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ORIGINAL RESEARCH

Post-Operative Poor Sleep Quality and Its Associated Factors Among Non-Small Cell Lung Cancer Patients: A Cross-Sectional Study

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Objective: The study aimed to determine the post-operative prevalence and factors associated to poor sleep quality in non-small cell lung cancer (NSCLC) patients in China.

Methods: NSCLC patients (n=307) who underwent thoracoscopic surgery at the Department of Thoracic Surgery of Shanghai Pulmonary Hospital were enrolled in this study. The Pittsburgh Sleep Quality Index (PSQI), Generalized Anxiety Disorder-7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9), Prince Henry Hospital Pain Score and the Six-Minute Walk Test (6MWT), and Forced Expiratory Volume in one second (FEV-1) were used to assess the factors that could lead to poor sleep quality. All assessments were carried out between April 1 and May 30, 2023. Descriptive analyses and stepwise factor regression were employed to determine the impact of various factors on sleep quality. The factors predictive of poor sleep quality were used to develop a predictive nomogram. The Hosmer-Lemeshow test was used to assess the predictive value of the nomogram.

Results: The median PQSI score was 8 (interquartile range (IQR) 5–12), and 74.6% of patients had poor sleep quality. The median anxiety and depression scores were 6 (IQR 3–9) and 4 (IQR 2–7), respectively. The PSQI latency dimension had the highest score, while the use of sleep medications dimension had the lowest score. The multivariate analysis revealed that patients who were female (OR, 2.38; 95% CI, 1.40–4.05; P <0.01), had post-secondary education (OR, 0.42; 95% CI, 0.19–0.92; P =0.03), tertiary education (OR, 0.38; 95% CI, 0.17–0.84; P =0.02), comorbidities (OR, 2.57; 95% CI, 1.51–4.39; P <0.01), a pain score 1 (OR, 4.22; 95% CI, 2.37–7.50; P <0.01), and cough (OR, 2.97; 95% CI, 1.63–5.40; P <.001) were more like to experience poor sleep quality. The positive predictive value of the nomogram was 79.80% (p=0.390).

Conclusion: Sociodemographic variables, comorbidities, and pain could be used to predict the post-operative sleep quality in NSCLC patients.

Keywords: carcinoma, non-small-cell lung, associated factors, sleep quality

Introduction

Lung cancer is one of the most common malignancies worldwide and the leading contributor to cancer-related mortality.[1] Advancements in diagnostic, surgical techniques, immunotherapy and chemotherapy have led to an improvement in survival in lung cancer patients. Thoracoscopic surgery continues to be the primary treatment modality for early-stage non-small cell lung cancer (NSCLC).[2,3] Numerous studies have demonstrated that lung cancer patients tend to exhibit lower sleep quality compared to those with other cancer types.[4,5] Poor sleep quality was found to contribute to poor post-operative rehabilitation, physical performance,[6] and overall quality of life.[7] Moreover, cancer patients with poor sleep quality were also found to be at risk of developing physical injuries, cognitive impairment,[8,9] pain sensitivity, and cardiovascular events.[10] Sleep disturbances tend to coexist with other medical conditions, and patients tend to seek

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medical intervention only when their symptoms become severe.[6] Sociodemographic variables, disease-related circumstances, exercise capacity, and psychological factors have all been linked to poor sleep quality.

Studies have identified younger age,[11] lower educational status, female gender,[12] poorer financial status, and higher body weight[13,14] as risk factors for poor sleep quality. Divorced or widowed individuals tended to experience better sleep quality compared to those who remained married, while those who became divorced had poorer sleep quality.[15] Furthermore, poor sleep was associated with educational level among post-operative patients.[16]

A cancer diagnosis and the demanding nature of cancer treatment frequently give rise to heightened anxiety, stress, and depression in patients. Multiple studies[17,18] have highlighted the connection between these psychological challenges and poor sleep quality. Furthermore, anxiety and stress can amplify the somatization of physical symptoms, such as pain, which can exacerbate patients' distress and hinder their overall well-being during the cancer journey.[19]

Poor sleep was also associated with several comorbidities, including cardiovascular disease, hypertension, type 2 diabetes, and obstructive sleep apnea (OSA).[20] OSA was found to be present in 56.6% of patients with lung conditions.[21] These findings suggest that comorbidities may contribute to worse sleep quality in lung cancer patients.

