RESEARCH ARTICLE

Factors contributing to chronic obstructive pulmonary disease patients' functional performance: Structural equation modelling based on theory of unpleasant symptoms

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Abstract

Aim: This study aimed to predict the functional performance of patients with chronic obstructive pulmonary disease by clarifying the relationship among disease severity, uncertainty, social support, symptom experience, coping, and functional performance.

Design: A model-testing design was used.

Methods: The subjects of this study were outpatients with chronic obstructive pulmonary disease who visited the respiratory clinic of a general hospital in Seoul, Korea. The data were collected using validated instruments from July 2018 to April 2019, of which 202 questionnaires in total were used for data analysis. Collected data were analysed by using IBM SPSS v27.0 and Mplus 8.0.

Results: The severity of the disease, uncertainty, and symptom experience should be reduced to improve the functional performance of chronic obstructive pulmonary disease patients. Furthermore, reduced uncertainty can improve functional performance by reducing symptom experience. Nursing interventions for the improvement of pulmonary function and reduction of symptom experience should be developed.

KEYWORDS
chronic obstructive, patients, physical functional performance, pulmonary disease

1 | INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterized by airflow limitations and persistent respiratory symptoms (Global Initiative for Chronic Obstructive Lung Disease [GOLD], 2021). In 2015, about 251 million people were reported to be diagnosed with COPD, and the prevalence of COPD had increased by 44.2% compared to 1990 (Soriano et al., 2017). The prevalence of COPD in Korean people over 40 years of age was 10.8% in 2019 (Korea Centers for Disease Control and Prevention, 2020). In addition, COPD ranked 3rd among the top 10 global causes of death in 2019 (World Health Organization [WHO], 2019). This tended to be more noticeable with aging (Korea Centers for Disease Control and Prevention, 2020), thus, the number of COPD patients is expected to increase in the future due to the extended lifespan and aging society.

Due to experiencing symptoms such as dyspnea and fatigue, COPD patients have difficulty in performing daily living activities, leading to decreased functional performance (Ding et al., 2018). This negatively influences patients' daily living, quality of life and satisfaction, and prognosis and treatment directions (Nguyen et al., 2016). Accordingly, it is necessary to identify the factors that affect the functional performance of COPD patients for developing measures to improve it.

2 | BACKGROUND

Chronic obstructive pulmonary disease causes various clinical symptoms in everyday life due to airflow limitations in the respiratory system. COPD patients mostly experience respiratory symptoms such as dyspnea, coughing, and mucus production; the disease is accompanied not only by physical symptoms such as fatigue, weight loss, and chest tightness, but also psychological symptoms such as anxiety and depression (GOLD, 2021). Due to the experience of various repetitive symptoms, the level of physical activity and personal life ability of COPD patients decrease (Soriano et al., 2017). This results in a low level of functional performance which makes it difficult to participate in social activities, work life, and perform daily activities. Functional performance refers to the physical, psychological, social, occupational and spiritual activities that maintain health and well-being by fulfilling basic needs and performing daily roles (Leidy, 1994). Improving functional performance is important for positive prognosis and treatment since performance degradation may predict the exacerbation of COPD and death rate and decrease the quality of life (Nguyen et al., 2016).

Patients with chronic disease endure uncertainty from the recurrent symptoms, disease progression and unpredictable prognosis; the lack of information (Hoth et al., 2013) and uncertainty has a negative impact on the experience of symptoms, social and psychological adaptation, and quality of life (Lee et al., 2019). Most patients have physical, psychological, and financial burden and stress, and social support can help solve these problems. Social support has a positive effect on motivation of self-management and treatment of COPD patients (Russell et al., 2018), which can relieve dyspnea, anxiety or depression, and also prevent disease deterioration and improve health status (Han et al., 2014). COPD cannot be completely cured; however, it can be managed by helping patients to cope and to adapt to it, resulting in the proper maintenance of their physical, social, and emotional functions (Heijmans et al., 2004). In other words, the functional performance, which is needed to maintain health and well-being of COPD patients can be changed by coping with symptom experience. Therefore, it is necessary to understand these variables, uncertainty, social support, and coping as significant factors that affect the symptom experience and the functional performance of COPD patients.

According to previous studies, disease severity in COPD patients affects symptom experience (Antoniu et al., 2016), and uncertainty increases symptom experience (Hoth et al., 2013) while social support decreases it (Han et al., 2014). In addition, previous studies have reported that functional performance decreased when symptom experience was strong (Soriano et al., 2017), and functional performance changed depending on coping (Heijmans et al., 2004). However, such earlier studies merely presented the relationship and the influential factor between the two variables. Hence, there are few studies that have examined how the predisposing factors and results of symptom experience are related and influence one another by focusing on the symptom experience. Gaining an understanding of the patients' symptom experience and the influencing predisposing factors can facilitate better control and coping with the predisposing factors, which may thereby improve the functional performance.

The theory of unpleasant symptoms states that symptoms are affected by three factors: physiological, psychological, and situational; symptom experiences vary by duration, degree, quality, and pain level. In addition, symptoms affect performance, which includes functional status, cognitive function, and physical function (Lenz et al., 1997). The theory of unpleasant symptoms emphasizes the importance of symptom experience to guide nursing research and practice, and improve understanding (Lenz, 2018).

