BMJ Open Respiratory Research

Canonical correlation analysis of factors that influence quality of life among patients with chronic obstructive pulmonary disease based on QLICD-COPD (V2.0)

Yuxi Liu ,[1] Jinghao Ruan,[1] Chonghua Wan,[1] Jianfeng Tan,[1] Bin Wu,[2] Zhihuan Zhao[3]

To cite: Liu Y, Ruan J, Wan C, *et al*. Canonical correlation analysis of factors that influence quality of life among patients with chronic obstructive pulmonary disease based on QLICD-COPD (V2.0). *BMJ Open Resp Res* 2022;**9**:e001192. doi:10.1136/bmjresp-2021-001192

YL and JR are joint first authors.

Received 28 December 2021
Accepted 28 April 2022

[1]School of Humanities and Management/Research Center for Quality of Life and Applied Psychology, Guangdong Medical University, Dongguan, Guangdong, China
[2]Affiliated Hospital of Guangdong Medical University, Zhanjiang, Guangdong, China
[3]The First Affiliated Hospital of Kunming Medical University, Kunming, Yunnan, China

Correspondence to
Chonghua Wan;
wanchh@hotmail.com

ABSTRACT

Background

The Quality of Life Instrument for Chronic Diseases (QLICD)-COPD (V2.0) was designed to assess the health condition of patients with chronic obstructive pulmonary disease (COPD). The objective of this study was to evaluate the quality of life (QOL) of patients, the influential clinical factors and the relationships between QOL and clinical objective indicators.

Methods Two hundred and sixty-one inpatients with COPD in the acute exacerbation stage were evaluated using the QLICD-COPD (V2.0) and data on clinical objective indicators were collected. The relationships between QOL and the clinical objective indicators were determined using canonical correlation analysis.

Results The standardised scores for the patients in four domains, namely, physical function, psychological function, social function and a disease-specific module, were 49.00±12.91, 59.89±13.51, 68.59±11.94 and 51.84±13.58, respectively. The total score for the QOL of patients was 57.17±10.26. Two pairs of canonical variables were statistically significant (r_1=0.35, p<0.0001; r_2=0.26, p<0.05). These variables accounted for 45.8% and 33.8% of the variance, respectively. The levels of total protein, albumin, serum sodium and alkaline phosphatase and the percentages of neutrophils and lymphocytes were correlated with the QOL, with correlation coefficients ranging from −0.435 to 0.675.

Conclusion Clinicians should pay close attention to the levels of total protein, albumin, serum sodium and alkaline phosphatase and the percentages of neutrophils and lymphocytes to improve the QOL of patients.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Chronic obstructive pulmonary disease (COPD) is one of the most prevalent health problems among the elders with long disease duration.
⇒ Clinical objective indicators such as blood gas and pulmonary function data are influential factors affect the health condition of patients with COPD.
⇒ This study is to describe an exploratory analysis on relationships between quality of life (QOL) domains and clinical objective indicators.

WHAT THIS STUDY ADDS

⇒ Among the clinical objective indicators evaluated for patients with COPD, the levels of total protein, albumin, serum sodium and alkaline phosphatase and the percentages of neutrophils and lymphocytes possibly affect the QOL in patients with COPD.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings will provide useful information to help clinicians make devise appropriate strategies to improve the QOL of patients with COPD, and also helpful information for health management health policy making.

BACKGROUND

Chronic obstructive pulmonary disease (COPD) is a chronic bronchitis and/or emphysema characterised by airflow obstruction, which can develop further into a common chronic disease, such as pulmonary heart disease or respiratory failure. COPD has become a serious public health problem because of the large number of patients, high fatality rate and heavy social and economic burden. As a chronic respiratory disease, COPD has a long disease course and a high recurrence rate. Most of the available treatments are temporary interventions, and both the cure rate and the therapeutic effects of treatment are difficult to establish. Clinical objective indicators such as blood gas and pulmonary function data are used to determine the health condition of patients with COPD.

