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ORIGINAL RESEARCH

A Longitudinal Study of Trajectories and Factors Influencing Patient-Reported Outcomes in Chronic Obstructive Pulmonary Disease

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Purpose: To explore the trajectory of patient-reported outcomes and the factors influencing them in patients with COPD.

Patients and Methods: The study population, 236 patients with stable COPD who attended the outpatient clinic of the Department of Respiratory and Critical Care Medicine in a tertiary care hospital in Nanning City between October 2020 and November 2021, answered the modified patient-reported outcome scale for COPD (mCOPD-PRO). Patient-reported outcomes were investigated at the time of the patient's outpatient visit (T1), 1 month after the visit (T2), 3 months after the visit (T3), and 6 months after the visit (T4). Latent class growth modeling was used to determine the number and shape of trajectories, and multinomial logistic regression analysis were used to explore influence factors of each class.

Results: COPD patients' reported outcome trajectories were classified into 3 categories: health low-level group (14.80%), health risk group (54.70%), and good health group (30.50%). Logistic regression analysis showed that gender, BMI, smoking history, number of comorbidities, whether it was their first visit, and lung function classification were influential factors in patients' reported outcome trajectories ($P<0.05$). Female, obese, had a history of smoking, number of comorbid diseases >3, first diagnosis, and lung function class IV had a higher probability of entering the healthy low-level group.

Conclusion: COPD patients have poor self-reported health levels during the first 6 months after the outpatient visit, and there is group heterogeneity in patient-reported outcome trajectories; medical staff should give patients specific nursing interventions based on their current development of COPD, self-reported changes, and other relevant influencing factors.

Keywords: chronic obstructive pulmonary disease, patient-reported outcomes, trajectory, latent class growth model

Introduction

Chronic obstructive pulmonary disease (COPD) is a systemic inflammatory disease characterized by persistent airflow limitation.[1] A systematic evaluation of the global burden of disease[2] shows that COPD has become the third leading cause of death among people with non-communicable diseases worldwide, and it is expected that by 2030, 4.5 million people will die each year from COPD and related complications.[3] According to WHO, the number of people with COPD reached 251 million worldwide in 2016, causing 3 million deaths, accounting for 5.3% of the annual deaths, and is expected to reach 6.7% in 2060. The number of COPD cases in China has reached 100 million, making it a major burden for the population.[4] Studies have shown that as many as two-thirds of patients with stable COPD have an acute exacerbation that is not detected in time, thus affecting the prognosis and quality of life for patients.[5] Therefore, it is essential to identify patients' disease progression in a timely manner using simple and comprehensive assessment methods. Research studies have shown that a focus on patient-reported outcomes is beneficial to understanding the full range of patient conditions, and that patient self-assessment, reporting of health-related outcomes, and early intervention are becoming priorities in the standardized treatment of COPD.[6] This has been included in the Global

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Initiative for Chronic Obstructive Lung Disease (GOLD) as it is one of the hotspots of interest for researchers in recent years.[7]

Patient-reported outcomes (PROs) are information related to a patient's health status that comes directly from the patient, without interpretation by a physician or other person.[8] First used in drug development, PROs have come to play an important role in medical quality control and clinical evaluation.[9] Most studies related to patient-reported outcomes are cross-sectional surveys, and the course of patient-reported outcomes over time is unclear. Chronic disease trajectory model[10] has pointed out that specific interventions should be implemented when targeting different stages of COPD. As COPD is characterized by a variety of clinical symptoms, long-term dynamic tracking of patients can help to understand the characteristics and predictors of disease development and provide new ideas for targeted interventions. However, there are a few reports of health trajectories based on patients' subjective experiences.[7] In this study, we applied the latent class growth model (LCGM) to analyze the trajectory of COPD patients' reported outcomes based on the chronic disease trajectory model.[10] Through this, we aimed to understand the dynamic changes of COPD patients' reported outcomes, to identify different subgroups, and to explore the influencing factors of different trajectories. These findings provide medical staff with the opportunity to provide patients with a comprehensive and specific treatment according to the trajectory of patients' reported outcomes.