Accordingly, the present study aimed to build a model that would predict functional performance of COPD patients based on the theory of unpleasant symptoms (Lenz et al., 1997; Figure 1), and facilitate the provision of evidential data for exploring an effective nursing intervention plan that can improve functional performance. The specific purposes were as follows:

- Identify the relationship between severity of the disease (physiological factor), uncertainty (psychological factor), social support (situational factor), symptom experience (symptom), coping, and functional performance (performance) in COPD patients.
- Present a final model that can explain the functional performance of COPD patients.

3 | METHODS

3.1 | Research design

A model-testing design was used to test the goodness-of fit of a hypothetical model based on the theory of unpleasant symptoms. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Checklist was used as a guideline.

3.2 | Sampling and setting

The subjects were recruited through convenience sampling from the outpatient clinics of the Department of Pulmonology in a general hospital in Seoul, Korea. The researcher checked the reservations of the Department of Pulmonology and selected potential subjects according to the criteria for selecting the subjects of this study. Since the sample size of 200–400 is desirable for a testing structural equation model, a survey was conducted on a total of 210 COPD patients who understood the purpose of the study and agreed to participate. A total of 202 subjects excluding eight subjects with missing responses were used for analysis. Specific subject selection criteria were as follows: patients (1) diagnosed
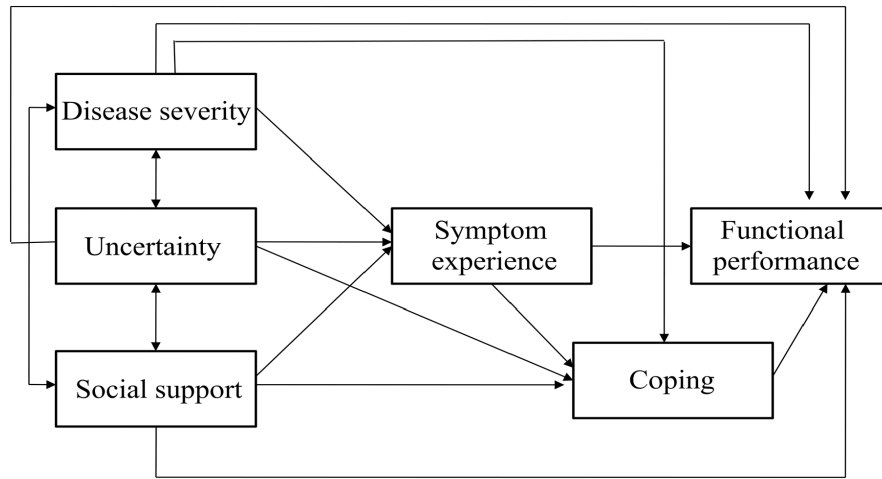
FIGURE 1 Conceptual framework of the study.

with COPD by a pulmonary specialist and monitored on an outpatient basis; (2) who were 18 years or older and could communicate; (3) diagnosed with COPD more than 3 months ago; and (4) who have a test result of spirometry within the past 3 months. Subject exclusion criteria were as follows: patients (1) with dementia or cognitive impairment; (2) with heart failure to exclude the causes of cardiac dyspnea; and (3) diagnosed with a common cold, pneumonia, or lung cancer.

3.3 | Measurement instruments

This study used validated instruments that measure subjects' general characteristics, disease-related characteristics, disease severity, uncertainty, social support, symptom experience, coping, and functional performance. The English version instruments of uncertainty and coping were previously translated and published in Korean. The instruments translation procedure for social support, symptom experience, and functional performance were based on the WHO guidelines for translation (World Health Organization [WHO], 2016).

3.3.1 | General and disease-related characteristics

Information related to general characteristics of the subjects, including age, gender, education level, marital status, employment status, average monthly household income, and smoking history, was collected. Disease-related characteristics included the duration of COPD diagnosis, the use of oxygen at home or during activities, and classification of airflow limitation severity in COPD. The severity of airflow limitation was classified into four stages as follows. (1) Forced expiratory volume in 1 second (FEV_1) ≥80% predicted was GOLD 1 (mild); (2) 50% ≤ FEV_1 < 80% predicted was GOLD 2 (moderate); (3) 30% ≤ FEV_1 < 50% predicted was GOLD 3 (severe); and (4) FEV_1 < 30% predicted was GOLD4 (very severe) (GOLD, 2021).

3.3.2 | Disease severity

Disease severity was measured with FEV_1% predicted according to pulmonary function test. FEV_1% predicted is the percentage of patient's FEV_1 compared to the predicted value of a normal healthy person, and it varies according to height, age, and gender. The severity of airflow limitation can be determined using FEV_1% predicted (GOLD, 2021).The higher the FEV_1% predicted, the lesser the airflow limitation in the airway indicating lower severity of the disease.

3.3.3 | Uncertainty

Uncertainty was measured using Mishel's Uncertainty in Illness Scale-Community Form (MUIS-C). MUIS-C is an appropriate instrument to measure the uncertainty of the disease in patients with chronic diseases and their families residing in the community (Mishel, 1997). MUIS-C consists of 23 items on a five-point Likert scale. The present study used the Korean version translated by Chung et al. (2005), and the scale is on a five-point Likert scale from one point for "strongly disagree" to five points for "strongly agree". Average scores were obtained, and higher scores indicate a higher level of uncertainty. The Cronbach's α of MUIS-C was 0.74–0.92 (Mishel, 1997), and the Cronbach's α in the present study was 0.75.