In recent years, methods to assess the quality of life (QOL) of patients with COPD have attracted significant attention globally. Many drugs, clinical treatments and rehabilitation

techniques have been evaluated to improve the QOL of patients and many studies have been conducted to explore the factors that affect QOL.[1–3] The tools commonly used to evaluate the status of patients with COPD are the Short Form 36 (SF-36), Chronic Respiratory Questionnaire (CRQ) and St George's Respiratory Questionnaire (SGRQ). Most studies only focus on the patient's lung function and the results of blood gas analysis. In order to obtain data in line with China's national standards and a more comprehensive understanding of the objective indicators that affect QOL, the COPD measurement scale known as the Quality of Life Instrument for Chronic Diseases (QLICD)-COPD (V2.0) was used to evaluate patients in this study. Blood routine, urine routine, blood biochemistry and blood gas analyses were performed, as well as pulmonary function tests.

We aimed to investigate QOL and its clinical influencing factors in patients with COPD as well as to obtain valid evidence regarding methods to improve QOL. The patient-reported outcomes (PROs) and QOL assessments were based on the patient's subjective feelings and were measured using a scale for individual health. These two variables are manifestations of the same measurements in different stages of development. Therefore, PROs and QOL are difficult to separate and can be measured simultaneously using the PRO/QOL tool library.[4 5] The general view is that QOL can be used instead of PROs when evaluating clinical outcomes in patients.[6] In this study, these two concepts were considered to be equivalent.

METHODS

Patient and public involvement

This study was to evaluate the quality of life (QOL) of patients, the influential clinical factors and the relationships between QOL and clinical objective indicators. For the purposes of this study, 261 patients with COPD with acute exacerbation treated at the First Affiliated Hospital of Kunming Medical University, Dalang Hospital of Dongguan City, Shilong PokOi Hospital of Dongguan City and the Affiliated Hospital of Guangdong Medical University of Respiratory Medicine were selected as study participants.

The inclusion criteria were as follows: (1) patients met the COPD diagnostic criteria[7]; (2) had the ability to read and write, and had a primary school educational level or above; and (3) participated in the evaluation voluntarily. The exclusion criteria were (1) illiteracy or poor language ability; (2) inability to clearly express their feelings.

QLICD-COPD(V2.0)

Description

The QOL scale for COPD used in this study, the QLICD-COPD (V2.0), is a QOL measurement tool for patients with chronic diseases.[8] The scale consists of two modules: a generic module for QOL (QLICD-GM) and a disease-specific module for the relatively important and unique characteristics of patients. QLICD-GM consists of 9 items on physical functions (PHD), 11 items on psychological functions (PSD) and 8 items on social functions (SOD), for a total of three domains, 9 facets and 28 items. The specific module consists of four facets, namely, cough and expectoration, dyspnoea, pulmonary encephalopathy and special psychological impact. The entire scale contains four domains with 37 items and each item is separated into five levels.

Scoring

The scale consists of positive and negative items, which are scored using the five-point equidistant method. Higher scores for positive items indicate better QOL, whereas higher scores for negative items indicate poorer QOL. During the summation process, the total score for negative items is converted into a positive value. The standardised total score for each field and domain is calculated and presented as a range: standardised score=(raw score−minimum score)*100/(maximum score−minimum score).[9]

Evaluation

The scale was evaluated by Yang *et al*[10] and the results showed that the α value for the coefficient of internal consistency, the r value for the test–retest reliability and the split-half value for the scale were 0.93, 0.94 and 0.84, respectively. Most of the α and r values for each domain were above 0.6. Additionally, most of the correlation coefficients between each item and the associated domain were above 0.5. Most patients completed the questionnaire in 15–20 min. The results demonstrated that the QLICD-COPD V2.0 is a valid, reliable, sensitive and feasible tool in clinical settings, and that the tool can be used in China to assess QOL for patients with COPD.

Data collection

The investigator distributed the questionnaire to each patient and provided a brief description of the purpose and significance of the survey. The patients completed the questionnaire on the first day or on the second day of admission according to their condition. The investigator reviewed the questionnaires completed in order to ensure its integrality. If missing values were found, the questionnaire would be returned to the patients to fill in the missing item. The clinical objective indicators for the patients were also assessed with blood routine, urine routine, blood biochemistry, blood gas and pulmonary function tests. We collected 78 clinical objective indicators, such as total protein, albumin and so on.