As a result of the disease, the majority of lung cancer patients tend to experience pain, coughing, shortness of breath, and difficulty walking.[22] Studies have shown that these symptoms can interfere with sleep and increase the perception of pain.[9,23] A poor lung function can further exasperate these symptoms and thus contribute to poor sleep quality. Various factors can lead to poor lung function, including such as tobacco smoking and lack of exercise.[24–26] A strong correlation was found between exercise capacity and sleep.[27] Exercise can improve sleep by reducing sleep latency and increasing slow-wave sleep.[28] Chen et al has shown that engaging in 4 hours of exercise before bedtime can improve the sleep quality[29] and improve overall quality of life in lung cancer patients.[30]

Lung cancer surgery can further reduce the lung function. In addition, the surgical trauma, post-operative pain, and prolonged chest tube drainage can further increase the discomfort and interfere with sleep quality.[31] Although previous studies have explored sleep problems in advanced lung cancer patients and those undergoing chemotherapy, there is limited research on the sleep problems experienced by NSCLC patients following surgery. Therefore, this study aimed to make use of the Pittsburgh Sleep Quality Index (PSQI) to determine the prevalence of poor sleep quality among lung cancer patients during the first month after thoracic surgery. In addition, the impact of sociodemographic factors, lung function, pain, anxiety, depression, comorbidities, and 6-minute walk time (6MWT) on post-operative sleep quality was also assessed. These factors were then used to develop a nomogram to predict poor sleep quality in lung cancer patients treated with thoracic surgery.

Materials and Methods

Participants

We conducted a cross-sectional study in a Class III Grade A hospital in Shanghai between April 1 to May 30, 2023. We recruited participants from the department of thoracic surgery's outpatients. A total of 307 NSCLC patients participated in this research.

Inclusion Criteria and Exclusion Criteria

Inclusion Criteria

a. histopathology confirmed the diagnosis of non-small cell lung cancer; b. 1 month after thoracoscopic surgery; c. No distant metastases, or chemotherapy or radiation treatment received; d. Participants signed informed consent forms voluntarily; e. Age older than 18 years.

Exclusion Criteria

a. Unstable patients who need immediate medical attention; b. moderate to severe cognitive impairment; c. Patients with psychosis or severe suicidal ideation with planning and intent; d. people with severe hearing and visual impairment.

Methods

Standard protocol approvals, registrations, and patient consents. The study protocol and consent forms were approved by the institutional ethics committee of Shanghai Pulmonary Hospital (Ethics number: Q23-347) and conducted in accordance with the Declaration of Helsinki and other international ethics guidelines. Patients provided written informed consent.

Sample-Size Calculation

We used one method to calculate sample size for logistic regression analysis: one requires a minimum of 10 observations per variable.[32] The size of the sample might be adequate for the method.

Data on demographic and clinical variables, including age, gender, BMI, education (primary school or below, junior high school, high school, university), marital status (never married, married, divorced, widowed), annual income (RMB, converting yuan to dollars or euro at the current conversion rate) (<50,000 yuan, 50,000–100,000 yuan, >100,000 yuan), smoking history (yes or no), presence of comorbidities (like 2 diabetes mellitus, hypertension, heart disease) (yes or no), a clinical diagnosis of obstructive sleep apnea based on polysomnography (yes or no), coughing (yes or no), shortness of breath (yes or no), surgical approach (lobectomy or segmentectomy), robotic resection (yes or no), and chest tube indwelling time (days from the operation until chest tube removal).