3.3.4 | Social support

Social support was measured using Multidimensional Scale of Perceived Social Support (MSPSS) developed by Zimet et al. (1988). MSPSS consists of 12 items in three subareas: support from family, friends, and significant others. MSPSS is on a seven-point Likert scale from one point for "very strongly disagree" to seven points for "very strongly agree". Average scores were obtained for the present study. Higher scores indicate higher level of support from family, friends, and significant others (Zimet et al., 1988). The reliability of MSPSS measured with Cronbach's α was 0.77–0.92, and that of the present study was 0.88.

3.3.5 | Symptom experience

Symptom experience was measured using a revised version of Memorial Symptom Assessment Scale (MSAS) developed by Portenoy et al. (1994). Revised Memorial Symptom Assessment Scale (RMSAS) was later modified by Jablonski et al. (2007) for COPD patients. RMSAS consists of 19 items in the subdomains of frequency and severity, which were on a four-point Likert scale, and distress, which was on a five-point Likert scale. Average scores were calculated, and high scores indicate high frequency, severity, and distress. The reliability of RMSAS measured with Cronbach's α at the time of its development was 0.86 (Jablonski et al., 2007), and that of the present study was 0.94.

3.3.6 | Coping

Coping was measured using Coping Strategy Indicator (CSI) developed by Amirkhan (1990). CSI consists of a total of 33 items in three subdomains of coping including problem solving, seeking social support, and avoiding the event; each subdomain consists of 11 items. Since active coping was reported to be more effective than avoidance coping for chronic diseases (Frazier, 2000), the present study used problem solving-focused coping and social support seeking, which means active coping, among the subareas of CSI. Problem solving-focused coping is a problem-focused approach to actively manage stress factors, and social support seeking is a process of actively approaching others for comfort, help, and advice (Amirkhan, 1990).

The CSI scale used in the present study was the Korean version by Shin and Kim (2002). It is a three-point Likert scale ranging from one point for "not at all" to three points for "a lot", and higher scores indicate high coping in each area (Amirkhan, 1990). According to Amirkhan's CSI tool Amirkhan (1990), the mean score of problem solving-focused coping was at 21–31 points, and coping to seek social support ranged between 18 and 28 points. The reliability of CSI measured by Cronbach's α for problem solving-focused coping and social support seeking was 0.88 and 0.90, respectively (Amirkhan, 1990), and those of the present study was 0.88 and 0.83, respectively.

3.3.7 | Functional performance

Functional performance was measured using Functional Performance Inventory-Short Form (FPI-SF) developed by Leidy and Knebel (2010) for COPD patients. FPI-SF is an abbreviated version of Functional Performance Inventory (FPI), and consists of a total of 32 items in six subdomains of body care, maintaining the household, physical exercise, recreation, spiritual activities, and social interaction (Leidy & Knebel, 2010). FPI-SF is a four-point scale ranging from one point for "no difficulty was felt while performing activities" to three points for "much difficulty was felt while performing activities," and if activity was not performed, "don't do for health reasons" or "choose not to" can be selected.

Functional Performance Inventory-Short Form scores were reverse coded from three points for "no difficulty was felt while performing activities" to one point for "much difficulty was felt while performing activities". If activity was not performed for the reasons of "don't do for health reasons" or "choose not to," zero point was assigned; high scores represent high level of functional performance. The reliabilities of FPI-SF and the present study measured by Cronbach's α were 0.93 (Leidy & Knebel, 2010) and 0.92, respectively.

3.4 | Ethical considerations

The present study was conducted after approval was obtained from the IRB of the institution the investigator is affiliated (KANGDONG 2018-01-014). For the protection of subjects' rights, they were treated anonymously throughout the research process. The purpose of the research and the research process were provided in advance, and voluntary written consent to participate in the research was obtained. In particular, they were assured that their treatment process would not be affected by whether or not they participated in the research study, that they could withdraw at any time during the study, and that their information would not be used for any purpose other than the research. The subject's personal information was encrypted, and the data will be destroyed after 3 years.

3.5 | Data collection

Data were collected from July 2018 to April 2019. After explaining the purpose, necessity, and contents of the study, the researcher obtained written consent and conducted a survey. Because there were many elderly COPD patients who would find it difficult to read and understand sentences, the researcher collected data through one-on-one interviews using a questionnaire, and the time to complete the questionnaire took about 30 min. In addition, $FEV_1\%$ predicted values were obtained from a pulmonary function test performed within the last 3 months of the survey, and the investigator verified the pulmonary function test results. After the survey, the study participants were compensated with a return gift for their participation.

3.6 | Data analysis

The collected data were analysed using IBM SPSS v27.0 and Mplus 8.0. Pearson's correlation coefficients were used to determine the relationships among the disease severity of the participants, uncertainty, social support, symptom experience, coping, and functional performance. Full-information maximum likelihood (FIML) was used to estimate the research model, and the fitness of the hypothetical model was confirmed with χ^2 statistics, normed χ^2, comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA) values. When CFI is 0.9 or more, it is evaluated as good. When SRMR is 0.08 or less,

and RMSEA is 0.08 or less, it is considered a good fit (Bentler, 1990; Browne & Cudeck, 1993; Hu & Bentler, 1999). For significance tests for the path coefficients of the structural model, unstandardized coefficient (*B*), standardized coefficient (*β*), critical ratio (C.R.), and *p* values were used; squared multiple correlations (SMC) was used for the explanatory power of the endogenous variables. Mediating effects were determined using bootstrapping.