Statistical analysis

SPSS V.13.0 and SAS V.8.0 software were used to process the data. Descriptive analysis was used to assess the overall QOL in all domains, and correlations between the clinical objective indicators and QOL scores were analysed

using simple correlation analysis. Simple correlation analysis is used to determine the correlation between a single X and Y variables without taking into account the correlation between individual variables within the X and Y sets of variables. In this study, we selected the clinical objective indicators through simple correlation analysis which were statistically significant($p<0.05$) into the canonical correlation analysis.

Canonical correlation analysis is an approach that involves the application of structure coefficients as indices for the identification of important indicators. As a generalisation of simple and multiple correlations, canonical correlation analysis is a statistical analysis method used to determine the correlation between two sets of variables. The pair of linear combinations with the largest correlation coefficients is identified and the correlation coefficients for both sets of variables are combined to obtain the correlation for the combined set, which serves as a more comprehensive and representative indicator.[11] In canonical correlation analysis, a linear equation is applied separately to the observed predictor and dependent variables to create one unobserved variable for each set. These two equations are generated because they yield the largest possible correlation between the two unobserved variables. The first canonical correlation is the highest possible correlation between any synthetic predictor variable and synthetic outcome variable and is the most suitable candidate for interpretation. The criteria for important variables in each canonical function are the structure coefficient and the bivariate correlation between an observed variable and a synthetic variable.[12] The clinical objective indicators which were found to be correlated through simple correlation analysis were defined as canonical variables V. The four domain scores for the QLICD-COPD (V2.0) scale were defined as canonical variables U and canonical correlation analysis was performed.

RESULTS

Sociodemographic characteristics of the participants

A total of 261 participants were included in this study. The patients met the COPD diagnostic criteria and were in the acute exacerbation stage. There were 199 men (76.2%) and 62 women (23.8%) and the average age was 70.9±9.6 years. Other individual sociodemographic characteristics are presented in table 1.

The total scores for QLICD-COPD(V2.0) in patients with COPD

The score for each domain was calculated according to the rules for QLICD-COPD (V2.0). The standardised score ($\bar{x}$ ±s) of physical functions domain, psychological functions

Table 1 Sociodemographic characteristics of the participants (N=261)

Characteristics	n (%)	Characteristics	n (%)
Age (years)		Occupation	
<50	5 (1.9)	Worker	70 (26.8)
50~59	25 (9.6)	Farmer	98 (37.5)
60~69	83 (31.8)	Teacher	16 (6.1)
70~79	98 (37.5)	Cadre	43 (16.5)
80~89	47 (18.0)	Individual household	8 (3.1)
≥90~	3 (1.2)	Other*	26 (10.0)
Gender		Ethnic groups	
Male	199 (76.2)	Han	253 (96.9)
Female	62 (23.8)	Others	8 (3.1)
Marriage		Income†	
Unmarried	4 (1.5)	Poor	54 (20.7)
Married	220 (84.3)	Fair	182 (69.7)
Divorced	3 (1.2)	High	25 (9.6)
Widowed	34 (13.0)		
Education		Medical insurance	
Primary school	114 (43.7)	Self-paid	27 (10.3)
Junior middle school	96 (36.8)	Social medical insurance	195 (74.7)
High school	36 (13.8)	Commercial insurance	4 (1.6)
Junior college	9 (3.4)	Rural cooperative public medical service	35 (13.4)
Bachelor or above	6 (2.3)		

*Other occupations (not listed in the table, eg, doctor, nurse) are group together in the 'other'.
†Is evaluated by patient himself/herself according to this/her perceptions.

Table 2 Simple correlation analysis for the scores of each domain and the total score of QLICD-COPD (V2.0) with values of clinical objective indicators in patients with chronic obstructive pulmonary disease

