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Original Article

The relationship between obstructive sleep apnea, dyspnea, and health-related quality of life in lung cancer survivors: a cross-sectional study in the Republic of Korea

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ABSTRACT

Objectives: The purpose of this study was to explore the relationships among obstructive sleep apnea (OSA), dyspnea, and health-related quality of life (HRQOL), as well as the factors influencing HRQOL.

Methods: A total of 129 lung cancer survivors (mean age, 53.4 years; 77 men and 52 women; mean time since diagnosis, 1.6 years; and cancer stage [1/2/3/4/relapse], 43/31/19/34/2, respectively) completed a questionnaire that included demographic and clinical information, as well as questions about the severity of sleep apnea, dyspnea, and HRQOL. The severity of OSA, dyspnea, and HRQOL were assessed using the Berlin questionnaire, the Dyspnea-10 item (FACIT-Dyspnea), and the European Organization for Research and Treatment of Cancer QLQ-C30, respectively.

Results: The severity of OSA and dyspnea exhibited negative correlations with HRQOL ($p < 0.05$). Multiple regression analysis revealed that several factors significantly impacted the HRQOL of lung cancer survivors. These included the extent of dyspnea ($\beta = -0.369$, $p < 0.01$), weight loss ($\beta = 0.192$, $p < 0.01$), OSA score ($\beta = -0.215$, $p < 0.01$), stage 2 cancer ($\beta = -0.181$, $p < 0.01$), and poor perceived health status ($\beta = -0.179$, $p < 0.05$).

Conclusion: These findings suggest that breathing difficulties, including OSA and dyspnea, contribute to decreased HRQOL. This study offers valuable insights for researchers and clinicians, aiding in the development of effective strategies to manage these issues in daily life.

Keywords: Dyspnea; Lung neoplasms; Obstructive sleep apnea; Quality of life

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Introduction

In general, survivors of lung cancer experience a range of symptoms including fatigue, pain, loss of appetite, coughing, shortness of breath, and insomnia [1]. Difficulty breathing can lead

to anxiety and depression, impacting all aspects of quality of life (QOL). Additionally, respiratory dysfunction and systemic inflammation are linked to higher cardiovascular mortality. Given that the survival rate for lung cancer decreases more rapidly than for other cancers, survivors often face significant psychological and emotional challenges throughout their illness [2].

Environmental pollutants and endogenous free radicals from inflammatory cells significantly impact lung cell pathology. Oxidative stress is a key factor in the development of lung cancer, chronic obstructive pulmonary disease, and obstructive sleep apnea (OSA) [3]. Clinical symptoms of OSA, such as snoring and apnea during sleep, are closely associated with daytime dyspnea. Intermittent high-dose hypoxia at night can enhance autonomous sympathetic activity and arterial vasoconstriction, which may lead to motor disorders by triggering abnormal cardiac responses during physical activity [4].

Breathing difficulties in lung cancer survivors have been shown to disrupt their physical, psychological, and social activities. These complications lead to reduced motor function, decreased performance levels, and emotional distress, ultimately resulting in disability and diminished health-related quality of life (HRQOL) [5]. Consequently, treating advanced lung cancer presents significant challenges. Thus, improving the QOL, which depends on accurate symptom assessment, often becomes the primary focus of cancer treatment and rehabilitation. It has been reported that dyspnea more significantly affects the physical aspect of HRQOL than the psychological aspect [6].

According to the 3-dimensional theoretical framework of health aimed at improving HRQOL, physical, social, and mental health serve as key health indicators [7]. Recent advances in targeted therapy and immunotherapy have significantly transformed the treatment landscape for lung cancer. Despite these advancements, the treatment outcomes for advanced lung cancer remain poor, with nearly all patients facing significant challenges related to their condition. Beyond improving survival rates, it is crucial to focus on maintaining QOL and prolonging periods of acceptable health [8]. Studying HRQOL is vital for understanding how diseases and treatments impact patient well-being. It helps identify discrepancies between patient-reported symptoms and those observed by healthcare providers, and it is essential for developing effective long-term management strategies [9]. Therefore, it is important to identify factors that affect HRQOL, especially those related to breathing problems in lung cancer patients.

To achieve these goals, appropriate assessment and treatment skills must be developed for clinical practice.