4 | RESULTS

4.1 | General and disease-related characteristics

The general and disease-related characteristics of the participants are presented in Table 1. The average age was 68 years, and half the subjects were aged between 60 and 69 years (101 participants, 50.0%). The number of male participants was higher (186 participants, 92.1%), and the most prevalent educational level was high

school graduation (80 participants, 39.6%). There were 160 (79.2%) married participants, and more than half of the participants (108 participants, 53.5%) were unemployed. In terms of smoking history, 49 participants (24.3%) were smokers at the time of the survey, 139 participants (68.8%) were former smokers.

The average duration of COPD diagnosis was 55 months, and most participants (197 participants, 97.5%) did not use oxygen at home or during activities. In terms of the classification of airflow limitation severity in COPD, the majority (116 participants, 57.4%) were GOLD 2.

4.2 | Descriptive statistics of disease severity, uncertainty, social support, symptom experience, coping, and functional performance

The descriptive statistics of disease severity, uncertainty, social support, symptom experience, coping, and functional performance used in the hypothetical model of the present study are presented

TABLE 1 Descriptive characteristic of the participants (*N* = 202).

Variables	Categories	*n*	%	Mean ± SD
Age (year)	≤59	16	7.9	68.34 ± 6.84
	60–69	101	50.0	
	≥70	85	42.1	
Gender	Men	186	92.1	
	Women	16	7.9	
Education level	≤Elementary school	39	19.4	
	Middle school	51	25.2	
	High school	80	39.6	
	≥College	32	15.8	
Marital status	Married	160	79.2	
	Single	2	1.0	
	Etc. (divorced, seperated, widowed)	40	19.8	
Employee type	Yes	94	46.5	
	No	108	53.5	
Household income (₩)	<1,000,000	73	36.1	
	1,000,000 ≤ ~2,000,000<	33	16.3	
	2,000,000 ≤ ~3,000,000<	44	21.8	
	≥3,000,000	52	25.8	
Smoking history	Never	14	6.9	
	Former	139	68.8	
	Current	49	24.3	
Duration of COPD Diagnosis (month)				55.09 ± 38.39
Oxygen use status	Yes	5	2.5	
	No	197	97.5	
Classification of airflow limitation severity in COPD	GOLD 1	28	13.9	
	GOLD 2	116	57.4	
	GOLD 3	47	23.3	
	GOLD 4	11	5.4	

in Table 2. The mean score of FEV$_1$% predicted, indicating disease severity, was 59.75±18.98%; the average score of uncertainty was slightly higher at 64.21±1.10 points. The mean scores of social support and symptom experience were 3.98±1.19 points and 0.62±0.47 points, respectively. In addition, the average scores of problem solving-focused coping and seek social support coping were 19.18±0.67 points and 18.12±0.65 points, respectively; the mean score of functional performance was 2.41±0.47 points. The absolute values of skewness and kurtosis should not be greater than 3 and 10, respectively, in univariate normality tests (Moon, 2020), and these criteria were satisfied in the present study indicating the fulfilment of the normality assumption necessary for model analysis.

4.3 | The relationships among the disease severity, uncertainty, social support, symptom experience, coping, and functional performance

The results of correlation analysis among variables are presented in Table 3. Disease severity showed a statistically significant correlation with functional performance ($r = 0.207$, $p = 0.033$). The lower severity of disease was significantly associated with the higher functional performance. Uncertainty showed statistically a negative correlation with social support ($r = -0.201$, $p = 0.004$), functional performance ($r = -0.282$, $p < 0.001$), and a positive correlation with symptom experience ($r = 0.313$, $p < 0.001$). The lower uncertainty has a relationship with the higher social support and functional performance, and a significant relationship with the lower symptom experience. Social support showed negative correlation with symptom experience ($r = -0.152$, $p = 0.031$), and a positive correlation with functional performance ($r = 0.244$, $p < 0.001$). The higher social support was significantly associated with the lower symptom experience and the higher functional performance. Symptom experience showed a positive correlation with coping ($r = 0.334$, $p < 0.001$), and negative correlation with functional performance ($r = -0.624$, $p < 0.001$). The lower symptom experience was significantly associated with the lower coping and the higher functional performance.

Multicollinearity means that independent variables are not independent of each other but strongly correlated. If multicollinearity is high, the estimation precision of the model is very low, and the path coefficients are unreliable (Kwon, 2015). The absence of multicollinearity problems in structural equation modelling is confirmed when the distribution of the absolute values of correlations (r) among the measured variables is <0.80 (Yu, 2022). As a result of examining the correlation between the measured variables in this study, there was no multicollinearity between the measured variables because the absolute values of the correlation coefficients between the variables ranged from 0.023 to 0.624.

TABLE 2 Descriptive statistics of disease severity, uncertainty, social support, symptom experience, coping, and functional performance ($N = 202$).