Clinical objective indicator	n	PHD	PSD	SOD	SPD	TOT
TP	260	0.150*	0.199**	0.125*	0.165**	0.209**
ALB	260	–	–	–	0.174**	–
TBA	194	−0.176*	–	–	–	–
ALP	196	–	−0.176*	−0.174*	–	–
Scr	260	0.122*	–	–	–	–
K	260	–	–	−0.133*	–	–
Na	260	–	–	–	−0.132*	−0.127*
NEUT%	259	−0.132*	−0.147*	−0.161**	–	−0.160**
LYMPH%	259	–	0.149*	0.145*	–	0.143*
MONO%	258	0.183**	–	–	–	0.128*
LYMPH	259	–	–	0.133*	–	–
MONO	258	0.163**	–	–	–	–
HCT	257	−0.217*				
PCO_2	205	−0.268**	–	–	–	−0.148*
FVC	153	0.161*	–	–	–	0.164*
FEV1	152	0.217**		0.163*		–
CRP	212	−0.136*	–	–	–	−0.144*

The value in the table represents the correlation coefficient, – means that the clinical objective indicators are not related to the domain score,
*Means that the correlation is significant when the confidence level (two-sided) is 0.05.
**Means that the correlation is significant when the confidence level (two-sided) is 0.01.
ALB, albumin; ALP, alkaline phosphatase; CRP, C-reactive protein; FEV1, 1-second forced expiratory volume; FVC, forced vital capacity; HCT, hematocrit; K, serum potassium; LYMPH%, percentage of lymphocytes; LYMPH, lymphocytes; MONO, monocytes; MONO%, percentage of monocytes; Na, serum sodium; NEUT%, percentage of neutrophils; PCO_2, partial pressure of carbon dioxide; PHD, physical function; PSD, psychological functions; SOD, social function; TBA, total bile acid; TP, total protein.

domain, social functions domain and specific module domain were 49.00±12.91, 59.89±13.51, 68.59±11.94 and 51.84±13.58 respectively. The standardised score of total scores ($\bar{x}$±s) for all domains were 57.17±10.26.

Simple correlation analysis

Simple correlation analysis was performed for the clinical objective indicators with complete data, the scores for each QLICD-COPD (V2.0) domain and the total scores (table 2).

The results showed that the level of total protein (TP), albumin (ALB), total bile acid (TBA), alkaline phosphatase (ALP), creatinine (Scr), serum potassium (K), serum sodium (Na) for the blood biochemistry, the percentage of neutrophils (NEUT%), percentage of lymphocytes (LYMPH%), percentage of monocytes (MONO%), lymphocytes (LYMPH), monocytes (MONO) and hematocrit (HCT) in blood routine tests, the partial pressure of carbon dioxide (PCO_2) in blood gas analysis, forced vital capacity (FVC), 1-second forced expiratory volume (FEV1) in the pulmonary function test and C-reactive protein (CRP) were related to QOL.

Correlation analysis showed that the detection ranges and average values of the clinical objective indicators were related to the QOL of patients with COPD (table 3).

Canonical correlation analysis

Because the FVC and FEV1 values were too small, they were not included in canonical correlation analysis. Fifteen clinical objective indicators were identified by screening the simple correlations, with correlation as the X value and the four domains of QLICD-COPD (V2.0) as the Y values. X_1 was TP, X_2 was ALB, X_3 was TBA, X_4 was ALP, X_5 was Scr, X_6 was K, X_7 was Na, X_8 was NEUT%, X_9 was LYMPH%, X_{10} was MONO%, X_{11} was LYMPH, X_{12} was MONO, X_{13} was HCT, X_{14} was PCO_2, X_{15} was CRP, Y_1 was PHD, Y_2 was PSD, Y_3 was SOD and Y_4 was SPD. Using canonical correlation analysis for the X and Y variables, four common variables were obtained (table 4).

The results showed that within the four pairs of canonical variables, two pairs of canonical variables were statistically significant (r_1=0.35, p<0.0001; r_2=0.26, p<0.05), demonstrating that there was a correlation between QOL and the clinical objective indicators. The first pair of canonical variables contained 45.8% of the information and the second pair contained 33.8%.