Methods

Patients

Using the convenience sampling method, COPD patients attending the respiratory medicine outpatient clinic of a tertiary care hospital in Nanning were selected as the subjects. Inclusion criteria: meeting the diagnostic criteria for stable COPD in the 2020 GOLD guidelines, patients have stable or mild symptoms such as cough, sputum and shortness of breath[7]; clear consciousness and no communication impairment; age ≥40 years (People at risk for COPD)[7]; complete clinical data. Exclusion criteria: severe mental and cognitive impairment; combination of malignancy or other end-stage disease; participation in other studies. This study was conducted in accordance with the Declaration of Helsinki and received ethics approval from the Medical Ethics Committee of the First Affiliated Hospital of Guangxi Medical University (2021KY-E-221).

Instruments

General Information Questionnaire

The questionnaire was designed by the investigators themselves after a literature review and included the following two sections: (1) demographic data: gender, ethnicity, age, height, weight, BMI, education, current residence (rural, non-rural), work status (unemployed, retired, working), personal monthly income, smoking history; (2) disease-related data: number of comorbidities, first visit, acute exacerbation occurred during follow-up, length of illness, the ratio of forced expiratory volume in 1 second (FEV_1) to predicted forced expiratory volume (FEV)(FEV1% pred), the ratio of forced expiratory volume in 1 second (FEV1) to forced expiratory volume (FEV) (FEV1/FVC), and COPD stage categorization according to GOLD criteria.[11]

The Modified Patient-Reported Outcome Scale for COPD

The mCOPD-PRO developed by Li et al[12] was used to assess patients' symptoms. The most relevant information collected came from patients within the last 2 weeks and contained 3 dimensions of physical, psychological, and environmental domains. A total of 27 entries were collected. Each item was scored on a 5-point Likert scale from 0 to 4 according to the severity of symptoms, with 0 indicating "not at all" or "not felt" and 4 indicating "always there" or "very obvious", and reverse entries were scored by direction. The score for each domain = (the sum of the scores for each entry in the domain)/(number of entries in the domain); the score for the scale = (the sum of the scores for all entries in the scale)/(number of entries in the scale). The total scale score was 0–4, with higher scores indicating lower levels of health. The scale proved reliable, with Cronbach's α coefficients of 0.954, 0.930, 0.929, and 0.673 for the total scale and the 3 dimensions, respectively, and content validity ranging from 0.429 to 0.902.

Data Collection

According to GOLD 2020 guidelines,[9] it is recommended that COPD patients should be followed up at 1–4 weeks and 12–16 weeks after their the visit, with a minimum follow-up pathway of 6 months.[13,14] In this study, patients were followed up with at 1 month, 3 months, and 6 months after their first outpatient visits to report health levels. Investigators were uniformly trained and qualified. The investigators explained in detail the purpose and content of the survey to the enrolled patients through a semi-structured interview and began the survey and follow-up after the patients signed their informed consents. The investigators recorded the patients' pulmonary function results on the day of the clinic visit, and after the questionnaires were completed, the investigators checked each item. If there were any omissions, they communicated with the patients and assisted them to complete them on the spot. Studies have revealed that PROs can be used for telephone research and the results have shown consistency with face-to-face evaluation.[15] The follow-up phase was completed by investigators using a dedicated follow-up telephone or WeChat follow-up in the respiratory medicine outpatient clinic. The investigators maintained active contact with the patient or family, and the follow-up time slots were selected from 8:30am to 10:30am and 16:00pm to 17:30pm, with a more appropriate follow-up time arranged according to the actual situation of the patient. The questionnaire completion time was controlled at 10 to 15 minutes. If necessary, we discussed with the patients and adjusted the follow-up time flexibly.

Statistical Analysis

IBMSPSS 26.0 and Mplus 8.4 software were used for data analysis, and the count data were expressed as cases and percentages and analyzed by chi-square test; the measurement data were expressed as mean ± standard deviation and analyzed by Pearson correlation. The latent class growth model was used to determine the trajectory categories and characteristics. The baseline model was a 1-category model, and the number of categories in the model was increased one by one to compare the fit indices among the models.[16] The analysis used Akaike information criterion (AIC), Bayesian information criterion (BIC), adjusted BIC, entropy, the Vong–Lo–Mendell–Rubin likelihood ratio test (VLMR) and the Bootstrap likelihood ratio test (BLRT). The parameter estimation method used in this study is robust maximum likelihood estimator (RMLE), which accounts for missing values in the follow-up data; ie, missing values are assumed to be randomly missing and do not affect the results. Differences were indicated as statistically significant at $P < 0.05$.