Variables	Mean ± SD	Min	Max	Possible range	Skewness	Kurtosis
Disease severity	59.75 ± 18.98	19.00	110.00		−0.0830	−0.183
Uncertainty	64.21 ± 1.10	31.00	89.00	23–115	0.190	−1.181
Social support	3.98 ± 1.19	1.00	7.00	1–7	−0.119	0.473
Family	5.13 ± 1.61	1.00	7.00	1–7	−1.318	1.192
Friends	3.87 ± 1.53	1.00	7.00	1–7	−0.215	−0.397
Significant other	2.93 ± 1.75	1.00	7.00	1–7	0.604	−0.619
Symptom experience	0.62 ± 0.47	0.00	2.48	0–4	1.509	2.612
Frequency	0.87 ± 0.56	0.00	3.06	0–4	1.153	1.618
Severity	0.65 ± 0.46	0.00	2.37	0–4	1.188	1.425
Distress	0.37 ± 0.47	0.00	2.37	0–4	2.023	4.449
Coping						
Problem-solving focused	19.18 ± 0.67	11.00	33.00	11–13	0.357	−0.820
Seeking social support	18.12 ± 0.65	11.00	33.00	11–13	0.508	−0.698
Functional performance	2.41 ± 0.47	0.84	3.00	0–3	−0.825	0.191
Body care	2.64 ± 0.47	1.00	3.00	0–3	−1.411	1.567
Maintaining the household	2.39 ± 0.59	0.38	3.00	0–3	−0.841	−0.019
Physical exercise	2.11 ± 0.62	0.80	3.00	0–3	−0.139	−1.167
Recreation	2.60 ± 0.54	0.60	3.00	0–3	−1.528	2.105
Spiritual activities	2.14 ± 1.07	0.00	3.00	0–3	−0.903	−0.609
Social interaction	2.51 ± 0.59	0.00	3.00	0–3	−1.256	0.171

4.4 | Test of the goodness of fit of the hypothetical model

The present study constructed a hypothetical model to investigate the relationships among the disease severity, uncertainty, social support, symptom experience, coping, and functional performance; the results are presented in Table 4. The χ^2 statistic of the structural model was 207.97 ($p < 0.001$) resulting in rejecting the hypothetical model; however, since the χ^2 test used to test the goodness of fit of the model is sensitive to sample size, the fitness of the model should be determined by comprehensively confirming the approximate goodness-of-fit indices (Lee & Lim, 2017). The goodness-of-fit was good with normed $\chi^2 = 1.705$, CFI = 0.935, SRMR = 0.059 and RMSEA = 0.055.

4.5 | The direct, indirect, and total effects of the final model

The results of the analysis of the direct, indirect, and total effects of the disease severity, uncertainty, social support, symptom experience, coping, and functional performance are presented in Table 5. Symptom experience decreased when uncertainty was low ($\beta = 0.236$, $p = 0.009$) and social support was high ($\beta = -0.200$, $p = 0.044$). The association between disease severity and symptom experience was nonsignificant ($\beta = -0.025$, $p = 0.745$), and the explanatory power of these variables was 11.9%. Coping was significantly higher with higher level of social support ($\beta = 0.278$, $p = 0.012$) and symptom experience ($\beta = 0.172$, $p = 0.047$), but no statistically significant relationship was found with disease severity

($\beta = 0.060$, $p = 0.407$) and uncertainty ($\beta = -0.043$, $p = 0.617$); the explanatory power of these variables for coping was 9.4%. In the relationship with functional performance, the lower the disease severity ($\beta = 0.238$, $p < 0.001$), uncertainty ($\beta = -0.164$, $p = 0.021$), and symptom experience ($\beta = -0.558$, $p < 0.001$), the higher the functional performance. Social support ($\beta = 0.082$, $p = 0.261$) and coping ($\beta = 0.029$, $p = 0.646$) were not significantly correlated with functional performance, and the explanatory power of these variables for functional performance was 51.8%. The paths of the research model are shown in Figure 2.

4.6 | Analysis of the mediating effect

The mediating effect was determined using bootstrapping (Table 6). Symptom experience mediated the effect that uncertainty exerted on functional performance ($B = -0.136$, 95% CI = [−0.283, −0.011]). That is, the negative effect that uncertainty exerts on the functional performance of COPD patients can be lowered by reducing symptom experience. However, the mediating effects were statistically nonsignificant for all other variables because they contained zero in the 95% bootstrapping confidence intervals for the mediating effects.

5 | DISCUSSION

The present study intended to investigate the functional performance of COPD patients based on the theory of unpleasant symptoms (Lenz et al., 1997), and a hypothetical model was constructed

TABLE 3 The relationships among the disease severity, uncertainty, social support, symptom experience, coping, and functional performance (N = 202).

Variables	Disease severity r (p)	Uncertainty r (p)	Social support r (p)	Symptom experience r (p)	Coping r (p)
Uncertainty	0.079 (0.264)				
Social support	0.100 (0.156)	−0.201** (0.004)			
Symptom experience	−0.023 (0.741)	0.313** (<0.001)	−0.152* (0.031)		
Coping	0.037 (0.599)	0.023 (0.742)	0.066 (0.351)	0.334** (<0.001)	
Functional performance	0.207* (0.033)	−0.282** (<0.001)	0.244** (<0.001)	−0.624** (<0.001)	0.075 (0.288)

*$p < 0.05$, **$p < 0.01$.

TABLE 4 Test of the goodness of fit of the hypothetical model (N = 202).

	χ^2	Df	Normed χ^2	CFI	SRMR	RMSEA
Hypothetical model	207.97 ($p < 0.001$)	122	1.705	0.935	0.059	0.055
Acceptance criteria	$p > 0.05$		≤3	≥0.90	≤0.08	≤0.08

Abbreviations: CFI, comparative fit index; df, degrees of freedom; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

TABLE 5 Standardized direct, indirect and total effects in the final model (N = 202).

