wald χ^2 Value	P value	OR (95% CI)
Age (years)	-0.082	0.022	13.704	<0.001	0.922(0.883~0.962)
GOLD Grade	-1.357	0.370	13.431	<0.001	0.257(0.124~0.532)
Depression Score (points)	0.101	0.022	20.505	<0.001	1.107(1.059~1.156)
Death anxiety score (points)	-0.072	0.023	10.204	0.001	0.930(0.890~0.973)
Quit-smoking partner complaints score (points)	0.072	0.016	19.645	<0.001	1.075(1.041~1.109)
Constant	4.413	1.591	7.696	0.006	

Clinical Utility of the Sustained Smoking Cessation Prediction Model in COPD Patients

To evaluate the clinical utility of the model, this study further constructed DCA and CIC for the prediction model, shown in Figures 3 and 4. The decision curve demonstrated that when the threshold probability was ≥ 0.07 , utilizing the prediction model yielded a higher net benefit than both the “intervention-all” line and “intervention-none” line. This indicates that the model can effectively meet the needs of clinical practice within this probability range.

In the clinical impact curve, the purple dashed line represents the actual number of COPD patients experiencing smoking cessation failure (observed high-risk cases). The solid line represents the number of patients predicted to be at high risk by the model (predicted high-risk cases). As the risk threshold increases, the gap between the two curves narrows, indicating good concordance. This suggests that the prediction model possesses substantial clinical utility.

Discussion

Based on the analysis results of the Logistic model, this study developed a prediction model for sustained smoking cessation in COPD patients and constructed a corresponding nomogram. The model identified that younger age, mild-to-moderate GOLD grade, higher depression scores, lower death anxiety scores, and higher quit-smoking partner complaints scores were independently associated with an increased risk of smoking cessation failure. Furthermore, internal validation of the prediction model was conducted using a calibration curve, Hosmer-Lemeshow test, and the C-index. The model’s clinical utility was evaluated using DCA and CIC analysis. The results indicate that the model possesses high discriminative accuracy and favorable clinical applicability, offering a valuable reference tool for assessing the risk of smoking cessation failure in COPD patients.

Strengthening smoking cessation interventions for smokers who face greater difficulty quitting and higher relapse risk can promote successful cessation.¹⁷ Initiating cessation interventions early helps improve smokers’ success rates.⁴⁶ For COPD patients, low quit attempt rates and high relapse rates are significant reasons for their cessation failure.^{9,10} Liang constructed a risk prediction model for nicotine dependence among smokers and developed a nomogram, providing a scientific basis for smokers’ self-health assessment and future effective tobacco control interventions by health authorities.⁴⁷ Currently, research on using prediction models for guiding smokers in maintaining cessation is relatively

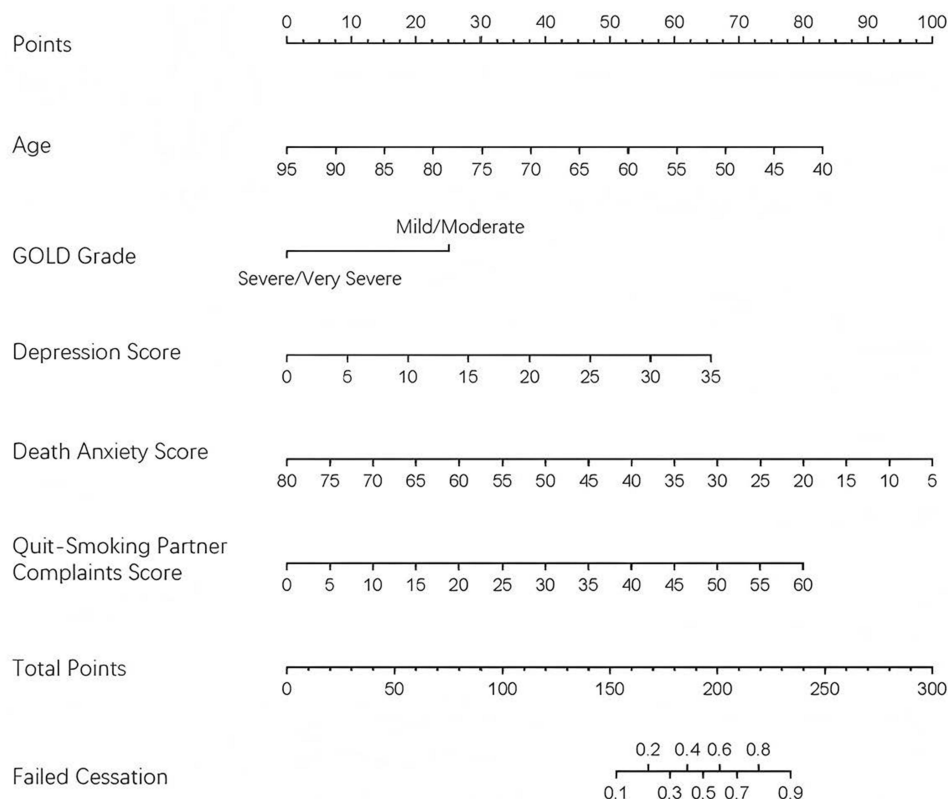


Figure 1 Nomogram for predicting sustained smoking cessation in COPD patients.