Table 5 shows that in the first pair of canonical variables, the levels of TP (X_1), ALB (X_2) and LYMPH% (X_9) were positively correlated with PSD (Y_2) and SPD (Y_4), while NEUT% (X_8) were negatively correlated. In other words, the higher the levels of TP, ALB and LYMPH% in the

Table 3 Values of clinical objective indicators in patients with chronic obstructive pulmonary disease

Clinical objective indicator	Number	Range	Average (x±s)	Minimum	Maximum
TP (g/L)	260	60–82	64.61±7.07	49.00	112.60
ALB (g/L)	260	35–54	35.65±4.93	20.70	49.20
TBA (μmol/L)	194	0–15	7.45±10.09	0.10	70.00
ALP (IU/L)	196	31–115	75.00±24.87	38.70	176.00
Scr (μmol/L)	260	42–97	77.89±30.00	33.00	272.00
K (mmol/L)	260	3.5–5.5	4.03±0.48	2.68	5.55
Na (μmol/L)	260	136–146	140.00±3.84	118.50	151.60
NEUT%	259	50–70	72.02±12.76	40.00	96.70
LYMPH%	259	20–40	18.34±10.14	0.90	48.40
MONO%	258	3–10	7.90±4.03	0.10	27.60
LYMPH (10^9/L)	259	0.8–4	1.36±0.75	0.23	4.91
MONO (10^9/L)	258	0.12–1.0	0.64±10.57	0.00	3.91
HCT (%)	257	33.5–45	41.01±7.98	17.40	68.30
PCO_2 (mm Hg)	205	35–45	52.28±11.33	24.00	89.00
FVC (L)	153	2.31–3.18	2.26±0.46	1.06	3.66
FEV1 (L)	152	2.31–3.18	1.23±0.37	0.43	2.71
CRP (mg/L)	212	≤10	33.24±26.77	1.25	128.00

ALB, albumin ; ALP, alkaline phosphatase; CRP, C-reactive protein; FEV1, 1-second forced expiratory volume; FVC, forced vital capacity; HCT, hematocrit ; K, serum potassium; LYMPH, lymphocytes; LYMPH%, percentage of lymphocytes; MONO%, percentage of monocytes; Na, serum sodium; NEUT%, percentage of neutrophils; PCO_2, partial pressure of carbon dioxide; Scr, creatinine; TBA, total bile acid; TP, total protein.

blood biochemistry and the lower the levels of NEUT% in blood routine results were, the higher the PSD and SPD scores and the better the QOL for patients with COPD would be. In the second pair of canonical variables, the level of Na (X_7) was positively correlated with SOD (Y_3), while ALP (X_4) was negatively correlated. In other words, the higher the level of Na in blood biochemistry and the lower the level of ALP were, the higher the SOD scores and the better the QOL of patients with COPD would be.

Redundancy analysis showed that among the first pair of canonical variables, V_1 could explain 8.27% of the total variation in the X variable set and 2.16% in the Y variable set, while U_1 could explain 43.64% of the total variation in the Y variable set and 11.38% in the X variable set. In the second pair of canonical variables, V_2 could explain 9.57% of the total variation in the X variable set and 1.98% in the Y variable set, while U_2 could explain 23.92% of the total variation in the Y variable set and 4.94% in the X variable set 4.94%.

DISCUSSION

At present, the number of deaths from respiratory diseases accounts for a quarter of all deaths, with COPD accounting for a large proportion.[13] QOL is an important indicator of the effectiveness of disease prevention and treatment measures,[14] as well as a sensory representation of a person's physical, mental and social abilities.

Comparison of the average scores for patients with COPD in various domains after standardisation revealed that social function had the highest score, followed by psychological function and the score for the

Table 4 Canonical correlation analysis for the scores of each domain of QLICD-COPD (V2.0) with values of clinical objective indicators in patients with chronic obstructive pulmonary disease

n	Correlation coefficient	Proportion	Approximate F value	df	P value
1	0.35	0.458	3.03	60	<0.0001
2	0.26	0.338	2.37	42	<0.0001
3	0.08	0.105	1.48	26	0.0625
4	0.08	0.100	1.57	12	0.1022

QLICD-COPD (V2.0), Quality of Life Instrument for Chronic Diseases-COPD (V2.0).