The Pittsburgh questionnaire, compiled by Buysse et al,[33] comprises nineteen items, with five items rated by sleep companions. The researchers calculated scores for 18 self-rated items related to seven domains, including subjective sleep quality, sleep latency, sleep duration, sleep disturbances, sleep medication administration, and daytime dysfunction. Likert scale (0–3) scoring for items. The cumulative score ranges from 0 to 21, with higher total scores showing poorer sleep quality. The best cutoff score to distinguish good and poor sleepers was 5, with a sensitivity of 89.6% and a specificity of 86.5% (kappa = 0.75, $p \leqslant 0.001$). This study had a Cronbach's alpha of 0.73. A self-rated questionnaire is used to assess sleep quality and disturbances over a period of one month.

The Patient Health Questionnaire (PHQ-9) was used to screen for depression.[34] This questionnaire contains nine items that record the frequency and rate of nine symptoms over the past two weeks. The scale ranges from 0 to 27. There are four levels of depression based on severity: minimal (0–4), mild (5–9), moderate (10–14), moderately severe (15–19) and severe (20 and over). The Chinese version of the PHQ-9 can detect depressive symptoms in lung cancer patients with high sensitivity. The cut-off score for this questionnaire is often 10.[35] This study had a Cronbach's alpha of 0.78.

The Generalized Anxiety Disorder (GAD-7) scale was used to screen for GAD and assess its severity.[36] The scale identifies probable cases of GAD through self-report, which can be categorized into four severity groups: minimal (0 to 4), mild (5 to 9), moderate (10 to 14) and severe (15 to 21). There is good reliability and validity in terms of its procedure. GAD-7 scores greater than or equal to 8 to define anxiety cases.[37] This study had a Cronbach's alpha of 0.87.

The Prince Henry Hospital Pain Score was often used to screen for pain after thoracic surgery.[38] It measures pain during basic activities: 0 (no pain on cough), 1 (pain on cough but not on deep breaths), 2 (pain on deep breathing but no pain on rest), 3 (slight pain at rest), and 4(severe pain at rest), as shown in Figure 1.

The Six-Minute Walk Test (6MWT) was performed at the first month post-procedure. The test was conducted according to a brief step-by-step protocol[39] using 2 white lines separated by a known distance along an internal flat corridor of 30 m. During the test, patients were instructed to walk for six minutes to cover as much distance as possible, but not run or jog. It was permissible to stop during the test and rest, but participants had to resume walking after resting. Meters were recorded in the 6MWT as the total distance walked.

Pulmonary function tests were performed by technicians in the Pulmonary Function laboratory, the Shanghai Pulmonary Hospital. The spirometry test was conducted using a spirometry device (Masterscreen PFT, Jaeger, Germany). The procedure was followed in accordance with the guidelines of the ATS-ERS.[40] The forced expiratory capacity at the first second of exhalation (FEV1) was measured.

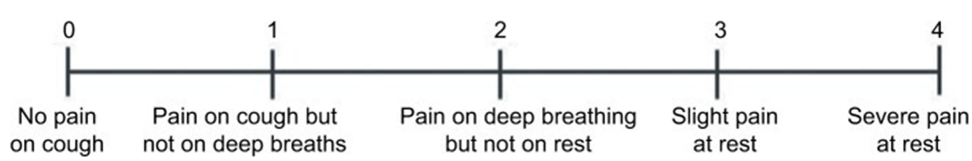

Figure 1 Prince Henry Hospital Pain Score.

Data Collection

In this investigation, all participants were invited to complete the questionnaire through face to face. The investigators explained the aim of the study to the participants and got their informed consent before the data collection process. The surveyors completed the questionnaires on-site and returned them immediately to the investigators. We contacted patients to ensure accurate data collection in the event of missing or improperly filled-out records. We extracted additional demographic and clinical information from each participant's medical record. Physical evaluators were trained physical therapists/ certified pulmonary function technicians. Assessments were performed in the same order (pulmonary function and 6MWD).