Results

General Information of Patients with Stable COPD

A total of 250 patients were investigated in this study, where 244, 239 and 236 patients completed the follow-up at 1, 3 and 6 months after the visit, respectively, with an overall loss to follow-up rate of 5.6%. The specific reasons for loss of follow-up were loss of contact in 3 cases with modified phone numbers, non-cooperation in 3 cases, such as transfer of family members to answer the phone, difficulties in questionnaire collection, and withdrawal from the study in 8 cases with diagnosis of lung malignancy.

Of the total 236 patients who completed 6 months of follow-up who were aged (64.69±9.23) years, 197 (83.5%) were male and 39 (16.5%) were female. Within the 236 patients, BMI was (22.40±4.17) kg/m^2. FEV_1% pred was [56.60 (41.18, 65.35)], and FEV_1/FVC was (52.62±13.39). The number of patients' comorbid diseases ranged from 0 to 11, of which 75 (31.8%) had no comorbid diseases, 76 had 1, 46 had 2, and 39 had ≥3. Other general data are shown in Table 1.

Model Fitting and Selection of Patient-Reported Outcome Trajectories

Using patient-reported outcome scores at different time periods as observations, 236 eligible study subjects were included in the model analysis, and, using LCGM set to free estimation of temporal parameters, 1 to 6 categories were extracted sequentially. AIC, BIC, and aBIC values decreased as the number of categories increased, and when the number of extracted latent categories increased from 1 to 3, AIC, BIC, and aBIC all followed LRT, and BLRT reached a significant level ($P<0.05$). When the number of categories was increased from 3 to 4, AIC, BIC, and aBIC values decreased and entropy increased, but LMR did not reach a significant level ($P>0.05$), suggesting that increasing the number of categories is not supported. Combining the above information with the theoretical background of COPD and the interpretability of the results, three categories were selected as the final model, as shown in Table 2.

Table 1 General Information of Patients with Stable COPD

Trait	Category	Number of Subjects	Composition Ratio (%)
Gender	Male	197	83.5
	Female	39	16.5
Age (years)	40~	74	31.4
	60~	99	41.9
	>70	63	26.7
BMI (kg/m^2)	<18.5	30	12.7
	18.5~23.9	115	48.7
	24~27.9	64	27.1
	≥28	27	11.4
Education level	Elementary school and below	91	38.6
	Junior high school	76	32.2
	High school/junior high school	43	18.2
	College and above	26	11.0
Place of residence	Rural	82	34.7
	Non-rural	154	65.3
Working status	Unemployed	102	43.2
	Retirement	100	42.4
	On-the-job	34	14.4
Personal monthly income (¥)	<1000	21	8.9
	1000–3000	156	66.1
	>3000	59	25.0
Smoking history	Yes	185	78.4
	No	51	21.6
Combined diseases	≤3	197	83.5
Number (species)	>3	39	16.5
First visit or not	Yes	29	12.3
	No	207	87.7
Acute exacerbation	Yes	29	12.3
During follow-up	No	207	87.7
Duration of disease	<3	96	40.7
(years)	3–10	73	30.9
	>10	67	28.4
Pulmonary function classification (grade)	I	43	18.2
	II	102	43.2
	III	57	24.2
	IV	34	14.4

Table 2 Fitting Results

Number of Classes	AIC	BIC	saBIC	Entropy	LMR	BLRT
1	1352.577	1376.824	1354.636	-	-	-
2	947.560	982.199	950.503	0.826	0.018	<0.001
3	664.005	709.035	667.830	0.914	0.006	<0.001
4	530.595	586.017	535.303	0.916	0.076	<0.001
5	467.291	533.104	472.882	0.899	0.414	<0.001
6	406.269	482.473	412.742	0.891	0.090	<0.001

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; saBIC, sample size adjusted BIC; LMR, Lo–Mendell likelihood ratio test; BLRT, bootstrap likelihood ratio test.