scarce. Studies on smoking cessation in COPD patients often focus primarily on individuals who have successfully quit, typically exploring only the factors influencing relapse.¹² Constructing a prediction model for sustained smoking cessation in COPD patients, quantifying the risk of relapse/failure to attempt quitting, and subsequently strengthening interventions for patients prone to cessation failure remain pressing issues. This study focuses on COPD patients who relapse or fail to attempt quitting, building a prediction model for sustained smoking cessation, which helps provide cessation support to a broader range of COPD patients. The prediction model constructed in this study provides an optimization strategy for clinical practice. This model enables risk stratification, guiding healthcare professionals to prioritize limited medical resources for intervening in patients at high risk of smoking cessation failure. Additionally, specific predictive factors revealed by the model, such as depression scores and lower death anxiety scores, offer clear targets for developing precise intervention strategies. This shifts intervention measures from universal smoking cessation advice to personalized management tailored to individuals. When patients fail to quit smoking, the predictive factors of the model can provide key evidence for analyzing the reasons for failure and adjusting subsequent intervention plans, thereby improving intervention efficiency and success rates.

This study found that younger COPD patients and those with mild and moderate GOLD grades had a higher risk of smoking cessation failure, consistent with previous research findings.^{9,48,49} Data from the China National Chronic Obstructive Pulmonary Disease Surveillance show that the successful smoking cessation rate among COPD patients in China gradually increases with age. Specifically, the successful cessation rate was 12.0% for patients aged 50–60 years, 20.2% for those aged 60–70 years, and 27.2% for patients aged ≥ 70 years.¹⁰ The study by Tøttenborg indicated that patients with severe and very severe GOLD grades had a higher likelihood of smoking cessation compared to those with mild GOLD grades.⁴⁸ This may be because younger COPD patients and those with lower GOLD grades have a lower prevalence of comorbidities, experience exacerbations less frequently, and have milder respiratory symptoms.^{9,50,51} These milder disease symptoms may lead to a lack of motivation to quit and reduced awareness of their own health, hindering their smoking cessation efforts.⁵² Therefore, the findings of this study suggest that prioritizing targeted

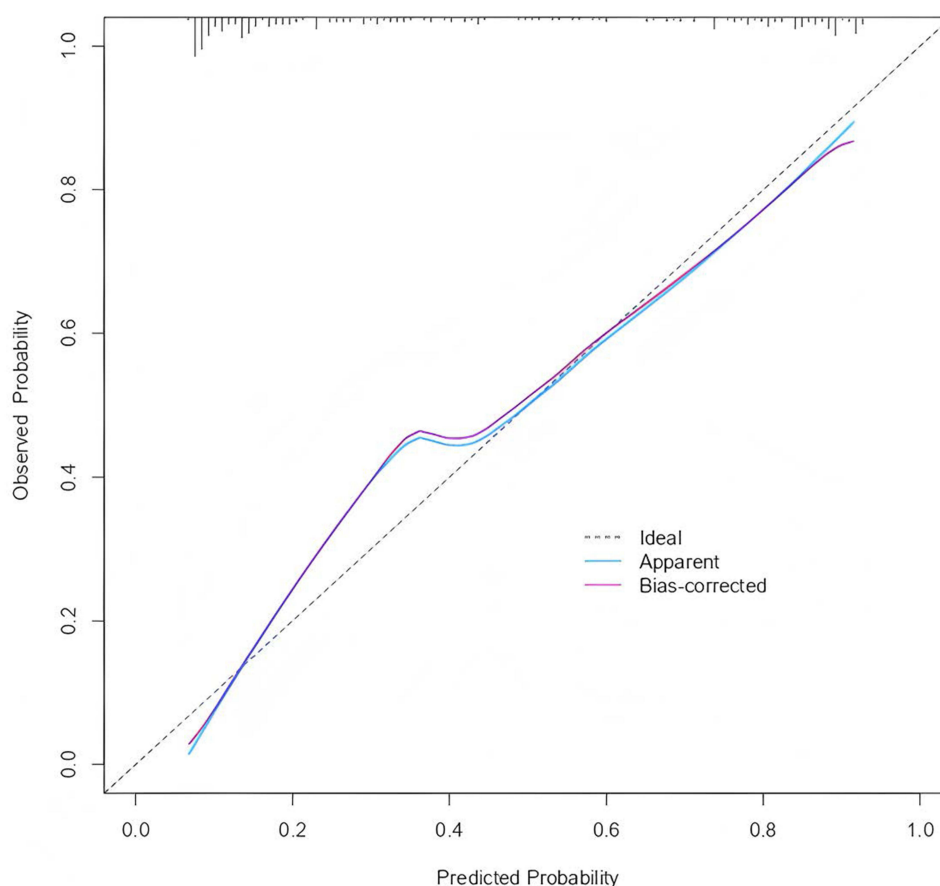


Figure 2 Calibration plot for the prediction model of sustained smoking cessation in COPD patients. In the calibration plot, the blue curve represents the apparent prediction (uncorrected curve) of the model. The purple curve represents the bias-corrected prediction (calibration curve). The black dashed line at a 45-degree angle represents the ideal prediction (ideal line), indicating perfect agreement between predicted and observed probabilities.

interventions for younger COPD patients and those with lower GOLD stages, combined with enhanced health education, may be associated with maintaining smoking cessation among COPD patients in clinical smoking cessation management.