Endogenous variables	Exogenous variables	Direct effect B (β)	p	C.R. (z)	Indirect effect B (β)	p	Total effect B (β)	p	SMC
Symptom experience	Disease severity	−0.005 (−0.025)	0.745	−0.326			−0.005 (−0.025)	0.745	0.119
	Uncertainty	0.244 (0.236)	0.009	2.595**			0.244 (0.236)	0.009	
	Social support	−0.176 (−0.200)	0.044	−2.016*			−0.176 (−0.200)	0.044	
Coping	Disease severity	0.012 (0.060)	0.407	0.830	−0.001 (−0.004)	0.747	011 (0.056)	0.444	0.094
	Uncertainty	−0.041 (−0.043)	0.617	−0.500	0.039 (0.041)	0.110	−0.002 (−0.002)	0.978	
	Social support	0.226 (0.278)	0.012	2.517*	−0.028 (−0.034)	0.164	0.198 (0.243)	0.018	
	Symptom experience	0.159 (0.172)	0.047	1.983*			0.159 (0.172)	0.047	
Functional performance	Disease severity	0.050 (0.238)	<0.001	3.954***	0.003 (0.016)	0.716	0.053 (0.254)	<0.001	0.518
	Uncertainty	−0.170 (−0.164)	0.021	−2.304*	−0.136 (−0.132)	0.013	−0.307 (−0.296)	<0.001	
	Social support	0.073 (0.082)	0.261	1.124	0.105 (0.119)	0.051	0.178 (0.201)	0.026	
	Symptom experience	−0.559 (−0.558)	<0.001	−6.701***	0.005 (0.005)	0.663	−0.554 (−0.553)	<0.001	
	Coping	0.032 (0.029)	0.646	0.459			0.032 (0.029)	0.646	

Abbreviations: B, unstandardized coefficient; C.R., critical ratio; SMC, squared multiple correlations; β, standardized coefficient.

*p < 0.05, **p < 0.01, ***p < 0.001.

based on the influencing factors identified through literature review and its validity was tested. Based on the results of the present study, the influencing factors related to the functional performance of COPD patients are discussed below.

This study, which builds on the theory of unpleasant symptoms (Lenz et al., 1997), establishes the disease severity as a physiological factor, uncertainty as a psychological factor, and social support as a situational factor in order to set the predisposal factors of symptom experience. In addition, the functional performance was set as a result of symptom experience and to test the adequacy of the model. In consequence, Normed χ^2, CFI, SRMR, and RMSEA satisfied the recommended indicator (Bentler, 1990; Browne & Cudeck, 1993; Hu & Bentler, 1999) and were found to be appropriate models for the prediction of the functional performance of COPD patients. By applying the theory of unpleasant symptoms (Lenz et al., 1997), the study was able to clarify the relationships among the predisposing factors of symptom experience, symptom experience, and the outcome of symptom experience, thus confirming the usefulness of the theory in explaining and predicting the functional performance of COPD patients.

In the present study, the uncertainty of COPD patients influenced symptom experience. According to a study by Hoth et al. (2013) ambiguity among the uncertainty of the patient influenced symptom experiences such as anxiety, depression, and dyspnea. Since the uncertainty of disease increases sensitivity to pain and reduces tolerance to pain stimuli, the uncertainty of COPD patients appears to have affected their symptom experience. Uncertainty increases when stimuli or information is deemed to be ambiguous (Mishel, 1988). Therefore, the COPD patients should monitor their symptoms to make stimuli and information clear. In addition, strategies must also be devised to provide useful information on diseases to COPD patients and to reduce uncertainty about treatment and prognosis by establishing a health care system so that patients can easily access treatment and rehabilitation.