Table 3 Intercept and Slope of Each Class

Classes	Intercept	*P*	Slope	*P*
Class 1 (health low-level group)	2.417	<0.001	−0.075	<0.001
Class 2 (health risk group)	1.872	<0.001	−0.135	<0.001
Class 3 (good health group)	1.175	<0.001	−0.077	<0.001

Applying the 3 LCGM model of categories and combining the characteristics of the trajectory of change in COPD patient-reported outcomes, COPD patient-reported outcomes were divided into 3 subgroups. The results showed that category group 1 had a higher mCOPD-PRO score at the outpatient visit (intercept = 2.417) with an overall decreasing trend (slope = −0.075, $P < 0.001$), indicating that the patient-reported outcomes were maintained at a low level. Therefore, category group 1 was named the "health low-level group". The mCOPD-PRO score at the outpatient visit was lower than that of category 1 (intercept = 1.872), with an overall decreasing trend (slope = −0.135, P < 0.001), but the mCOPD-PRO score was still high, so category 2 was named the "health risk group". Category group 3 had the lowest starting value (intercept = 1.175, $P < 0.001$), and the mCOPD-PRO score was generally decreasing (slope = −0.077, $P < 0.001$). The score was maintained at a low level, indicating that the patient-reported outcomes were maintained at a high level. Therefore, category group 3 was named the "good health group". The scores of patient-reported outcomes for different periods in each group are shown in Table 1, including 35 cases (14.80%) in the "health low-level group", 129 cases (54.70%) in the "health risk level group", and 72 cases (30.0%) in the "good health group". The potential categories of the trajectory of the change in the reported outcomes of the three groups are shown in Table 3 and Figure 1.

Single-Factor Analysis of Factors Influencing the Type of Trajectory of Patients' Reported Outcomes

The results showed that the three trajectory categories of gender, BMI, residence, work status, smoking history, number of comorbid diseases, whether first visit, acute exacerbation at follow-up, and pulmonary function class were statistically significant ($P<0.05$) when comparing patient-reported outcome scores, as shown in Table 4.

Logistic Regression Analysis of Factors Influencing the Type of Trajectory of Patients' Reported Outcomes

The variables with statistical significance in the univariate analysis were used as independent variables, and the three groups of trajectory categories were used as dependent variables for the unordered multicategorical logistic regression analysis. The trajectory categories were analyzed with the good health group and the health risk group as the reference group, respectively. The last category was used as the reference category for each independent variable, and the assignments are shown in Table 4. The results showed that the models fit well (χ^2 =81.157,

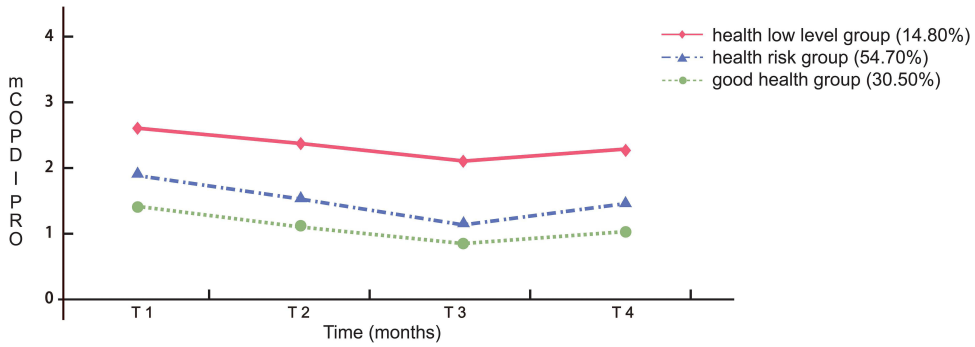

Figure 1 Potential categories of patient-reported outcomes trajectory.