HIGHLIGHTS

- This study identified demographic and clinical factors influencing obstructive sleep apnea (OSA), dyspnea, and health-related quality of life (HRQOL) in lung cancer survivors, as well as the relationships among them.
- OSA and dyspnea scores differed significantly across several demographic factors, including smoking and drinking status, as well as clinical factors, such as weight loss, perceived health status, and cancer type. However, no demographic factors appeared to influence the HRQOL score.
- Breathing difficulties such as OSA and dyspnea contribute to decreased HRQOL in lung cancer survivors.

Therefore, rehabilitation professionals should possess a thorough understanding of the respiratory issues associated with lung cancer. However, to our knowledge, no studies have yet reported on the impact of OSA and dyspnea on HRQOL in lung cancer survivors. Accordingly, this study aimed to explore the relationship between OSA, dyspnea, and HRQOL in individuals who have survived lung cancer.

Materials and Methods

Participants

The participants of this study were 129 lung cancer survivors who completed a Google Forms survey between September 1, 2022 and October 1, 2022. All participants were members of an online community café (https://cafe.naver.com/lung) designed for patients with lung cancer. This platform aims to share information on cancer management, facilitate communication, and provide emotional support. To recruit participants, we obtained permission from the café's administrator and posted a recruitment notice on the community bulletin board.

The questionnaire was divided into 2 sections: the first section gathered demographic and clinical information, while the second section focused on assessing the degree of dyspnea, sleep apnea, and HRQOL. The demographic data collected included age, sex, body mass index (BMI), education level, marital status, occupation, religion, smoking habits, and alcohol consumption. Age was categorized into 3 groups: under 50, 50 to 60, and 70 or older. BMI was divided into categories of less than or greater than 23 kg/m^2, which is the threshold for being considered overweight in Asian populations [10]. Specific clinical data related to lung cancer

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included the degree of weight loss, perceived health status, type of lung cancer, stage of the disease, time since diagnosis, and type of treatment received. The degree of weight loss was categorized as less than or equal to 4 kg [11]. The average age of the respondents was 53.4 years, with a range from 26 to 83 years. Demographic and clinical details are presented in Tables 1 and 2.

Initially, the online survey included 132 respondents diagnosed with lung cancer; however, 3 were excluded due to errors in their responses. Two respondents failed to complete the entire questionnaire, and 1 was identified as a caregiver from the first question. Ultimately, data from 129 respondents were analyzed.

Assessment Tools

Severity of OSA

The degree of OSA was assessed using the Korean version of the Berlin questionnaire, which was standardized by the Korea Centers for Disease Control and Prevention [12]. The questionnaire consisted of 3 sections: category 1, which included 6 questions about snoring; category 2, which contained 3 questions regarding fatigue; and category 3, which had 1 question pertaining to hypertension. Of the 10 questions, the first question was not scored, the sixth question could receive a score ranging from 0 to 2 points, and the other 8 questions were each scored from 0 to 1 point.

Degree of dyspnea

The Dyspnea-10 item (FACIT-Dyspnea) was utilized to assess the level of dyspnea. The severity of dyspnea was evaluated using the dyspnea domain, a sub-item of the Korean version of the Functional Assessment of Chronic Illness Therapy (FACIT) developed by FACIT.org. This questionnaire was formally approved by FACIT.org and includes 10 questions that gauge the extent of dyspnea experienced during daily activities. Each question was scored on a 4-point Likert scale, ranging from 0 (not at all) to 4 (very much so). The total score could range from 0 to 40, with higher scores indicating more severe dyspnea. In a previous study, the Cronbach's α

Table 1. Demographic characteristics of the respondents (*n* = 129)

Characteristic	Value
Age (y)	
≤ 49	45 (34.9)
50–69	70 (54.3)
≥ 70	14 (10.9)
Sex	
Male	77 (59.7)
Female	52 (40.3)
Body mass index (kg/m^2)	
≤ 22.9	71 (55.0)
≥ 23.0	58 (45.0)
Education level	
≤ Elementary school	7 (5.4)
Middle school	9 (7.0)
High school	36 (27.9)
≥ College	77 (59.7)
Marital status	
Married	114 (88.4)
Unmarried	15 (11.6)
Occupation	
Yes	85 (65.9)
No	44 (34.1)
Religion	
Yes	51 (39.5)
No	78 (60.5)
Smoking	
Never	43 (33.3)
No	80 (62.0)
Yes	6 (4.7)
Drinking	
No	105 (81.4)
Yes	24 (18.6)

Data are presented as *n* (%).