Table 5 The correlation coefficients between the canonical variables of clinical objective indicators and the scores of each domain of QLICD-COPD (V2.0) in patients with chronic obstructive pulmonary disease

Clinical objective indicator	Variable	V_1	V_2	Variable	U_1	U_2
TP	X_1	0.592	0.277	Y_1	0.423	0.167
ALB	X_2	0.451	−0.008	Y_2	0.898	0.324
TBA	X_3	−0.129	−0.002	Y_3	0.391	0.847
ALP	X_4	−0.175	−0.435	Y_4	0.780	−0.326
Scr	X_5	−0.007	0.120	–	–	–
K	X_6	0.032	−0.371	–	–	–
Na	X_7	0.063	0.675	–	–	–
NEUT%	X_8	−0.450	−0.302	–	–	–
LYMPH%	X_9	0.456	0.300	–	–	–
MONO%	X_{10}	0.187	0.146	–	–	–
LYMPH	X_{11}	−0.341	0.396	–	–	–
MONO	X_{12}	−0.051	0.005	–	–	–
HCT	X_{13}	−0.076	0.354	–	–	–
PCO_2	X_{14}	0.060	0.252	–	–	–
CRP	X_{15}	−0.247	−0.120	–	–	–

ALB, albumin; ALP, alkaline phosphatase; CRP, C-reactive protein; HCT, hematocrit; K, serum potassium; LYMPH%, percentage of lymphocytes; LYMPH, lymphocytes ; MONO, monocytes; MONO%, percentage of monocytes; Na, serum sodium; NEUT%, percentage of neutrophils; PCO_2, partial pressure of carbon dioxide; QLICD-COPD V2.0, Quality of Life Instrument for Chronic Diseases-COPD (V2.0); QLICD-COPD (V2.0), Quality of Life Instrument for Chronic Diseases-COPD (V2.0); Scr, creatinine; TBA, total bile acid; TP, total protein.

disease-special module, which reflects COPD symptoms. Physiological function had the lowest score. Physiological function mainly reflects a patient's appetite, sleep, defecation and other basic physiological functions, as well as pain and fatigue. The average score for this domain was low, possibly because COPD is a lung disease that limits airflow, which can seriously damage the human body, mostly due to chronic bronchitis and bronchial asthma complicated by emphysema. There is no method to cure COPD currently and the only available options are for controlling infection and treating symptoms using antispasmodic and anti-asthmatic drugs. COPD has many complications, such as chronic pulmonary heart disease, diabetes mellitus, cardiovascular and cerebrovascular diseases, cerebrovascular diseases, dyslipidaemia and peptic ulcer, and severe disease will directly result in the death of the patient. The aetiology of the disease is related to hypoxia, high blood viscosity, capillary spasms and long-term use of glucocorticoids and other drugs.[15] The average age of the participants in this study was 71 years. Most of the current research results suggest that there is a correlation between the age of patients and their QOL. Some researchers think age is an independent determinant of QOL for patients with COPD. With the increase of age, elderly patients with COPD develop more complications, which may affect their QOL.[16]

The psychological function mainly reflects the mental status of patients, including the three aspects of cognition, emotion, will and personality. Chronic diseases tend to increase an individual's susceptibility to emotional depression and produce a long-lasting decrease in mood.[17] Depression, anxiety and other emotional disorders have an important impact on the QOL of patients. The incidence of depression among patients with COPD is higher than that in healthy individuals. Prigatano *et al* found that depression and anxiety were highly correlated with QOL among patients with COPD using the Profile of Mood States.[18] Individuals with COPD also experience significant changes in their mental health when they suffer from long-term physical pain; hence, they tend to have a low psychological function score.

Because the factors that affect QOL in patients with COPD vary, including social and demographic factors, physical factors, psychological factors and clinical factors,[19] we used canonical correlation analysis to comprehensively assess the group relationships for multiple factors. Canonical correlation analysis showed that in the first pair of canonical variables, lower levels of TP, ALB and LYMPH% in blood biochemistry and higher levels of NEUT% in blood routine tests were correlated to lower scores for psychological function and the disease-specific module as well as worse QOL. TP consists of ALB and globulin and low levels of TP and ALB usually indicate a poor nutritional status. Patients should eat a light diet with a rich and reasonable nutrition, drink adequate amounts of water, rest sufficiently, perform physical exercise, reduce excess fat, burn excess calories, etc.[20] Both LYMPH and NEUT are white cells. Researchers have found that many lung diseases are characterised by excessive NEUT, which leads to inflammatory responses