Data Processing and Analysis

The EpiData version 3.1 software (EpiData Association, Odense, Denmark) was used for data entry and validation. All statistical analyses were conducted using the programming language R (R 4.3.0; The R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics were used to determine the distribution of demographic characteristics, including age, gender, BMI, education level, marital status, annual income, and so on. There are descriptive statistics for both groups presented as numbers and percentages or medians (interquartile ranges) if the distribution is skewed. χ^2 test or Fisher exact probability method or rank sum test was used for comparison between groups.

All multicategorical covariates were treated as categorical covariates. A stepwise logistic regression was applied in the exploratory phase of the statistical modeling. To determine the statistical significance of a single predictive variable, the Wald test and likelihood ratio test were used. The variable was included in the model only if both tests were significant. Before determining the final model, multicollinearity was checked. In this study, a 2-tailed $P<0.05$ was selected as the level of statistical significance.

Results

Participants' Characteristics

A total of 307 patients diagnosed with non-small cell lung cancer (NSCLC) within the first month following surgery were included in the study. The characteristics of these patients are summarized in Table 1. The average age of the participants was 59.97 years, with a range of 22 to 77 years (standard deviation = 11.63). The female population accounted for 53.09% of the sample, while males constituted 46.91%. The majority of the patients were married, comprising 92.83% of the total. Approximately 21.82% of the patients had received a limited education, consisting of primary school or lower. Additionally, 33.6% of the population were classified as overweight, with a body mass index (BMI) exceeding 25 kg/m^2. Among the participants, 27.36% reported an annual income below 50,000 yuan. Furthermore, 33.88% of the patients had a history of smoking. One or more comorbidities were present in 51.79% of patients. 40.72% were diagnosed with

Table 1 Characteristics of the Study Participants (n=307)

Variable	Total (n = 307)	Good Sleep (n = 78)	Poor Sleep (n = 229)	Statistic	P
Age (years), M (Q_1, Q_3)	60.00 (53.00–70.00)	60.00 (53.00–70.00)	59.00 (54.00–70.00)	Z=9.62	0.69
BMI (kg/m^2), M (Q_1, Q_3)	23.71 (21.70–26.02)	24.08 (23.12–25.95)	23.71 (21.50–26.27)	Z=8.90	0.21
Chest tube duration (day), M (Q_1, Q_3)	4.00 (3.00–5.00)	4.00 (3.00–5.00)	4.00 (3.00–5.00)	Z=9.63	0.67
FEV1 (L/min), M (Q_1, Q_3)	1.64 (1.62–1.67)	1.65 (1.62–1.67)	1.64 (1.62–1.67)	Z=9.06	0.37
6MWD (m), M (Q_1, Q_3)	520.00 (460.00–530.00)	512.00 (456.00–530.00)	520.00 (460.00–540.00)	Z=9.84	0.37
PHQ-9, M (Q_1, Q_3)	6.00 (3.00–9.00)	5.50 (2.25–8.00)	6.00 (3.00–9.00)	Z=9.80	0.42
GAD-7, M (Q_1, Q_3)	4.00 (2.00–7.00)	4.00 (1.00–6.00)	4.00 (2.00–7.00)	Z=9.98	0.22
Gender, n (%)				χ^2=10.64	<0.01
Male	144 (46.91)	49 (62.82)	95 (41.48)		
Female	163 (53.09)	29 (37.18)	134 (58.52)		

(*Continued*)

Table 1 (Continued).