This study found that elevated depression scores increase the risk of smoking cessation failure in COPD patients. Previous studies have indicated that COPD leads to a progressive decline in lung function, and chronic respiratory symptoms coupled with repeated hospitalizations due to acute exacerbations increase patients' psychological stress, fostering depressive symptoms.^{53–55} To alleviate negative emotions, patients often resort to smoking as a means of relieving depressive feelings, which further heightens their nicotine dependence.⁵⁶ Notably, chronic tobacco exposure has been shown to reduce serum serotonin (5-HT) levels and induce depressive behavior in COPD mouse models.⁵¹ Research by Vestergaard found that, compared to COPD patients who successfully quit smoking, those who continued smoking had a higher risk of hospitalization for depression.⁵⁷ These findings suggest that depressive symptoms may trap COPD patients in a vicious cycle of cessation failure: patients experiencing depression may attempt to relieve their depressive feelings through smoking, while continued smoking further increases their risk of depression. Therefore, integrating the assessment and management of depression into comprehensive smoking cessation interventions for COPD patients may represent a key direction for breaking the vicious cycle between depression and smoking. Currently, the issue of depression in COPD patients has gradually been incorporated as a key aspect of clinical management. In practice, researchers recommend using standardized tools (such as PHQ-9 and HADS) to screen patients for depression during routine follow-ups.⁵⁷ In terms of non-pharmacological interventions, pulmonary rehabilitation has been proven to help alleviate depressive symptoms in COPD patients. For moderate to severe cases, pharmacological treatments such as selective serotonin reuptake inhibitors may be considered, but they must be administered under close monitoring to

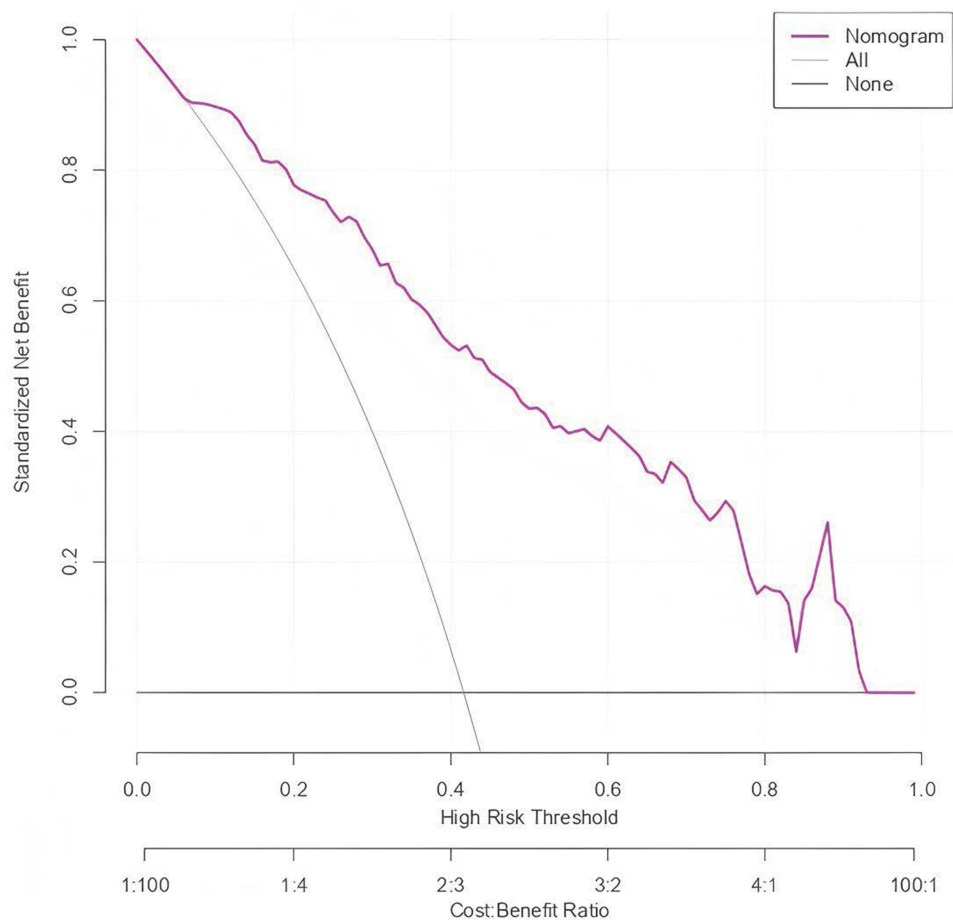


Figure 3 Clinical Decision Curve for the Prediction Model of Sustained Smoking Cessation in COPD Patients. The clinical decision curve is used to assess the clinical net benefit of the prediction model. The vertical axis represents the net benefit standardized, and the top horizontal axis represents the high-risk threshold. The bottom horizontal axis represents the cost-benefit ratio. The graph contains three curves: the purple line is the prediction model, indicating the net benefit if all patients underwent the prediction mo the gray line is the “intervention-all” line, indicating the net benefit if all patients received the intervention; the black line is the “intervention-none” line, indicating the net benefit if no patients received any intervention.