Table 2. Clinical characteristics of the respondents (*n* = 129)

Characteristic	Value
Weight loss (kg)	
≥ 4	78 (60.5)
≤ 4	51 (39.5)
Perceived health status	
Good	23 (17.8)
Okay	75 (58.1)
Bad	31 (24.0)
Cancer type	
Small cell	31 (24.0)
Adenocarcinoma	77 (59.7)
Squamous cell carcinoma	16 (12.4)
Others	5 (3.9)
Cancer stage	
1	43 (33.3)
2	31 (24.0)
3	19 (14.7)
4	34 (26.4)
Relapse	2 (1.6)
Time since diagnosis (y) (*n* = 128)	
< 1	72 (56.3)
1–2	35 (27.3)
> 2	21 (16.4)
Type of treatment	
Surgery	37 (28.7)
Chemotherapy	76 (58.9)
Radiotherapy	16 (12.4)

Data are presented as *n* (%).

coefficient for the FACIT-10-item short questionnaire for dyspnea was 0.95, indicating high reliability for clinical use [13].

HRQOL

HRQOL was assessed using the European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 questionnaire. This questionnaire consists of 30 questions divided into 3 domains: 15 questions in the functional scale domain, 13 in the symptomatic scale domain, and 2 in the global health status domain [14]. Each question was rated on a Likert scale. The scores for each domain were converted from 0 to 100 according to the guidelines provided by the EORTC. The average of the converted scores from all 3 domains was then calculated. The functional scale domain covers physical, role, emotional, cognitive, and social functions, with higher scores indicating better QOL. Conversely, in the symptomatic scale domain, a higher score indicates poorer QOL, while in the global health status domain, a higher score reflects better QOL.

Data Analysis

Statistical analyses were conducted using IBM SPSS ver. 22.0 for Windows (IBM Corp.). The demographic and clinical data of the respondents were presented as both real numbers and percentages. Differences in OSA, dyspnea, and HRQOL scores across demographic and clinical variables were analyzed using the independent t-test or 1-way analysis of variance (ANOVA). When statistical significance was established through 1-way ANOVA, the Scheffe test was utilized as a post hoc test. To assess internal validity, Cronbach's α values were calculated for the OSA, dyspnea, and HRQOL data collected in this study to determine the accuracy of these measures in evaluating their intended concepts. Additionally, correlations between OSA, dyspnea, and HRQOL scores were assessed using Pearson correlation coefficients. A multiple regression analysis was conducted using the stepwise method to determine the effects of demographic and clinical variables, as well as OSA and dyspnea scores, on HRQOL scores. For the analysis of demographic and clinical variables, nominal variables were converted into dummy variables. The reference group for these dummy variables was set at 0, as specified in the table describing the results of the multiple regression analysis. The significance level was set at $p = 0.05$. Tolerance and variance inflation factors were calculated to assess the multicollinearity of the independent variables in the multiple regression analysis.

Ethics Approval

Before participating in the study, participants were informed about the study's objectives, procedures, and the principle of anonymity governing the use of their data. They then provided their consent by signing an online form. Ethical approval for the study was obtained from the Cheongju University Institutional Review Board (approval number: 1041107-202208-HR-029-01).

Results

Demographic and Clinical data of Respondents

The demographic and clinical characteristics of the respondents are presented in Tables 1 and 2, respectively. The majority of respondents were in their 50s and 60s, with fewer in their 70s or older. There were more male than female respondents. Those with a BMI under 23 kg/m^2 were more common than those with a BMI of 23 kg/m^2 or higher. The highest level of education for most respondents was a college degree or higher. Married respondents were more prevalent than single ones. Additionally, a larger number of respondents were employed, religious, and abstained from smoking and drinking alcohol. Respondents who lost 4 kg of weight were more common than those who lost less than 4 kg. The perceived health status of respondents was most frequently reported as "okay" and least frequently as "good." The most frequently diagnosed cancer type among the respondents was adenocarcinoma, and the most common stage at diagnosis was stage 1. The majority had been diagnosed less than a year ago, and most had undergone chemotherapy previously.