Table 4 One-Way Analysis of Patient-Reported Outcome Trajectories

Projects	Category	Healthy Low-Level Group	Health Risk Group	Good Health Group	χ^2	*P*
Gender	Male	25 (17.8)	106 (82.2)	66 (91.7)	7.344	0.025
	Female	10 (28.6)	23 (17.8)	6 (8.3)		
Age (years)	40~	10 (28.6)	42 (32.6)	22 (30.6)	0.699	0.951
	60~	14 (40.0)	53 (41.1)	32 (44.4)		
	>70	11 (31.4)	34 (26.4)	18 (25.0)		
BMI (kg/m^2)	<18.5	7 (20.0)	16 (12.4)	7 (9.7)	15.006	0.018*
	18.5~23.9	11 (31.4)	63 (48.8)	11 (56.9)		
	24~27.9	8 (22.9)	41 (31.8)	8 (20.8)		
	≥28	9 (25.7)	9 (7.0)	9 (12.5)		
Education level	Elementary school and below	11 (31.4)	45 (34.9)	35 (48.6)	5.867	0.437*
	Junior high school	12 (34.3)	44 (34.1)	30 (27.8)		
	High school/junior high school	6 (17.1)	25 (19.4)	12 (16.7)		
	College and above	6 (17.1)	15 (11.6)	5 (6.9)		
Place of residence Working status	Rural	16 (45.7)	49 (38.0)	17 (23.6)	6.391	0.041
	Non-rural	19 (54.3)	80 (62.0)	55 (76.4)		
	Unemployed	18 (51.4)	63 (51.4)	21 (29.2)	10.876	0.028
	Retirement	10 (28.6)	52 (40.3)	38 (52.8)		
	On-the-job	7 (20.0)	14 (10.9)	13 (18.1)		
Personal monthly income (¥)	<1000	6 (17.1)	10 (28.6)	5 (6.9)	6.508	0.158*
	1000–3000	22 (62.9)	91 (70.5)	43 (59.7)		
	>3000	7 (20.0)	28 (21.7)	24 (33.3)		
Smoking history	Yes	29 (82.9)	109 (84.5)	47 (65.3)	10.559	0.005
	No	6 (17.1)	20 (15.5)	25 (36.7)		
Combined diseases	≤3	25 (71.4)	105 (81.4)	67 (93.1)	8.877	0.012
Number (species)	>3	10 (28.6)	24 (18.6)	5 (6.9)		
First visit or not	Yes	15 (42.9)	28 (21.7)	17 (23.6)	6.676	0.036
	No	20 (57.1)	101 (78.3)	55 (76.4)		
Urgent at the time of	Yes	9 (25.7)	14 (10.9)	6 (8.3)	6.243	0.043*
The follow-up visit	No	26 (74.3)	115 (89.1)	66 (91.7)		
Sexual aggravation						
Duration of disease (years)	<3	11 (31.4)	54 (41.9)	31 (43.1)	3.438	0.491
	3–10	14 (40.0)	35 (27.1)	24 (33.3)		
	>10	10 (28.6)	40 (31.0)	17 (23.6)		
Pulmonary function classification (level)	I	6 (17.1)	18 (14.0)	19 (26.4)	17.915	0.006
	II	8 (22.9)	59 (45.7)	35 (48.6)		
	III	12 (34.3)	36 (27.9)	9 (12.5)		
	IV	9 (25.7)	16 (12.4)	9 (12.5)		

Note: *Indicates Fisher's exact probability method.

P<0.001). The influencing factors for the health low-level group relative to the good health group were gender, BMI, number of comorbidities, whether first visit, and lung function classification ($P < 0.05$); for the health risk group, the influencing factor was smoking history ($P < 0.05$). Relative to the health risk group, the influencing factors for the health low-level group were BMI, whether first visit, and pulmonary function classification ($P < 0.05$), as shown in Table 5.