Variable	Total (n = 307)	Good Sleep (n = 78)	Poor Sleep (n = 229)	Statistic	P
2 diabetes mellitus, n (%)				χ^2=14.68	<0.01
No	267 (86.97)	58 (74.36)	209 (91.27)		
Yes	40 (13.03)	20 (25.64)	20 (8.73)		
Hypertension, n (%)				χ^2=0.36	0.55
No	182 (59.28)	44 (56.41)	138 (60.26)		
Yes	125 (40.72)	34 (43.59)	91 (39.74)		
Heart disease, n (%)				χ^2=2.01	0.16
No	284 (92.51)	75 (96.15)	209 (91.27)		
Yes	23 (7.49)	3 (3.85)	20 (8.73)		
OSA, n (%)				χ^2=0.44	0.51
No	293 (95.44)	76 (97.44)	217 (94.76)		
Yes	14 (4.56)	2 (2.56)	12 (5.24)		
Surgery type, n (%)				χ^2=2.35	0.13
Segment resection	214 (69.71)	49 (62.82)	165 (72.05)		
Lobectomies	93 (30.29)	29 (37.18)	64 (27.95)		
Robotic resection, n (%)				χ^2=1.67	0.20
No	293 (95.44)	77 (98.72)	216 (94.32)		
Yes	14 (4.56)	1 (1.28)	13 (5.68)		
Annual income (yuan), n (%)				χ^2=2.85	0.24
< 50,000	84 (27.36)	23 (29.49)	61 (26.64)		
50,000–100,000	129 (42.02)	37 (47.44)	92 (40.17)		
>100,000	94 (30.62)	18 (23.08)	76 (33.19)		
Marital status, n (%)				Fisher	0.04
Never married	4 (1.3)	1 (1.28)	3 (1.31)		
Married	285 (92.83)	73 (93.59)	212 (92.58)		
Divorced	11 (3.58)	0 (0.00)	11 (4.80)		
Widowed	7 (2.28)	4 (5.13)	3 (1.31)		
Education, n (%)				χ^2=11.03	0.01
Primary school or lower	67 (21.82)	11 (14.10)	56 (24.45)		
Junior high school	77 (25.08)	13 (16.67)	64 (27.95)		
High school	81 (26.38)	26 (33.33)	55 (24.02)		
University	82 (26.71)	28 (35.90)	54 (23.58)		
Presence of comorbidities				χ^2=12.36	<0.01
No	148 (48.21)	51 (65.38)	97 (42.36)		
Yes	159 (51.79)	27 (34.62)	132 (57.64)		
Smoking history, n (%)				χ^2=0.90	0.34
No	203 (66.12)	55 (70.51)	148 (64.63)		
Yes	104 (33.88)	23 (29.49)	81 (35.37)		
Pain score, n (%)				Fisher	<0.01
0	84 (27.36)	37 (47.44)	47 (20.52)		
1	197 (64.17)	31 (39.74)	166 (72.49)		
2	23 (7.49)	8 (10.26)	15 (6.55)		
3	3 (0.98)	2 (2.56)	1 (0.44)		
Shortness of breath, n (%)				χ^2=0.06	0.80
No	90 (29.32)	22 (28.21)	68 (29.69)		
Yes	217 (70.68)	56 (71.79)	161 (70.31)		
Cough, n (%)				χ^2=13.42	<0.01
No	59 (19.22)	26 (33.33)	33 (14.41)		
Yes	248 (80.78)	52 (66.67)	196 (85.59)		

Note: Yuan (¥; ¥ 1 equivalent to 0.15 United States dollars).
Abbreviations: FEV1, forced expiratory volume in one second; OSA, obstructive sleep apnea; BMI, Body Mass Index; 6MWD, Six-minute walk distance; PHQ-9, The Patient Health Questionnaire; GAD-7, the Generalized Anxiety Disorder 7-item scale.

hypertension, 13.02% were diagnosed with diabetes mellitus, 7.49% were diagnosed with heart disease, and 4.56% suffered from obstructive sleep apnea. 214 patients (69.71%) received lobectomy, while 93 patients (30.29%) received segmentectomy. A small proportion of patients (4.56%) underwent surgical resection using robotic procedures. The median duration of chest tube drainage was 4 days, with an interquartile range (IQR) of 3–5 days. The median forced expiratory volume in 1 second (FEV1) was 1.64 L/min, with an IQR of 1.62–1.67 L/min, and the median 6-minute walk distance (6MWD) was 520 m, with an IQR of 460–530 m. During the 30-day follow-up after surgery, the majority of patients (80.78%) reported cough, while 70.68% experienced shortness of breath and 72.64% had pain symptoms that did not affect their rest. 74.6% of the patients with lung cancer after surgery evaluated reported poor sleep quality, and PQSI scores had a median of 8, with an interquartile range (IQR) of 5–12. The anxiety scores had a median of 6, with an interquartile range (IQR) of 3–9, while the depression scores had a median of 4, with an IQR of 2–7.