Differences in OSA, Dyspnea, and HRQOL Scores by Respondents' Demographic and Clinical Characteristics

Tables 3 and 4 summarize the differences in OSA, dyspnea, and HRQOL scores based on the demographic and clinical characteristics of the respondents. When comparing OSA and dyspnea scores across these demographics, OSA scores varied significantly by age, gender, smoking, and drinking status ($p < 0.05$). Higher OSA scores were observed in the 50 to 60 age group, among males, nonsmokers, and nondrinkers. Similarly, dyspnea scores also showed significant differences ($p < 0.05$) related to BMI, religion, smoking, and drinking status, with higher scores noted in individuals with a BMI <23 kg/m^2, those who were religious, smokers, and drinkers. However, no demographic factors significantly influenced HRQOL scores ($p > 0.05$).

In comparing OSA, dyspnea, and HRQOL scores based on

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Table 3. Comparisons of OSA, dyspnea, and HRQOL scores according to respondents' demographic characteristics

Variable	Category	OSA			Dyspnea			HRQOL		
		Mean±SD	t or F	*p* (Scheffe)	Mean±SD	t or F	*p* (Scheffe)	Mean±SD	t or F	*p* (Scheffe)
Age (y)	≤49[a]	3.98±2.39	5.56	<0.01 (a<b, b>c)	9.22±6.94	0.35	0.70	41.66±21.90	0.36	0.69
	50–69[b]	4.91±2.45			9.97±7.88			42.05±24.08		
	≥70[c]	3.00±2.11			11.14±9.40			47.61±27.66		
Sex	Female	3.15±2.13	−5.12	<0.01	9.78±7.32	−0.05	0.95	43.22±24.63	0.27	0.78
	Male	5.19±2.33			9.87±8.00			42.04±23.08		
BMI (kg/m^2)	<23	4.10±2.40	−1.39	0.16	11.68±8.72	3.23	<0.01	42.96±25.09	0.23	0.81
	≥23	4.71±2.51			7.59±5.53			41.99±21.93		
Education level	Elementary school[a]	2.57±1.71	2.06	0.13	10.85±8.47	2.03	0.13	41.66±16.53	0.60	0.54
	Middle school[b]	4.37±2.54			11.57±9.18			39.49±23.32		
	≥College[c]	4.53±2.43			8.72±6.50			44.37±24.40		
Marital status	Married	4.54±2.45	0.70	0.41	10.00±7.82	−2.24	0.39	42.01±23.24	−0.68	0.41
	Unmarried	3.00±2.14			8.50±6.75			46.73±27.23		
Occupation	Yes	5.71±2.34	1.45	0.31	10.09±7.80	1.02	0.16	43.43±22.39	−0.85	0.40
	No	4.80±2.27			8.20±6.61			49.26±25.23		
Religion	Yes	5.79±2.22	1.22	0.22	8.69±6.46	−2.51	0.01	45.77±21.86	0.13	0.25
	No	5.23±2.54			12.23±9.28			40.79±24.24		
Smoking	Yes[a]	5.83±2.56	8.46	<0.01 (a>c)	15.83±11.87	3.30	0.04 (a>c)	27.77±26.79	0.37	0.25
	No[b]	4.89±2.33			10.36±7.64			42.39±23.29		
	Never[c]	3.21±2.30			8.02±6.73			44.81±23.65		
Drinking	Yes	5.37±2.48	−2.20	0.03	13.00±8.60	−2.04	0.04	37.50±23.98	1.14	0.26
	No	4.14±2.41			9.11±7.34			43.67±23.5		
Total		4.33±2.48			9.83±7.70			42.52±23.63		

OSA, obstructive sleep apnea; HRQOL, health-related quality of life; SD, standard deviation; BMI, body mass index.

the clinical data of the respondents, significant differences were observed in OSA scores related to weight loss, perceived health status, cancer type, lung cancer stage, and time since diagnosis ($p<0.05$). Higher OSA scores were noted in respondents who had experienced a weight loss of 4 kg, reported poor health status, had small cell or squamous cell carcinoma, were at stage 1, and had been diagnosed within the past year. Dyspnea scores also varied significantly depending on weight loss, perceived health status, cancer type, and cancer treatment ($p<0.05$). Higher scores were found in respondents with a weight loss of 4 kg, poor health status, those diagnosed with small cell or squamous cell carcinomas, and those undergoing chemotherapy. Additionally, HRQOL scores demonstrated significant differences based on weight loss, perceived health status, and cancer type ($p<0.05$). Respondents with a weight loss of less than 4 kg, good health status, adenocarcinoma, and those receiving chemotherapy tended to have higher HRQOL scores.