The present study found that social support for COPD patients affects their symptom experience. Previous studies found that greater social support for COPD patients from families or medical staff reduced the symptoms of dyspnea (Jang & Song, 2017) and social support for silicosis patients influenced the symptoms of anxiety and depression (Han et al., 2014). Social support and social network provide a wealth of information, contribute to self-management competency, and influence medication adherence (Koetsenruijter et al., 2016). It appears that social support for COPD patients may have decreased symptom experience by helping them with disease management or medication adherence, since COPD is a chronic disease that requires continuous management such as medication, removal of disease aggravating factors, and smoking cessation (GOLD, 2021). Accordingly, social support for COPD patients who require continuous treatment and management should be strengthened since it is a significant factor for reducing symptom experience. Support system through self-help groups or community should be activated, because the social support of family may weaken due to changes in modern society such as family disorganization.
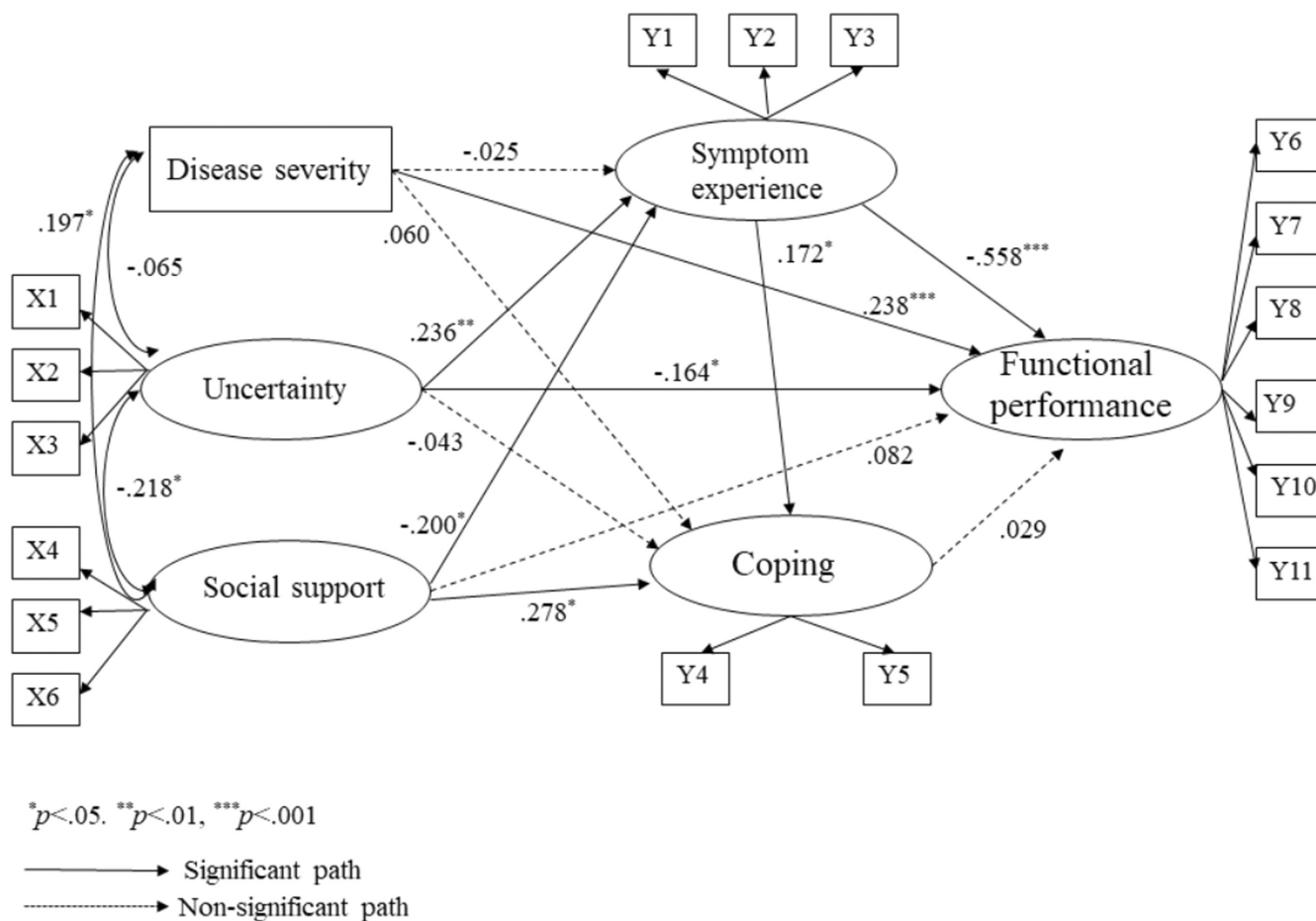
FIGURE 2 Path diagram of the study. *Note*: X1, uncertainty 1; X2, uncertainty 2; X3, uncertainty 3; X4, family; X5, friends; X6, significant other; Y1, frequency; Y2, severity; Y3, distress; Y4, problem-solving; Y5, seeking social support; Y6, body care; Y7, maintaining the household; Y8, physical exercise; Y9, recreation; Y10, spiritual activities; Y11, social interaction.

In addition, the antecedent factors that affect the functional performance of COPD patients were found to be disease severity, uncertainty, and symptom experience. Ding et al. (2018) reported that the functional performance of COPD patients increased when the disease severity decreased, supporting the findings from the present study. Accordingly, we need a plan to improve functional performance by lowering disease severity. Therefore, it is crucial for the prevention of the aggravation of disease severity to induce smoking cessation for COPD patients, and recommend preventive inoculations for influenza and pneumococcus for them, and active management such as early diagnosis and appropriate treatment (GOLD, 2021; Yawn et al., 2021). Furthermore, the lower the uncertainty, the better the functional performance. Since patients recognize uncertainty due to repeated symptom experiences, frequent hospitalization, and the prognosis of chronic disease (GOLD, 2021), strategies and nursing intervention programs to reduce uncertainty are necessary. Uncertainty may be reduced by providing COPD patients with sufficient information about disease management and emotional support as suggested by Kim and Lee (2013), who found that supportive nursing interventions consisting of physical, emotional, and information support reduced patients' uncertainty. Improving functional performance of COPD patients requires a

multidisciplinary integrated treatment program that includes all elements of exercise, education, nutrition, and psychiatric treatment. Aerobic exercise, muscle exercise, and patient-specific exercise prescriptions can improve symptoms and improve exercise ability by increasing muscle mass and improving efficiency. In addition, understanding COPD diseases, smoking cessation, environmental impact, management of dyspnea, nutrition therapy, proper use of medication, and the use of welfare services can improve functional performance of COPD patients by maintaining health promotion in the long run (Lee, 2015). Nurses should develop and utilize intervention programs to promote self-management of COPD patients, strengthen self-management capabilities, and promote self-efficacy.

The study found that the higher the social support and symptom experience of COPD patients, the higher the coping. It appears that COPD patients often used coping because symptom experience was the main cause of their stress. Furthermore, social support may induce effective coping by strengthening problem-solving ability (Paek et al., 2018), providing better understanding of the problem, and increasing motivation for action by playing the role of effective buffer in stressful situations (Fontana et al., 1989).

However, the present study found that COPD patients' disease severity and uncertainty did not directly influence coping. The finding

TABLE 6 Analysis of the mediating effect (N = 202).