such as pneumonia and bronchiectasis. A large number of NEUT can be found in the airway walls and lung tissues of patients with COPD, and the concentration and infiltration of NEUT in the airways and lung tissues are related to the severity and progression of lung infection.[21 22] In the second pair of canonical variables, lower levels of serum Na in blood biochemistry and higher levels of ALP were correlated with lower social function scores and worse QOL. Acid-base disturbances and electrolyte disturbances are common among patients with obstructive pulmonary disease because of decreased lung function and ventilatory disturbances. Low serum Na in the body leads to hyponatremia, which can cause nausea, vomiting, bloating and drowsiness and makes the patient believe the condition is more serious. This leads to a negative state of mind, influences the life and interpersonal relationships of patients, and seriously affects their quality of life. Shi[23] also reached the same conclusion. Bruno and Valenti[24] described the pathophysiological mechanisms of acid-base disorders and their impact on patient mortality, and noted that paying attention to the serum Na in the blood is helpful for correct diagnosis and targeted therapy. ALP is an indicator of liver function and is widely distributed in various organs of the body. Hernández-Mosqueira *et al*[25] found that ALP in tissues is involved in lipid metabolism and related gene expression. Hepatobiliary disease or bone disease can lead to elevated ALP, which affects the patient's position in their family and at work, reduces the amount of contact with other people and affects their QOL.

There are a few limitations which deserve to be mentioned. First, the lack of some clinical objective indicators is a serious limitation. Because these objective indicators were not included in the relevant statistical analysis, the final results were affected. In subsequent questionnaire collection processes, the accuracy and integrity of the data will be guaranteed as much as possible and priority will be given to patients who are not within the normal range for the indicators. Second, the participants were recruited through hospital, these patients with acute exacerbation of COPD, thus possibly having a negative influence on their QOL. It is possible that those who were in other period (eg, stabilisation period) with COPD would be more likely to have a good QOL. Selection bias in our study may exist. This could be considered further in future research studies. Third, redundancy analysis results showed that two pairs of canonical variables related to the QOL had a low explanatory value. The selected clinical objective indicators only reflect a small portion of the factors that influence QOL and many other factors can affect the QOL of patients with COPD. Therefore, social demographic factors, physical and psychological factors, clinical factors, and other factors should be taken into account for the development and application of scales and records of clinical objective indicators.

To summarise, among the clinical objective indicators evaluated for patients with COPD, the levels of TP, ALB, NEUT%, LYMPH%, serum Na and ALP can partly reflect the patient's QOL. In the course of treatment, clinicians should pay close attention to increases in ALP and NEUT% as well as decreases in TP, ALB, LYMPH% and serum Na. While using drugs and other therapeutic means to ease the patient's pain, health education and psychological treatment should also be provided. Physicians need to consider the various factors that affect the patients and take appropriate steps to improve their QOL.

Acknowledgements We have received substantial assistance from the staff of the First Affiliated Hospital of Kunming Medical University and the Affiliated Hospital of Guangdong Medical University. We sincerely acknowledge all the support.

Contributors YL and JR contributed to the study design, data analysis and manuscript writing. CW contributed to study design and revision of the manuscript. JT and BW contributed to the study design and made comments on the paper. ZZ contributed to the preparation of materials and data collection. All authors read and approved the final manuscript. CW is responsible for the overall content as the guarantor.

Funding This study was supported by a grant from the National Science Foundation of China (71373058), Science and Technological Planning Program of Guangdong Province (2013B021800074).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting or dissemination plans of this research.

Patient consent for publication Consent obtained directly from patient(s)

Ethics approval Ethical approval for this study was obtained from the Ethics Committee of the Affiliated Hospital of Guangdong Medical University (REC: PJ2015050KT). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