Internal Consistency in OSA, Dyspnea, and HRQOL Scores

In this study, the Cronbach's α values for OSA, dyspnea, and HRQOL were 0.70, 0.95, and 0.91, respectively. These values demonstrate acceptable internal consistency [15] and are consistent with results from previous research [16–18].

Correlations among OSA, Dyspnea, and HRQOL Scores

There was a positive correlation between OSA and dyspnea scores ($r=0.36$, $p<0.01$). Conversely, HRQOL scores were negatively correlated with both OSA ($r=-0.49$, $p<0.01$) and dyspnea scores ($r=-0.60$, $p<0.01$).

Influences of Demographic and Clinical Data, OSA Scores, and Dyspnea Scores on HRQOL

The influences of independent variables, including demographic and clinical data, as well as OSA and dyspnea scores, on HRQOL are detailed in Table 5. The multiple regression analysis indicated that the regression model was significant ($F=28.503$, $p<0.01$), explaining 51.8% of the variance. The Durbin-Watson statistic was 1.956, suggesting minimal autocorrelation between the residuals. Dyspnea severity ($\beta=-0.368$, $p<0.01$) emerged as the most significant predictor of HRQOL, followed by weight loss ($\beta=0.192$, $p<0.01$), OSA score ($\beta=-0.215$, $p<0.01$), stage 2 cancer ($\beta=-0.180$, $p<0.01$), and poor perceived health status ($\beta=-0.179$, $p<0.05$). All these variables

Table 4. Comparisons of OSA, dyspnea, and HRQOL scores according to respondents' clinical characteristics

Variable	Category	OSA			Dyspnea			HRQOL		
		Mean±SD	t or F	*p* (Scheffe)	Mean±SD	t or F	*p* (Scheffe)	Mean±SD	t or F	*p* (Scheffe)
Weight loss (kg)	<4	2.96±2.29	−5.81	<0.01	7.29±6.53	−3.26	<0.01	55.75±23.17	5.56	<0.01
	≥4	5.29±2.12			11.50±7.99			33.86±19.69		
Perceived health status	Good[a]	2.39±2.14	10.77	<0.01 (a,b<c)	3.69±4.02	31.08	<0.01 (c>a)	69.20±20.32	37.30	<0.01 (a>b,c)
	Normal[b]	4.68±2.16			8.78±5.74			41.83±19.34		
	Poor[c]	5.09±2.67			16.9±8.74			24.39±16.45		
Type of lung cancer	Small cellcarcinoma[a]	5.25±2.01	3.93	0.01 (a>b, b>c)	11.67±8.25	2.93	0.03 (a,c>b)	36.35±21.16	3.06	0.03 (a<b, b>c)
	Adenocarcinoma[b]	3.77±2.49			8.31±7.09			47.26±24.22		
	Squamous cell carcinoma[c]	5.25±2.38			13.50±8.56			31.38±22.68		
	Others[d]	5.20±2.77			10.20±5.76			43.33±14.53		
Cancer stage	1[a]	4.74±2.37	2.68	0.03 (a,b<d)	7.48±4.18	2.02	0.09	47.43±21.43	2.24	0.06
	2[b]	4.93±2.12			10.35±4.97			32.39±16.93		
	3[c]	4.68±2.98			12.84±10.78			14.33±32.32		
	4[d]	3.32±2.35			10.82±10.24			45.52±24.60		
	Relapse[e]	2.50±0.70			7.00±9.89			54.16±0.00		
Time since diagnosis (y)	<1[a]	4.57±2.22	3.25	0.04 (a<c)	10.16±7.24	0.96	0.38	39.38±20.41	2.20	0.11
	1–2[b]	4.68±2.97			10.42±8.57			43.75±27.57		
	>2[c]	3.14±2.03			7.71±7.78			51.38±25.70		
Type of treatment	Surgery[a]	4.43±2.32	0.45	0.63	7.13±6.13	3.34	0.03 (a<b)	47.01±28.72	1.00	0.36
	Chemotherapy[b]	4.23±2.52			11.02±8.55			41.14±21.55		
	Radiotherapy[c]	4.87±2.55			10.43±5.03			38.67±19.71		
Total		4.33±2.48			9.83±7.70			42.52±23.63		

OSA, obstructive sleep apnea; HRQOL, health-related quality of life.