Table 5 Logistic Regression Analysis of Patient Reported Outcome Trajectories

Variables	*B*	*SE*	Wald χ^2	*P*	*OR* (95% *CI*)
C1 versus C3					
Gender (ref = female)	−1.833	0.685	7.157	0.007	0.160 (0.042–0.613)
BMI (ref = ≥28 kg/m^2)	-	-	-	-	-
<18.5	−0.186	0.853	0.047	0.828	0.830 (0.156–4.421)
18.5–23.9	−1.646	0.699	5.547	0.019	0.193 (0.049–0.759)
24–27.9	−0.733	0.769	0.909	0.340	0.480 (0.106–2.168)
Place of residence (ref = rural)	−0.269	0.549	0.240	0.624	0.764 (0.261–2.241)
Work status (ref = active)	-	-	-	-	-
Unemployed	0.208	0.703	0.087	0.767	1.231 (0.310–4.881)
Retirement	−1.047	0.705	2.205	0.138	0.351 (0.088–1.398)
Smoking history (ref = no)	0.644	0.605	1.133	0.287	1.903 (0.582–6.225)
Number of comorbid diseases (ref = >3)	−1.577	0.710	4.941	0.026	0.207 (0.051–0.830)
Whether first visit (ref = no)	1.333	0.561	5.643	0.018	3.792 (1.263–11.391)
Acute exacerbation at follow-up (ref = no)	1.162	0.715	2.640	0.104	3.198 (0.787–12.993)
Pulmonary function classification (ref = grade IV)	-	-	-	-	-
I	−1.745	0.819	4.540	0.033	0.175 (0.035–0.869)
II	−1.734	0.711	5.945	0.015	0.177 (0.044–0.712)
III	0.149	0.740	0.040	0.841	1.160 (0.272–4.946)
C2 versus C3					
Gender (ref = female)	−0.940	0.559	2.829	0.093	0.390 (0.131–1.168)
BMI (ref = ≥28 kg/m^2)	-	-	-	-	-
<18.5	0.652	0.712	0.839	0.360	1.920 (0.475–7.754)
18.5–23.9	0.204	0.568	0.129	0.719	1.227 (0.403–3.737)
24–27.9	0.960	0.617	2.419	0.120	2.612 (0.779–8.760)
Place of residence (ref = rural)	−0.492	0.374	1.737	0.188	0.611 (0.294–1.271)
Work status (ref = active)	-	-	-	-	-
Unemployed	0.908	0.508	3.198	0.074	2.479 (0.917–6.706)
Retirement	0.051	0.483	0.011	0.915	1.053 (0.408–2.714)
Smoking history (ref = no)	1.055	0.394	7.156	0.007	2.872 (1.326–6.222)
Number of comorbid diseases (re = >3)	−0.784	0.560	1.959	0.162	0.456 (0.152–6.222)
Whether first visit (ref = no)	0.073	0.403	0.033	0.856	1.076 (0.488–2.371)
Follow-up acute exacerbation (ref = no)	0.228	0.565	0.164	0.686	1.257 (0.415–3.801)
Pulmonary function classification (ref = grade IV)	-	-	-	-	-
Grade I	−0.736	0.604	1.482	0.223	0.479 (0.147–1.566)
Class II	−0.208	0.505	0.170	0.680	0.812 (0.302–2.185)
Grade III	0.616	0.597	1.064	0.302	1.851 (0.575–5.964)
Comparison of C1 and C2					
Gender (ref = female)	−0.892	0.526	2.883	0.090	0.410 (0.146–1.148)
BMI (ref = ≥28 kg/m^2)					
<18.5	−0.838	0.728	1.327	0.249	0.433 (0.104–1.800)
18.5–23.9	−1.850	0.634	8.522	0.004	0.157 (0.045–0.544)
24–27.9	−1.694	0.687	6.085	0.014	0.184 (0.048–0.706)
Place of residence (ref = rural)	0.223	0.481	0.216	0.642	1.250 (0.487–3.208)
Work status (ref = active)	-	-	-	-	-
Unemployed	−0.700	0.641	1.191	0.275	0.497 (0.141–1.746)
Retirement	−1.098	0.666	2.718	0.099	0.333 (0.090–1.230)
Smoking history (ref = no)	−0.411	0.580	0.504	0.478	0.663 (0.213–2.064)
Number of comorbid diseases (ref = >3)	−0.793	0.531	2.232	0.135	0.453 (0.160–1.281)
Whether first visit (ref = no)	1.260	0.493	6.520	0.011	3.524 (1.340–9.269)
Follow-up acute exacerbation (ref = no)	0.934	0.588	2.525	0.112	2.544 (0.804–8.052)
Pulmonary function classification (ref = grade IV)	-	-	-	-	-
I	−1.009	0.738	1.871	0.171	0.365 (0.086–1.548)
II	−1.526	0.634	5.789	0.016	0.217 (0.063–0.754)
III	−0.467	0.607	0.592	0.442	0.627 (0.191–2.060)

Note: C1 – low health group, C2 – health risk group, and C3 – good health group.

Discussion

Different Trajectories of Change in Patient-Reported Outcomes Exist in Patients with Stable COPD

Researches have pointed out that patients' health trajectories are individually heterogeneous.[17] Patients with COPD are subject to social and environmental factors after consultation and have varying degrees of disease control, resulting in large differences in their health levels.[18] Some studies have explored the potential health trajectories of patients based on quality-of-life indicators.[19,20] However, there are fewer studies based on patient-centered trajectories of patient-reported outcomes. In this study, the LCGM model was used to identify three groups of potential categories of trajectories of reported outcomes in stable COPD patients, namely, "health low-level group", "health risk group", and "good health group". The groups indicated differences in self-reported changes in health levels within 6 months of the patients' outpatient visits.