Variables	B	SE	β	95% CI
Disease severity → symptom experience → functional performance	0.003	0.009	0.014	−0.015, 0.022
Disease severity → coping → functional performance	0.000	0.001	0.002	−0.002, 0.004
Disease severity → symptom experience → coping → functional performance	0.000	0.000	0.000	−0.001, 0.001
Uncertainty → symptom experience → functional performance	−0.136	0.070	−0.132	−0.283, −0.011
Uncertainty → coping → functional performance	−0.001	0.010	−0.001	−0.020, 0.020
Uncertainty → symptom experience → coping → functional performance	0.001	0.005	0.001	−0.005, 0.014
Social support → symptom experience → functional performance	0.099	0.113	0.112	−0.013, 0.376
Social support → coping → functional performance	0.007	0.028	0.008	−0.034, 0.071
Social support → symptom experience → coping → functional performance	−0.001	0.006	−0.001	−0.015, 0.005
Disease severity → symptom experience → coping	−0.001	0.003	−0.004	−0.007, 0.006
Uncertainty → symptom experience → coping	0.039	0.035	0.041	−0.007, 0.125
Social support → symptom experience → coping	−0.028	0.049	−0.034	−0.152, 0.007
Symptom experience → coping → functional performance	0.005	0.007	0.005	−0.021, 0.050

Abbreviations: *B*, unstandardized coefficient; CI, confidence interval; SE, standard error; *β*, standardized coefficient.

of Papava et al. (2016) was different from that of the present study; they found that problem-focused coping and emotion-focused coping increased when COPD patients' disease severity was high. The reason may lie in the fact that the subjects in the previous study were 61 years or older male smokers with high disease severity of GOLD 4, while the average age of the subjects in the present study was 68 years, and gender and smoking status were not controlled; GOLD 2 accounts for more than half did. Therefore, unlike previous studies, this study is thought to have not affected coping due to low disease severity. Since coping can widely vary depending on age, stress type, disease severity, gender, and cultural differences (Carver & Connor-Smith, 2010), a replication study with these factors considered is needed.

The mediating effect of COPD patients' symptom experience in the relationship between uncertainty and functional performance was confirmed in the present study. Uncertainty is related to physical and psychological symptoms such as anxiety and depression due to gradually progressing disease and unpredictable prognosis, and symptom experience reduces functional performance (Jang & Min, 2018). In other words, symptom experience should be reduced

to improve the functional performance of COPD patients, and ultimately, uncertainty should be reduced to decrease symptom experience. Since uncertainty about the disease may be caused by unclear explanation, uncertain treatment effects, and lack of information about the progress of the disease (Mishel, 1988), COPD patients' uncertainty should be reduced by providing them with sufficient information about the characteristics of the disease, treatment process, and lifestyle improvement.

In the present study, coping did not have mediating effects in the relationships among disease severity, uncertainty, social support, symptom experience, and functional performance. Thus, verification of the mediating effect of coping is necessary through a replication study.

5.1 | Limitations

A few limitations of this study were recognized. First, in general and disease-related characteristics, only occupational status was

investigated and the reason for the unemployment (COPD or other diseases, retirement etc) was not asked. Thus, the effect of COPD on employment status was not explored. Second, since the survey was conducted through a one-to-one interview using a questionnaire rather than a self-reported survey, personal characteristics of the interviewer might affect responses of study subjects. In addition, the relationship between the interviewer and the study subjects could affect the progress of the survey. Third, in the classification of air flow limitation severity in COPD, GOLD 2 accounts for more than half the cases. There is a limit to indicating the effect of disease characteristics of the above severity on uncertainty, symptoms, and functional performance. Therefore, further research is needed for various GOLD categories. Finally, only one measured variable, $FEV_1\%$ predicted, was used for determining the disease severity of COPD in the present study; it may not be able to accurately reflect disease severity. Therefore, a future study that reflects disease severity using various variables such as modified Medical Research Council (mMRC), 6-minute walk test (6MWT), and the number of hospitalizations is needed.

6 | CONCLUSION

The present study is a model test study to identify factors that affect the functional performance of COPD patients based on the theory of unpleasant symptoms (Lenz et al., 1997), and to construct a hypothetical model and test the research hypothesis. Although χ^2 statistic was 207.97 (df = 122, $p<0.001$), other goodness-of-fit indices such as normed χ^2 = 1.705, CFI = 0.935, SRMR = 0.059, and RMSEA = 0.055 showed satisfactory goodness of fit. COPD patients' experience of symptoms decreased when their uncertainty was lower and it increased when their social support was lower. Coping diminished when social support and symptom experience decreased, and the functional performance improved with lower disease severity, uncertainty and symptom experience. In addition, the symptom experience of COPD patients was found to have a statistically significant mediating effect in the relationship between uncertainty and functional performance. That is, COPD patients' reduced uncertainty increases functional performance by reducing symptom experience.

7 | RELEVANCE FOR CLINICAL PRACTICE

The present study presented strategies to improve functional performance by identifying factors that affect the functional performance of COPD patients. Since functional performance increases when disease severity and symptom experience are low, nursing interventions for improving pulmonary function and reducing symptom experience should be developed and applied in clinical practice. In addition, reducing uncertainty can help reduce symptom experience in COPD patients, thereby improving their functional performance. Therefore, it is necessary to develop uncertainty

intervention programs through the provision of specific and collective information and efficient educational methods, and apply them in clinical practice so that their effectiveness can be verified. Measuring uncertainty and functional performance are good indicators of a patient's psychological and physical condition. Therefore, in addition to the tools used for research purposes, it is necessary to develop a short, simple, and reliable questionnaire and use it in clinical practice.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interst.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICAL APPROVAL

The study was approved by the Institutional Review Board (IRB) of the Kangdong Sacred Heart Hospital (KANGDONG 2018-01-014).

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