assess potential respiratory impacts.⁵⁸ Additionally, remote health support systems such as telephone follow-ups and mobile-based psychological education have also been demonstrated to effectively reduce depression.^{59,60}

This study indicates that a decrease in death anxiety scores is independently associated with an increased risk of smoking cessation failure in COPD patients. Existing research has demonstrated that death anxiety can significantly motivate COPD patients to adopt smoking cessation behaviors.^{49,61,62} Terror Management Theory posits that awareness of mortality can trigger existential anxiety in individuals, prompting them to employ defense mechanisms to alleviate this anxiety.⁶³ Consequently, when COPD patients recognize the threat smoking poses to their lives, they tend to quit smoking to mitigate the anxiety induced by this awareness of death. The Health Belief Model states that perceived risk of disease is a critical component of behavior change.⁶⁴ When COPD patients accurately perceive the health hazards of smoking, it facilitates their adoption of smoking cessation behaviors.³⁴ Therefore, given the observed correlation between death anxiety and sustained smoking abstinence in this study, it would be valuable to design and test corresponding health education interventions in prospective studies to explore the efficacy and safety of eliciting death anxiety as an auxiliary smoking cessation strategy.

This study reveals that higher quit-smoking partner complaints scores increase the risk of smoking cessation failure in COPD patients, consistent with previous findings.⁶⁴ Research by Eklund found that criticism and complaints from peers attempting to persuade cessation can make patients feel a loss of autonomy in quitting, weaken their motivation to quit, and reduce their cessation success rates.⁶⁵ Studies by Chen indicated that smoking behavior is closely linked to smokers’ self-

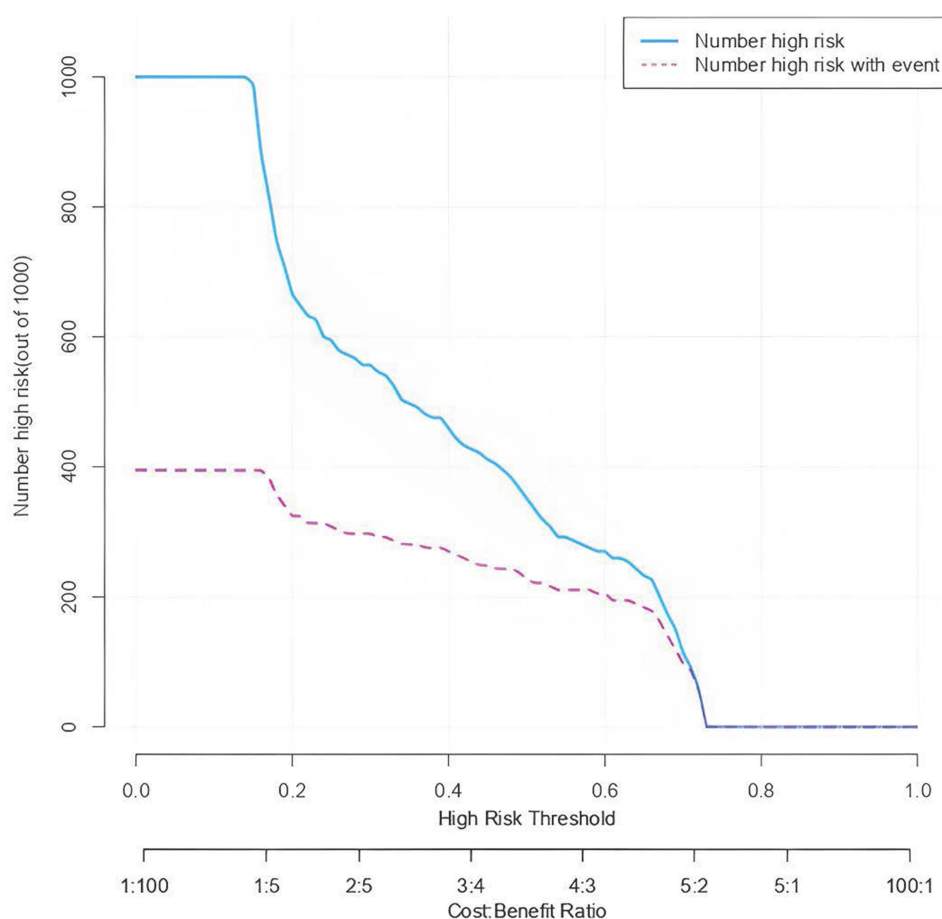


Figure 4 Clinical Impact Curve of the Sustained Smoking Cessation Prediction Model in COPD Patients. The CIC illustrates the relationship between the number of patients predicted to be at high risk and the number of patients who actually experienced the event (smoking cessation failure). The solid blue line represents the total number of patients predicted to be at high risk for smoking cessation failure across different high-risk thresholds. The dashed purple line represents the number of patients who actually experienced the event at the same high-risk thresholds. The x-axis represents the high-risk threshold, and the y-axis represents the number of high-risk patients (per 1000 patients). This graph is used to evaluate the clinical utility of the prediction model and its ability to identify high-risk populations.