Table 5. Results of the multiple regression analysis for HRQOL

Independent variable	Unstandardized coefficients		Standardized coefficients Beta	t	*p*	Collinearity statistics		F (*p*)	R^2	Adjusted R^2	Durbin-Watson
	B	SE				Tolerance	VIF				
(constant)	73.041	3.186		22.927	<0.001			28.503 (<0.001)	0.537	0.518	1.956
Dyspnea	−1.131	0.235	−0.369	−4.820	<0.001	0.643	1.554				
Weight loss[a]	9.258	3.399	0.192	−2.723	0.007	0.756	1.323				
OSA	−2.065	0.697	−0.215	−2.962	0.004	0.712	1.404				
Cancer stage[b]											
Stage 2	−9.967	3.451	−0.181	−2.888	0.005	0.960	1.041				
Perceived heath status[c]											
Bad	−9.872	3.999	−0.179	−2.469	0.015	0.715	1.398				

Dependent variable: HRQOL.
HRQOL, health-related quality of life; SE, standard error; VIF, variance inflation factor; OSA, obstructive sleep apnea.
[a]Reference group: ≥4 kg; [b]Reference group: stage 1; [c]Reference group: good.

negatively impacted HRQOL. The regression model showed no evidence of multicollinearity among the variables, with a tolerance of ≥0.1 and a variance inflation factor of <10.

Discussion

Risk factors for lung cancer include smoking, comorbidities, obesity, exposure to dust or chemicals, personal history, and

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family history. These factors also contribute to the development of breathing difficulties, such as OSA and dyspnea, which are linked to diseases like cardiovascular disease, metabolic syndrome, and diabetes [19]. Lung cancer impairs lung cells and diminishes lung function, leading to pulmonary distress. Breathing problems can occur at all stages of cancer and may be severe even in patients with early-stage disease [20]. Psychological factors can further worsen these conditions. Additionally, these complications reduce pulmonary function and diminish cardiopulmonary endurance, making daily activities more challenging and ultimately lowering HRQOL [21]. Therefore, exploring the relationship between breathing difficulties and HRQOL could be beneficial in supporting the daily care of lung cancer survivors.

A previous study identified dyspnea as a critical outcome of OSA [22]. Consistent with these findings, our study also demonstrated a correlation between OSA and dyspnea scores. These conditions may further be associated with physical, emotional, and cognitive changes. Notably, snoring and exposure to tobacco smoke emerged as the primary risk factors for both OSA and dyspnea [23]. Fifty-eight percent of individuals at risk for OSA and dyspnea were smokers, which indicates they are nearly 3 times more likely to develop breathing problems compared to former smokers or nonsmokers [24]. Additionally, our findings suggest that the severity of OSA and dyspnea is greater in smokers than in nonsmokers. Moreover, in the context of lung cancer, variations in OSA, dyspnea, and HRQOL may be influenced by factors such as weight loss, perceived health status, and the specific type of lung cancer.

Multiple regression analysis identified several factors impacting HRQOL, including OSA, weight loss, dyspnea, cancer stage, and perceived health status. In individuals with lung cancer, HRQOL is significantly associated with the severity of OSA and dyspnea, which are consistently shown to be critical determinants of HRQOL [25]. In lung diseases, particularly cancer, severe dyspnea leads to heightened emotional distress [26]. Consequently, breathing difficulties are a prevalent issue that adversely affects HRQOL in lung cancer patients. This indicates that specific strategies targeting breathing problems, such as OSA and dyspnea, need to be developed to enhance overall health status and HRQOL in lung cancer.

Furthermore, according to previous studies, weight loss is strongly correlated with high morbidity and mortality across various etiologies and is considered a poor prognostic factor for survival in lung cancer patients [27]. A recent study highlighted a distinct difference in median survival times between patients with ≤5% weight loss (11.5–13.6 months) and those with >5% weight loss (6.7 to 8.4 months) [28]. The study also found that a weight loss of <4 kg was associated with a higher HRQOL score compared to a loss of ≥4 kg. Given that over 60% of lung cancer patients experience significant weight loss [29], this represents a major challenge that profoundly impacts their lives. Cancer cachexia is a complex metabolic syndrome characterized by muscle loss, which may or may not include fat loss, and is strongly linked to weight loss. This syndrome often involves anorexia, increased inflammation, and muscle protein breakdown [30]. Diagnosing cancer cachexia in lung cancer patients is difficult, yet approximately 50% of these patients develop some degree of cachexia before death [31]. Unintended weight and muscle loss significantly impair physical function and mobility, thereby diminishing QOL and tolerance to cancer treatments [32]. Notably, a weight loss of 4.5 kg is considered a critical factor that may shorten the survival period for cancer patients. This condition can also negatively impact treatment response, care costs, and the overall well-being of the patient. Furthermore, a recent study indicated that greater weight loss is associated with poorer QOL [33].