Prevalence of Anxiety and Depression Symptoms

The prevalence of anxiety and depression among patients diagnosed with non-small cell lung cancer (NSCLC) is presented in Table 2. Among the NSCLC patients, 46.26% and 61.89% exhibited mild to severe levels of anxiety or depression, respectively, as indicated by a score of ≥5. Additionally, 15.31% of individuals scored ≥8 on the Generalized Anxiety Disorder 7-item scale (GAD7), indicating anxiety disorders, while 21.82% scored ≥10 on the Patient Health Questionnaire 9-item scale (PHQ9), indicating depressive disorders.

Sleep Quality Score Distribution

The dimension with the highest score (3 points) was sleep latency. The second dimension with the highest score was sleep efficiency. Conversely, the use of sleep medications scored lowest, with most patients reporting they do not use them (Figure 2).

Factors Associated with Sleep Quality

A univariate analysis was performed for variables independently. Female (OR, 2.38; 95% CI, 1.40–4.05; P <0.01), high school (OR, 0.42; 95% CI, 0.19–0.92; P =0.03), university (OR, 0.38; 95% CI, 0.17–0.84; P =0.02), presence of comorbidities (OR, 2.57; 95% CI, 1.51–4.39; P <0.01), pain score 1 (OR, 4.22; 95% CI, 2.37–7.50; P <0.01), and cough (OR, 2.97; 95% CI, 1.63–5.40; P <.001) were statistically significantly associated with poor sleep (Table 3). Collinearity between associated factors and other variables than tested was excluded (such as comorbidities with cardiovascular disease, hypertension, type 2 diabetes). After adjustment, each predictor had a variance inflation factor below 10 and a tolerance greater than 0.1, so there was no multicollinearity among them. Furthermore, a multivariate analysis identified that female (OR, 2.31; 95% CI, 1.24–4.30; P <0.01), high school (OR, 0.34; 95% CI, 0.14–0.85; P =0.02), university (OR, 0.23; 95% CI, 0.08–0.60; P <0.01), presence of comorbidities (OR, 4.38; 95% CI, 2.17–8.82; P <0.01), pain score 1 (OR, 4.08; 95% CI, 2.10–7.94; P <0.01), and cough (OR, 2.91; 95% CI, 1.44–5.87; P <0.01) were

Table 2 Prevalence of Anxiety and Depression Among Lung Cancer Patients During the First Month After Surgery

Variable	Total (n = 307)	Good Sleep (n = 78)	Poor Sleep (n = 229)	Statistic	P
Severity of anxiety (GAD-7), n (%)				Fisher	0.72
Score 5–9 (mild)	116 (37.79)	26 (33.33)	90 (39.30)		
Score 10–14 (moderate)	24 (7.82)	6 (7.69)	18 (7.86)		
Score ≥15 (severe)	2 (0.65)	0 (0.00)	2 (0.87)		
Severity of depression (PHQ-9), n (%)				Fisher	0.28
Score 5–9 (mild)	123 (40.07)	26 (33.33)	97 (42.36)		
Score 10–14 (moderate)	46 (14.98)	10 (12.82)	36 (15.72)		
Score 15–19 (moderately severe)	20 (6.51)	8 (10.26)	12 (5.24)		
Score ≥20 (severe)	1 (0.33)	0 (0.00)	1 (0.44)		

Abbreviations: GAD-7, the Generalized Anxiety Disorder 7-item scale; PHQ-9, The Patient Health Questionnaire.