identity.⁴⁴ Criticism and complaints from peers can damage the smoker's self-concept, inducing psychological tension. To alleviate this tension, smokers may adjust their cognition to rationalize smoking, defending their unhealthy behavior, which further impedes cessation efforts. Therefore, although the causal relationship remains unclear, the findings of this study still provide important clues for clinical practice: namely, that the approach to providing smoking cessation advice is crucial. We recommend that healthcare professionals, when guiding patients' families, should emphasize the use of supportive communication rather than criticism or complaints, with the aim of creating a more favorable home environment for achieving successful smoking cessation. Transforming supervision and criticism into affirmation of patients' positive attempts to quit smoking may be key to promoting smoking cessation. Research by Daniel shows that among various forms of family support behaviors, only "praising or encouraging efforts to quit" significantly enhanced smokers' willingness to quit, while other supportive behaviors (such as encouraging the use of cessation aids, inquiring about progress, or reminding them of family responsibilities) did not significantly influence their quitting behavior.⁶⁶ Notably, Nagawa pointed out that whether smokers are willing to accept advice from a quit-smoking partner largely depends on the quality and strength of their relationship. Supporters with stronger bonds are better able to understand and respond to the smoker's individualized needs, thereby providing more targeted and acceptable support.⁶⁷ Therefore, selecting individuals with close relationships to the patient as core supporters during the quitting process, and training these quit-smoking partners to adopt positive communication strategies—shifting from supervision and blame to affirming the patient's active attempts to quit—may be crucial in facilitating successful smoking cessation among COPD patients.

This study has several limitations. First, the predominantly elderly cohort may limit generalizability to younger COPD patients and might have contributed to the higher smoking cessation rate observed. Further validation in broader age groups is needed. Second, self-reported data are susceptible to recall and response biases. Future studies could use smart devices for real-time data collection to improve reliability. Third, as a cross-sectional study, causal inference is limited; longitudinal studies are required to establish causality and enhance prediction accuracy. Fourth, single-center sampling from a tertiary hospital introduces selection bias and limits applicability to primary care or community settings. Multi-center sampling is recommended for better generalizability. Fifth, the sample size was insufficient to separately analyze “relapse” and “no quit attempt” subgroups. Future work should develop phase-specific models for “initiating cessation” and “maintaining abstinence”. Sixth, although the model showed good internal performance, its real-world effectiveness remains unproven. Prospective implementation studies are needed to assess its clinical utility and impact on long-term cessation outcomes.

Conclusions

Lower age, mild or moderate GOLD grade, higher depression score, lower death anxiety score, and higher quit-smoking partner complaints score are associated with an increased risk of smoking cessation failure in COPD patients. The prediction model developed based on these factors demonstrates good discrimination and calibration, indicating significant clinical utility. This model provides a basis for the early identification of COPD patients at high risk of relapse or failure to attempt quitting within one year of cessation, enabling targeted interventions for high-risk individuals to improve smoking cessation success rates.

Abbreviations

CAT, Chronic Obstructive Pulmonary Disease Assessment Test; CI, Confidence Interval; CIC, Clinical Impact Curve; C-index, Concordance Index; COPD, Chronic Obstructive Pulmonary Disease; CPSS, Chinese Perceived Stress Scale; DCA, Decision Curve Analysis; FTND, Fagerström Test for Nicotine Dependence; GOLD, Global Initiative for Chronic Obstructive Lung Disease; HEM, Health Ecology Mo IQR, Interquartile Range; mMRC, Modified Medical Research Council Dyspnea Questionnaire; OR, Odds Ratio; PHQ-9, Patient Health Questionnaire-9; PIQ, Partner Interaction Questionnaire; SCHBS, Smoking Cessation Health Belief Scale; SEQ-12, Smoking Self-Efficacy Questionnaire; T-DAS, Threat-Oriented Death Anxiety Scale.

Data Sharing Statement

The data used and analyzed in this study are available upon request from the corresponding author.

Ethics Approval and Informed Consent

This study was approved by the Medical Ethics Committee of Tianjin Medical University (Approval No. TMUhmec20230018), and written informed consent was obtained from all participants. This study complies with the Declaration of Helsinki, and all participants were informed about the purpose of the study.

Funding

This work was supported by Tianjin Science and Technology Program (24YDTPIC00300) and the National Natural Science Foundation of China (Grant No. 72574163).

Disclosure

The authors report no conflicts of interest in relation to this work.

Huimin Tong and Zheng Tian are the co-first authors of this paper.

Liwei Jing and Lan Wang are the co-corresponding authors of this paper.