According to our findings, patients with stage 2 cancer had significantly lower HRQOL than those with stage 1 cancer. Previous research has found that patients with stage 1 cancer experience better physical and social well-being than those with more advanced cancer [34]. At stage 1, symptoms can be effectively managed with intensive medical care and the maintenance of healthy habits. Consequently, treatments such as chemotherapy, radiotherapy, and surgery are crucial at this stage for reducing or eliminating tumors. In contrast, despite the availability of numerous treatment options for stage 2 cancer, individuals still face significant psychological and emotional challenges. These challenges stem from anxiety and depression due to managing more severe physical conditions, as well as uncertainty about disease progression and future long-term care. This may be closely linked to the perceived health status of individuals with cancer and contributes to the deterioration of HRQOL in patients with lung cancer. These findings align with recent studies [34,35]. Therefore, it is essential for individuals with advanced-stage lung cancer to either receive effective treatment or learn to manage the psychosocial and emotional challenges associated with a cancer diagnosis, as this can help improve their HRQOL.

This study found that lung cancer patients who had a negative view of their health status showed a lower HRQOL. Perceived health status is closely associated with illness perception, which includes the mental representations and personal beliefs individuals hold about an illness [36]. Another recent study indicated that a strong illness perception could improve overall QOL [37]. Therefore, when evaluating the factors that affect QOL in lung cancer patients,

their illness representations must be taken into account. This highlights the idea that HRQOL can be improved by mitigating potential threats posed by the illness and by strengthening positive beliefs about it [38]. Thus, focusing on illness perception is a clinically relevant strategy for boosting the HRQOL of lung cancer survivors.

We acknowledge several limitations of our study that should be addressed in future research. First, our reliance on online data collection through sampling may have skewed the results, as this method depends on the willingness of respondents to participate in surveys and only captures data from individuals who have access to online platforms. Importantly, older adults often face difficulties in using the internet and engaging with social network services, which could make it challenging to generalize our findings to the entire population. Second, the use of a self-administered Google survey might produce different outcomes compared to surveys conducted by physicians or healthcare professionals [39]. Individuals managing specific medical conditions might provide responses they believe to be accurate, potentially biasing their answers. Moreover, the absence of direct physical interaction in online surveys can lead to issues such as the effects of cancer treatment, participation of inappropriate respondents, and misunderstandings of the questionnaire, all of which could compromise the accuracy of the data. These factors are considered limitations of the study. Therefore, our findings need to be validated in studies conducted in clinical settings. Lastly, it is important to consider potential variations in responses between newly diagnosed patients and those with advanced lung cancer, as response rates to questionnaires may vary depending on the stage of the disease.

Conclusion

In individuals with lung cancer, breathing difficulties such as OSA and dyspnea are life-threatening symptoms that significantly impact HRQOL. To develop therapeutic strategies addressing the physical and emotional issues associated with lung cancer, it is essential to first evaluate and explore the relationships between these problems using appropriate assessment tools. The purpose of this study was to identify the demographic and clinical factors influencing OSA, dyspnea, and HRQOL, and to explore the relationships among them in lung cancer patients. Our results revealed a significant relationship among OSA, dyspnea, and HRQOL. HRQOL is significantly influenced by several factors related to lung cancer, including dyspnea, weight loss, OSA, cancer stage, and perceived health status. These findings suggest that breathing difficulties such as OSA and dyspnea contribute to decreased HRQOL. This study provides valuable insights for researchers and clinicians to develop suitable strategies to manage these challenges in daily life.

Notes

Ethics Approval

This study was approved by the Cheongju University Institutional Review Board (approval number: 1041107-202208-HR-029-01) and performed in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained for publication of this study.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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None.

Availability of Data

The datasets are not publicly available but are available from the corresponding author upon reasonable request.

Authors' Contributions

Conceptualization: HK, DO; Data curation: HK; Formal analysis: DO, DK; Investigation: all authors; Methodology: HK, DO; Project administration: HK, DO; Resources: HK; Software: HK, DO; Supervision: DO; Writing–original draft: HK, DO; Writing–review & editing: all authors. All authors read and approved the final manuscript.

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