The results of this study showed that the lowest percentage of patients in the "health low-level group" (14.80%) may be related to the inclusion of stable COPD patients in this study. This group did not show significant changes in reported outcomes, and the mCOPD-PRO score remained at the highest level compared with the other two groups. It also reported the worst outcomes. The reason for the "health low-level group" may be that patients with a low initial health status have a longer recovery period, and it is more difficult to improve their health significantly. The results of this study showed that the "health low-level group" was the worst. The results of this study also showed that the highest percentage of patients (54.70%) were in the "health risk group", indicating that more than half of the patients had high mCOPD-PRO scores and were at risk of deterioration in their health status. The reason for the emergence of the "health risk group" may be that, in the face of changes in the disease, patients are subject to physical, psychological and social burdens, and their health status is difficult to be relieved quickly, which is a certain risk.[21] The "good health group" is a group of people who are in good health. In contrast, patients in the "good health group" (30.5%) had the lowest mCOPD-PRO score and the highest self-reported health level, and the patients reported better outcomes as time progressed. The reason for the "good health group" may be that some patients with stable COPD have better physical and psychological quality, and after effective treatment, care, and self-management, their adverse symptoms are reduced and their health status is maintained at a high level.[22] The results of the present study suggest that "health" is the most important aspect of COPD, and that the "health low-level group" and "health risk group" are the priority groups for COPD disease management.

Analysis of Factors Influencing the Patient-Reported Outcome Trajectories of Patients with Stable COPD

The results of this study showed that among the demographic factors, gender, BMI, and smoking history were influential in the dynamic trajectory of reported outcomes in patients with stable COPD. Compared to female patients, male patients (OR=0.160, 95% CI =0.042–0.613, p=0.007) were less likely to be in the "health low-level group" than the "good health group", suggesting that women have lower self-reported health levels than men and have more difficulty in relieving their self-perceived health status. The results of this study are similar to those of Perez et al.[23] A study of COPD patients' reported experience of outcomes showed that women with COPD reported more symptoms.[24] The study suggests that female COPD patients are more likely to experience negative psychological distress such as anxiety and depression, leading to a lower level of acceptance of the disease, and that adverse psychological factors predispose to lower levels of self-perceived health.[25] However, the inclusion of fewer female patients in this study may have biased the findings. The current priority population for COPD prevention and treatment is still mainly older men.[26] Medical professionals should pay attention to female COPD patients, especially to their psychological status, to promote their physical and psychological recovery, and thus improve patient-reported health.

Compared to obese (BMI >28 kg/m^2) patients, patients with normal BMI (18.5<23.9 kg/m^2) (OR=0.193, 95% CI=0.049–0.759, p=0.019) were less likely to be in the "health low-level group" than the "good health group"; patients with normal BMI (18.59 kg/m^2) (OR=0.157, 95% CI=0.045–0.544, P=0.004) and overweight (24<BMI<28 kg/m^2) (OR=0.184, 95% CI=0.048–0.706, P=0.014) patients were also less likely to be in the "health low-level group" than the "health risk group", suggesting that obese patients have poorer reported outcomes than normal-weight or overweight

patients, similar to the results of the Ragland et al.[27] Studies suggested that the body mass index of COPD patients is negatively correlated with the patients' awareness of self-management,[28] and that the low exercise tolerance and poor self-management ability of obese patients may be the reason for their poor self-perceived health status. However, some studies[29] suggested that COPD patients with lower body weight have a lower level of health due to poorer immunity, and it is still unclear whether obesity is a risk factor or a protective factor for COPD patients. Further studies are still needed.

Compared to non-smokers, patients with a history of smoking (OR=2.872, 95% CI=1.326–6.122, *P*=0.007) were more likely to be in the "health low-level group" than the "good health group", similar to the conclusion of previous studies.[30] Smoking is one of the most important risk factors for COPD, leading to abnormal lung function and increased mortality.[31] Some study suggested that never-smoking COPD patients (patients who have never smoked before) are more likely to recover and have fewer acute exacerbations than current-smoking patients.[32] Therefore, investigators should conduct education on the dangers of smoking and provide targeted smoking cessation strategies, which in turn will improve patients' adverse symptoms and enhance their health.

Among the disease-related factors, the number of comorbidities, first visit, and lung function class were also influential in the dynamic trajectory of reported outcomes in patients with stable COPD. Compared to patients with >3 comorbidities, patients with ≤3 comorbidities (OR=0.207, 95% CI=0.051–0.830, *P*=0.026) were less likely to be in the "health low-level group" than that the "good health group". As the number of comorbidities increased, patients reported lower state of health, similar with the results of previous studies.[33,34] The findings may be related to the fact that multiple diseases complicate the health condition and increase the burden of treatment, leading to poor self-image of the patients. Medical professionals should pay attention to the comorbidity status of COPD patients and encourage patients to actively cope with multiple diseases to reduce the disease burden.