References

- GOLD. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease [EB/OL] [1/26]. Available from: <https://goldcopd.org/about-us/>. Accessed January 6, 2026.
- Wang C, Xu J, Yang L, et al. Prevalence and risk factors of chronic obstructive pulmonary disease in China (the China pulmonary health [CPH] study): a national cross-sectional study. *Lancet*. 2018;391(10131):1706–1717. doi:10.1016/S0140-6736(18)30841-9
- Adeloye D, Song P, Zhu Y, et al. Global, regional, and national prevalence of, and risk factors for, chronic obstructive pulmonary disease (COPD) in 2019: a systematic review and modelling analysis. *Lancet Respir Med*. 2022;10(5):447–458. doi:10.1016/S2213-2600(21)00511-7
- H CC, Rostron B, Cosgrove C, et al. Association of cigarette, cigar, and pipe use with mortality risk in the US population. *JAMA Intern Med*. 2018;178(4):469–476. doi:10.1001/jamainternmed.2017.8625
- Zhang J, Lin XF, Bai CX. Comparison of clinical features between non-smokers with COPD and smokers with COPD: a retrospective observational study. *Int J Chron Obstruct Pulmon Dis*. 2014;9(1):57–63. doi:10.2147/COPD.S52416
- Zhao L, Dan X, Chen W. Smoking cessation is the most effective measure for the prevention and treatment of chronic obstructive pulmonary disease. *Chin J Tubercul Respirat Dis*. 2017;40(12):894–897. doi:10.3760/cma.j.issn.1001-0939.2017.12.005
- Woodruff PG, G BR, Bleecker E, et al. Clinical significance of symptoms in smokers with preserved pulmonary function. *N Engl J Med*. 2016;374:1811–1821. doi:10.1056/NEJMoa1505971
- Stratelis G, Molstad S, Jakobsson P, et al. The impact of repeated spirometry and smoking cessation advice on smokers with mild COPD. *Scand J Prim Health*. 2006;24(3):133–139. doi:10.1080/02813430600819751
- Jing F, Shu C, Ning W, et al. Smoking cessation status of patients aged 40 and over with chronic obstructive pulmonary disease in China from 2014 to 2015. *Chin J Epidemiol*. 2020;41(7):1021–1027. doi:10.3760/cma.j.cn112338-20200124-00057
- Dan S, Jinrong Z. Study on the effect of health education on smoking cessation behavior in patients with chronic obstructive pulmonary disease. *Chinese Journal of Drug Abuse Prevention and Treatment*. 2021;27(3):298–301.
- Y ZY, T TW, Zhang H, et al. Barriers and facilitators for smoking cessation in Chinese smokers with chronic obstructive pulmonary disease: a qualitative study. *Int J Chronic Obstr*. 2022;17:1107–1120. doi:10.2147/COPD.S356935
- Cavusoglu F, Beser A, Kılinc O. The obstacles encountered by COPD patients about quitting smoking. *Progress in Health Sciences*. 2019;1:28–35. doi:10.5604/01.3001.0013.3692
- Schiller JS, Ni H. Cigarette smoking and smoking cessation among persons with chronic obstructive pulmonary disease. *Am J Health Promot*. 2006;20(5):319–323. doi:10.4278/0890-1171-20.5.319
- Zheng T, Yimiao L, Xinyi L, et al. Qualitative study on facilitating and hindering factors of smoking cessation in patients with chronic obstructive pulmonary disease. *Chinese Journal of Practical Nursing*. 2024;40(26):2034–2040.
- Muneeb Hassan M, Ameerq M, Jamal F, et al. Prevalence of covid-19 among patients with chronic obstructive pulmonary disease and tuberculosis. *Annals of Medicine*. 2023;55(1):285–291. doi:10.1080/07853890.2022.2160491
- M HM, H TM, Ameerq M, et al. Risk factors identification of COVID-19 patients with chronic obstructive pulmonary disease: a retrospective study in Punjab-Pakistan. *Immunity, Inflammation and Disease*. 2023;11(8):e981. doi:10.1002/iid3.981
- Jiahui M. *Current Status of Tobacco Relapse and Analysis of Its Influencing Factors in Male Patients with Coronary Heart Disease One year After PCI*. North China University of Science and Technology; 2020; doi:10.27108/d.cnki.gghlu.2020.000896
- Yang MJ, Sutton SK, Hernandez LM, et al. A just-in-time adaptive intervention (JITAI) for smoking cessation: feasibility and acceptability findings. *Addict Behav*. 2023;136:107467. doi:10.1016/j.addbeh.2022.107467
- Shiffman S, Shumaker SA, Abrams DB, et al. Models of smoking relapse. *Health Psychol*. 1986;5:13–27. doi:10.1037/0278-6133.5.Suppl.13
- Sun X, Zheng Z, Liang J, et al. Development and validation of a simple clinical nomogram for predicting obstructive sleep apnea. *Journal of Sleep Research*. 2022;31(5):e13546. doi:10.1111/jsr.13546
- Liu P, Cai G, Gu H, et al. Diagnostic nomogram to differentiate between epididymal tuberculosis and bacterial epididymitis. *Infection*. 2023;51(2):447–454. doi:10.1007/s15010-022-01916-6
- Lili S, Qingqing Z, Jieying W, et al. Application effect of smoking cessation intervention based on timing theory in patients with chronic obstructive pulmonary disease. *Contemporary Nurse*. 2022;29(10):24–27. doi:10.19792/j.cnki.1006-6411.2022.29.007
- Shaofei W. *Study on the Impact of Smoking Cessation on Clinical Symptoms and Lung Function in Patients with Chronic Obstructive Pulmonary Disease*. Chengde Medical University; 2013.
- Yingying Z. *Evidence-Based Evaluation of Acupoint Special Therapy for Smoking Cessation and Interview Study on Influencing Factors of Smoking Cessation in COPD Patients*. Beijing University of Chinese Medicine; 2022; doi:10.26973/d.cnki.gbjzu.2022.000890
- Uikey MS, Dayal P. Association between comorbid psychiatric disorders and persistent smoking after a diagnosis of chronic obstructive pulmonary disease among patients seeking treatment at a tertiary care hospital in India. *Cureus*. 2023;15(4).
- Pant S, J YH, Cho S, et al. Development of a deep learning model to predict smoking status in patients with chronic obstructive pulmonary disease: a secondary analysis of cross-sectional national survey. *Digital Health*. 2025;11:20552076251333660. doi:10.1177/20552076251333660
- Meikun H, Xiaojun L, Zongfu M. Influencing factors of health-related behaviors. *Chin J Epidemiol*. 2019;40(3):366–370. doi:10.3760/cma.j.issn.0254-6450.2019.03.021
- Guiling X, Qing W, Min Z, et al. Current status of physical activity and analysis of influencing factors in stroke survivors. *Journal of Practical Clinical Medicine*. 2024;28(13):115–120+125.
- Xuehui Z. *Study on Influencing Factors of Female Breast Cancer Screening Behavior Based on Health Ecology Model*. Jilin University; 2021; doi:10.27162/d.cnki.gjlin.2021.006094
- Liu J, Yang Y, Zhou J, et al. Prevalence and associated factors of compliance behaviors among middle-aged and older hypertensive patients in China: results from the China health and retirement longitudinal study. *Int J Environ Res Public Health*. 2020;17(19):7341. doi:10.3390/ijerph17197341
- Tao F, Qian C, Lulu J, et al. Explanation of influencing factors of chronic diseases in elderly people based on health ecology model. *Chinese General Practice*. 2012;15(1):33–36+40.
- Tingting Q. *Analysis of Tobacco Use Status and Influencing Factors in Tobacco-Related Cancer Patients in Shandong Province[D]*. Shandong University; 2021; doi:10.27272/d.cnki.gshdu.2021.000824