ORCID iD

Yuxi Liu http://orcid.org/0000-0002-9589-7046

REFERENCES

1 Ståhl E, Lindberg A, Jansson S-A, *et al*. Health-Related quality of life is related to COPD disease severity. *Health Qual Life Outcomes* 2005;3:56.
2 Cedano S, Belasco AGS, Traldi F, *et al*. Influence that sociodemographic variables, clinical characteristics, and level of dependence have on quality of life in COPD patients on long-term home oxygen therapy. *J Bras Pneumol* 2012;38:331–8.
3 Carrasco Garrido P, de Miguel Díez J, Rejas Gutiérrez J, *et al*. Negative impact of chronic obstructive pulmonary disease on the health-related quality of life of patients. Results of the EPIDEPOC study. *Health Qual Life Outcomes* 2006;4:31.
4 Emery M-P, Perrier L-L, Acquadro C. Patient-Reported outcome and quality of life instruments database (PROQOLID): frequently asked questions. *Health Qual Life Outcomes* 2005;3:12.
5 Fung CH, Hays RD. Prospects and challenges in using patient-reported outcomes in clinical practice. *Qual Life Res* 2008;17:1297–302.
6 Wan KY, Sun FQ, Xuan H. Canonical correlation analysis on influence factors of patient-reported outcomes/quality of life in patients with stroke. *RS* 2015;6:631–6.
7 Respiratory diseases association of Chinese medical Association. Group of chronic obstructive pulmonary disease. guidelines for the

diagnosis and treatment of chronic obstructive pulmonary disease. *J Tuber Resp Dise* 2007;30:8–17.
8 Wan CH, XM L, Zhao XD. The quality of life instrument for patients with chronic disease. *J Beha Medi Scie* 2005;12:1130–1.
9 Wan CH, XM L, Yang Z. *Evaluation and application of quality of life in patients with chronic diseases*. Beijing: Science Press, 2015.
10 Yang Z, XM L, Wan CH. Development and evaluation of life rating scale for patients with chronic obstructive pulmonary disease. *Gene Pract* 2007;13:1080–3.
11 Ronald P, Cody Jeffrey K. *Applied statistics and SAS programming language*. 5th ed, 2005.
12 Sherry A, Henson RK. Conducting and interpreting canonical correlation analysis in personality research: a user-friendly primer. *J Pers Assess* 2005;84:37–48.
13 JB G, YJ X. *Internal medicine*. 8th ed. People's Medical Publishing House, 2013.
14 Yacavone RF, Locke GR, Provenzale DT, *et al*. Quality of life measurement in gastroenterology: what is available? *Am J Gastroenterol* 2001;96:285–97.
15 McGarvey LP, John M, Anderson JA, *et al*. Ascertainment of cause-specific mortality in COPD: operations of the torch clinical endpoint Committee. *Thorax* 2007;62:411–5.
16 Chen XG, Zhou AL. Research progress on influencing factors in quality of life in patients with chronic obstructive pulmonary disease. *J Clinc Pul Me* 2008;4:449–51.
17 Ma X, Zhao XD. *Medical psychology*. 3rd ed. People's Medical Publishing House, 2015.
18 Prigatano GP, Wright EC, Lervin D. Quality of life and its predictors in patients with mild hypoxcmia and chronic obstructive pulmonary disease：short-term effects on exercise endurance and health status. *Arch Bronconeumol* 1999;35:261–6.
19 Yang Z, Yang YP, Zhao ZH. Study on quality of life and its influencing factors in quality of life in patients with chronic obstructive pulmonary disease. *C Gene Pract* 2007;13:1084–5.
20 Quinlan GJ, Martin GS, Evans TW. Albumin: biochemical properties and therapeutic potential. *Hepatology* 2005;41:1211–9.
21 Cowburn AS, Condliffe AM, Farahi N, *et al*. Advances in neutrophil biology: clinical implications. *Chest* 2008;134:606–12.
22 Babusyte A, Jeroch J, Stakauskas R, *et al*. The effect of induced sputum and bronchoalveolar lavage fluid from patients with chronic obstructive pulmonary disease on neutrophil migration in vitro. *Medicina* 2010;46:315–22.
23 Shi PP. Clinical analysis of the relationship between 56 cases of chronic obstructive pulmonary disease with respiratory failure and hyponatremia. *Jilin Medical Journal* 2016;2:286–8.
24 Bruno CM, Valenti M. Acid-Base disorders in patients with chronic obstructive pulmonary disease: a pathophysiological review. *J Biomed Biotechnol* 2012;2012:1–8.
25 Hernández-Mosqueira C, Velez-delValle C, Kuri-Harcuch W. Tissue alkaline phosphatase is involved in lipid metabolism and gene expression and secretion of adipokines in adipocytes. *Biochim Biophys Acta* 2015;1850:2485–96.