Compared to non-first-time patients, first-time patients (OR=3.792, 95% CI=1.263–11.391, *P*=0.018) were more likely to be in the "health low-level group" compared to the "good health group"; first-time patients (OR=3.524, 95% CI=1.340–9.269, P=0.011) were also more likely to be in the "health low-level group" compared to the "health risk group", which may be related to the low awareness of disease and poor coping skills among first-time patients. Some research study showed that most COPD patients cannot receive timely diagnosis after symptom showing, suggesting early diagnosis has become one of the difficulties in the management of COPD.[35] Investigators should adopt personalized disease education and health promotion to improve patients' disease perception and coping skills and improve their health outcomes.

Compared to COPD patients with pulmonary function in GOLD IV category, patients in GOLD I (OR=0.175, 95% CI=0.035–0.869, *P*=0.033) and GOLD II (OR=0.177, 95% CI=0.044–0.712, *P*=0.015) were less likely to be in the "good health group"; compared to the "good health group", COPD patients in Gold II (OR=0.217, 95% CI=0.063–0.754, *P*=0.016) category were also less likely to be in the "health low-level group", suggesting that COPD patients in high Gold category reflect low levels of health, in line with the results of Ragland et al.[27] Pulmonary function, as the gold standard for the assessment of COPD patients' condition, reflects the severity of their condition.[36] It has been shown by some research studies that self-monitoring of respiration can help identify illness changes in their condition early.[37] Therefore, caregivers should pay attention to patients with poor pulmonary function and encourage them to pay close attention to their own airway function, as well as review their pulmonary function regularly to improve their quality of life.

Strengths and Limitations

To the best of our knowledge, our study is one of the first to identify different COPD patients' reported outcome trajectories and associated influencing factors. Our results provide a new perspective on COPD symptom management, helping medical professionals to quickly identify COPD patients with low health levels, achieving effective interventions at an early stage, and providing development of COPD patients' reported outcomes provides theoretical support.

We acknowledged several limitations. First, the follow-up time is insufficient, this study is a monocentric study, the sample size is relatively small, the investigation time period is still short, and follow-up studies with a longer period should be conducted to comprehensively grasp the changes in patients' self-health level throughout their survival period.

Second, the data collection method of this study was not perfect: this study used telephone follow-up, fewer objective laboratory indicators were included, and patient medication information and exercise information (pulmonary rehabilitation, etc.) were not included; it is necessary to collect more data for in-depth comparative analysis in the future. Finally, the study was conducted in only one large hospital in Guangxi due to human resources, time, and other factors, which limited the sample representativeness.

In conclusion, this study plans to collect more clinical indicators, conduct a multicenter, large-sample, long-term longitudinal study, improve data collection, further validate the results of this study, and include patients with COPD in the acute exacerbation phase of hospitalization; it also plans to apply a mixed study approach to explore the trajectory of changes in COPD patient-reported outcomes in depth. We recorded participants' mMRC breathlessness, lung function index, blood pressure, oxygen saturation and body mass index, etc, and the clinical information is uploaded with this submission. However, their clinical indicators seem to have little effect on the results, so we did not put them in the tables. This is a real lack of consideration. In the future, we will explore the relationship between clinical indicators and patient's subjective experience to refine our study.

Conclusion

This study used LCGM to fit 3 trajectories of changes in reported outcomes in stable COPD patients by longitudinal tracking method to confirm the group heterogeneity of patient-reported outcomes, which provides guidance for medical staff to implement staged and individualized health interventions for COPD patients and facilitates the implementation of dynamic health assessment for the health low-level group of stable COPD patients (Female, obese, with smoking history, number of comorbid diseases >3, first visit). The study also provides guidance for the implementation of dynamic health assessment and timely nursing interventions based on the results of self-assessment to improve COPD patients' health status and promote their recovery. However, this study also has the following shortcomings: only a tertiary care hospital in Guangxi, China, was surveyed, which may have sample bias, so a multicenter joint survey can be conducted in the future; the follow-up method may cause measurement bias and exercise effect on the results, and the data collection method can be improved and validated again in the future; this study only conducted a 6-month follow-up, and the follow-up period can be extended in the future, and patients with acute exacerbations can be included to observe trajectory of change in the long-term health level of COPD patients.

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Disclosure

All authors declare no conflict of interest.

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