33. WHO. *Guidelines for Controlling and Monitoring the Tobacco Epidemic*. World Health Organization; 1998.
34. Tong H, Tian Z, He J, et al. A scoping review of factors influencing smoking cessation in patients with chronic obstructive pulmonary disease. *COPD*. 2024;21(1):2390988.4.
35. Shenglian L, Liying Z, Wang L. Study on effect evaluation and countermeasures of China's targeted aspiration-building education policy: based on the test of DID and DDD models. *Forum on Contemporary Education*. 2023;5:44–54.
36. Ying Z, Wenhui T, Lili H, et al. Preliminary analysis of smoking and smoking cessation status in patients with chronic obstructive pulmonary disease. *Journal of Capital Medical University*. 2016;37(5):579–582.
37. Hanqiao M, Han L, Qianying J, et al. Study on psychological traits of community smokers and their influence on the degree of nicotine dependence. *Chinese General Practice*. 2020;23(15):1889–1894.
38. Tritter A, Fitzgeorge L, Prapavessis H. The effect of acute exercise on cigarette cravings while using a nico-tine lozenge. *Psychopharmacology*. 2015;32(14):2531–2539. doi:10.1007/s00213-015-3887-0
39. Leung DY, Chan SS, Lau CP, et al. An evaluation of the psychometric properties of the smoking self-efficacy questionnaire (SEQ-12) among Chinese cardiac patients who smoke. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*. 2008;10(8):1311–1318. doi:10.1080/14622200802238928
40. Xiuyue Z, Ruping L. Study on sustained smoking cessation behavior and self-efficacy in cases from smoking cessation clinic. *Taiwan Journal of Medicine*. 2009;13(3):223–230.
41. Junaid K, Akram I, Daood M, et al. Validity of the patient health questionnaires (phq-2 and phq-9) for screening depression among human immunodeficiency virus patients in Lahore, Pakistan. *World Journal of Virology*. 2022;11(05):341–351. doi:10.5501/wjv.v11.i5.341
42. Hao L, Xueping H, Xiaoyan Z, et al. Study on characteristics and relationships between perceived stress and coping styles in adolescent patients with depression complicated with non-suicidal self-injury behavior. *Chinese J Mod Drug App*. 2023;17(9):45–49.
43. Hong Y. *Study on Cross-Cultural Adaptation and Application of the Death Anxiety Scale*. Beijing University of Chinese Medicine; 2011.
44. Haide C, Xinwei L, Ningmeng C, et al. Prediction of nicotine dependence on perceived control over smoking cessation behavior in male smokers: the role of social support and complaint-criticism. *Psychol Sci*. 2019;42(6):1499–1504.
45. Wang L, Chen L, Ni H, et al. Development of an acute kidney injury risk prediction model for patients undergoing extracorporeal membrane oxygenation. *Heliyon*. 2022;8(12):e12585. doi:10.1016/j.heliyon.2022.e12585
46. Yang Z, Shengyun W, Yujiao J. Study on smoking cessation rate at different time points of smoking cessation intervention and its influencing factors in patients with COPD. *Journal of Medical Theory and Practice*. 2023;36(5):871–873.
47. Danyan L, Hong L, Yaojie L, et al. Study on nicotine dependence and its influencing factors among adult smokers in nanning. *Chinese Journal of Disease Control & Prevention*. 2016;20(5):447–451.
48. Cong L, Wei C, Yuqin Z, et al. Clinical characteristics of quitters and current smokers with chronic obstructive pulmonary disease. *Journal of Clinical Research*. 2022;39(6):808–811.
49. S TS, W TR, P JS, et al. Determinants of smoking cessation in patients with COPD treated in the outpatient setting. *Chest*. 2016;150(3):554–562. doi:10.1016/j.chest.2016.05.020
50. Adibi A, D SD, Safari A, et al. The acute COPD exacerbation prediction tool (ACCEPT): a modelling study. *Lancet Respir Med*. 2020;8(10):1013–1021. doi:10.1016/S2213-2600(19)30397-2
51. Shuhui F, Wenjing Z, Xin W, et al. Changes in lung function in smokers without respiratory symptoms and analysis of its impact on smoking cessation. *Practical Preventive Medicine*. 2014;21(7):888–890.
52. Ying H, Xiaoli W. Impact of incentive smoking cessation intervention on smoking cessation success rate and lung function in patients with chronic obstructive pulmonary disease. *Nursing of Integrated Traditional Chinese and Western Medicine*. 2022;8(2):136–138.