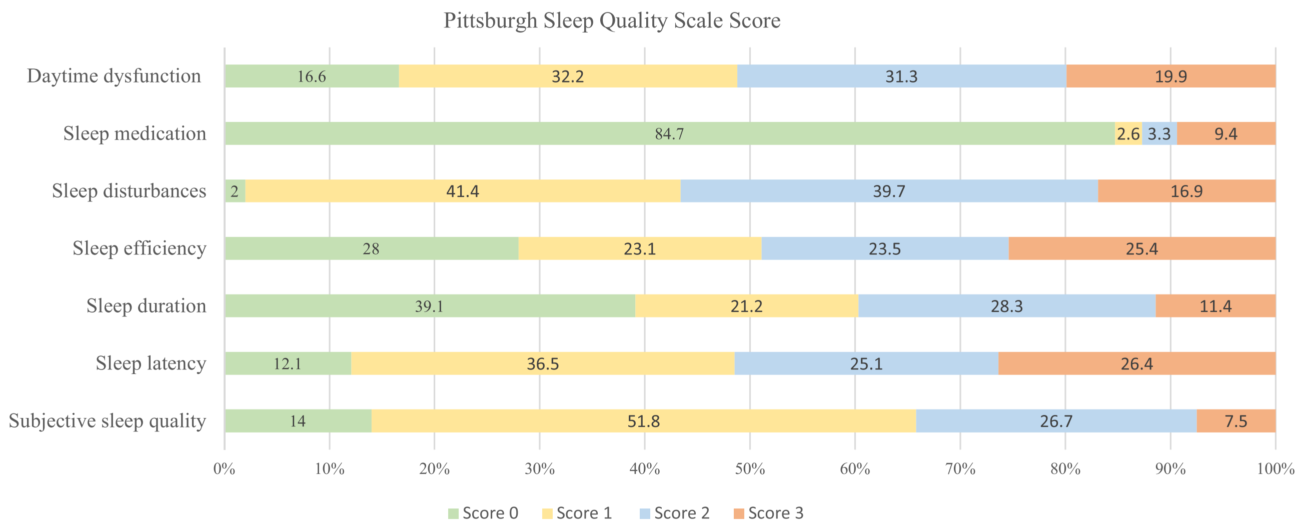

Figure 2 Distribution of the score of each dimension of the PSQI (n = 307).

independent predictors of poor sleep (Table 3). A Hosmer-Lemeshow test demonstrated a nonsignificant *P*=0.39. Although this model has an accuracy of 79.80%, a large amount of variability remained unexplained (Nagelkerke R^2 coefficient, 31.5%). A nomogram was produced by incorporating associated factors (Figure 3).

Table 3 Univariate and Multivariate Logistic Regression of Variables Independently Associated with Poor Sleep

Variables	**Univariate Logistic Regression**		**Multivariate Logistic Regression**	
	OR (95% CI)	**P value**	**OR (95% CI)**	**P value**
Age	1.00 (0.98–1.02)	0.844		
BMI	0.94 (0.86–1.03)	0.182		
Chest tube duration	1.08 (0.97–1.19)	0.162		
FEV1	0.07 (0.00–1.95)	0.118		
6MWD	1.00 (1.00–1.01)	0.265		
PHQ-9	1.02 (0.96–1.08)	0.573		
GAD-7	1.04 (0.97–1.12)	0.297		
Gender				
Male	Ref		Ref	
Female	2.38 (1.40–4.05)	0.001	2.31 (1.24–4.30)	<0.01
Surgery type				
Segment resection	Ref			
Lobectomies	0.66 (0.38–1.13)	0.127		
Robotic resection				
No	Ref			
Yes	4.63 (0.60–36.02)	0.143		
Annual income (yuan)				
< 50,000	Ref			
50,000–100,000	0.94 (0.51–1.73)	0.837		
>100,000	1.59 (0.79–3.21)	0.195		
Marital status				
Never married	Ref			
Married	0.97 (0.10–9.45)	0.978		
Divorced	5,217,120.26 (0.00-Inf)	0.983		
Widowed	0.25 (0.02–3.77)	0.317		

(*Continued*)

Table 3 (Continued).