53. Schofield I, Kerr S, Tolson D. An exploration of the smoking-related health beliefs of older people with chronic obstructive pulmonary disease. *J Clin Nurs*. 2007;16(9):1726–1735. doi:10.1111/j.1365-2702.2007.01701.x
54. Jonsdottir R, Jonsdottir H. The experience of women with advanced chronic obstructive pulmonary disease of repeatedly relapsing to smoking. *Scand J Caring Sci*. 2007;21(3):297–304. doi:10.1111/j.1471-6712.2007.00472.x
55. S WJ, S EJ, Fitzsimons D. 'It's not worth stopping now': why do smokers with chronic obstructive pulmonary disease continue to smoke? A qualitative study. *J Clin Nurs*. 2011;20(5–6):819–827. doi:10.1111/j.1365-2702.2010.03319.x
56. Mingxin C, Purui Y, Aimin G. Analysis of influencing factors of nicotine dependence in smoking patients with chronic obstructive pulmonary disease. *Preventive Med*. 2024;36(7):575–579.
57. H VJ, Sivapalan P, Sørensen R, et al. Depressive symptoms among patients with COPD according to smoking status: a Danish nationwide case-control study of 21 184 patients. *ERJ Open Research*. 2020;6(4):00036–2020. doi:10.1183/23120541.00036-2020
58. Siraj RA. COPD and comorbid mental health: addressing anxiety, and depression, and their clinical management. *Medicina*. 2025;61(8):1426. doi:10.3390/medicina61081426
59. Qiu YF, Hu JS, Wu M, et al. The effects of tele-based interventions for depression and anxiety symptoms in patients with chronic obstructive pulmonary disease (COPD): a systematic review and meta-analysis. *General Hospital Psychiatry*. 2024;91:143–150. doi:10.1016/j.genhosppsych.2024.10.014
60. Septiana NZ, Isrofin B, Nawantara RD. Enhancing mental health outcomes in COPD patients: the global potential of telehealth interventions for anxiety and depression management. *General Hospital Psychiatry*. 2025;94:24–25. doi:10.1016/j.genhosppsych.2025.02.003
61. Van Eerd EAM, Risør MB, Van Rossem CR, et al. Experiences of tobacco smoking and quitting in smokers with and without chronic obstructive pulmonary disease—a qualitative analysis. *BMC Family Practice*. 2015;16:1–8. doi:10.1186/s12875-015-0382-y
62. Vuong K, Hermiz O, Razee H, et al. The experiences of smoking cessation among patients with chronic obstructive pulmonary disease in Australian general practice: a qualitative descriptive study. *Family Practice*. 2016;33(6):715–720. doi:10.1093/fampra/cmw083
63. Arndt J, R CC, L GJ, et al. Blowing in the (social) wind: implications of extrinsic esteem contingencies for terror management and health. *Journal of Personality and Social Psychology*. 2009;96(6):1191. doi:10.1037/a0015182
64. Sang H, Zhang L, Chunlin H, et al. Application effect of intervention program based on health belief model and theory of planned behavior in patients with coronary heart disease. *Chinese Journal of Physicians*. 2024;26(3):432–436.
65. Eklund BM, Nilsson S, Hedman L, et al. Why do smokers diagnosed with COPD not quit smoking?—a qualitative study. *Tob Induc Dis*. 2012;10(1):1–7. doi:10.1186/1617-9625-10-17

66. Daniel JA, Kim-Mozeleski JE, Poudel KC, Sun A, Burke NJ, Tsoh JY. Family support and readiness to consider smoking cessation among Chinese and vietnamese American male smokers. *J Smok Cessat.* 2021;2021:6678219. doi:10.1155/2021/6678219
67. S NC, A LI, Davis M, et al. Experiences using family or peer support for smoking cessation and considerations for support interventions: a qualitative study in persons with mental health conditions. *Journal of Dual Diagnosis.* 2023;19(1):40–48. doi:10.1080/15504263.2022.2159732

International Journal of Chronic Obstructive Pulmonary Disease

Dovepress
Taylor & Francis Group

Publish your work in this journal

The International Journal of COPD is an international, peer-reviewed journal of therapeutics and pharmacology focusing on concise rapid reporting of clinical studies and reviews in COPD. Special focus is given to the pathophysiological processes underlying the disease, intervention programs, patient focused education, and self management protocols. This journal is indexed on PubMed Central, MedLine and CAS. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/international-journal-of-chronic-obstructive-pulmonary-disease-journal>