Variables	Univariate Logistic Regression		Multivariate Logistic Regression	
	OR (95% CI)	P value	OR (95% CI)	P value
Education				
Primary school or lower	Ref		Ref	
Junior high school	0.97 (0.40–2.33)	0.940	0.84 (0.30–2.31)	0.73
High school	0.42 (0.19–0.92)	0.031	0.34 (0.14–0.85)	0.02
University	0.38 (0.17–0.84)	0.016	0.23 (0.08–0.60)	<0.01
Presence of comorbidities				
No	Ref		Ref	
Yes	2.57 (1.51–4.39)	<0.001	4.38 (2.17–8.82)	<0.01
Smoking history				
No	Ref			
Yes	1.31 (0.75–2.28)	0.344		
Pain score				
0	Ref		Ref	
1	4.22 (2.37–7.50)	<0.001	4.08 (2.10–7.94)	<0.01
2	1.48 (0.57–3.86)	0.427	1.73 (0.54–5.53)	0.36
3	0.39 (0.03–4.51)	0.454	0.16 (0.01–2.11)	0.16
Shortness of breath				
No	Ref			
Yes	0.93 (0.53–1.64)	0.803		
Cough				
No	Ref		Ref	
Yes	2.97 (1.63–5.40)	<0.001	2.91 (1.44–5.87)	<0.01

Note: Yuan (¥; ¥ 1 equivalent to 0.15 United States dollars).
Abbreviations: BMI, Body Mass Index; FEV1, forced expiratory volume in one second; 6MWD, Six-minute walk distance; PHQ-9, The Patient Health Questionnaire; GAD-7, the Generalized Anxiety Disorder 7-item scale.

Discussion

Poor sleep quality can contribute to post-operative complications, including delirium, heightened pain perception, longer hospital stays (LOS), and delayed neurocognitive recovery.[41] Furthermore, poor sleep has been linked to increased risk of cardiovascular diseases such as coronary heart disease, hemorrhagic stroke, ischaemic stroke, and even cancer

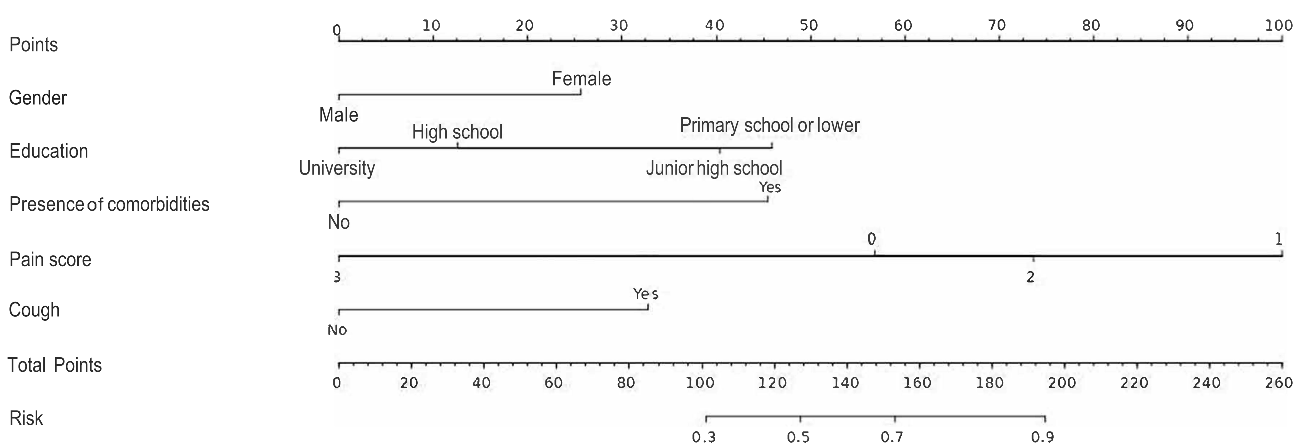

Figure 3 Nomogram for estimating poor sleep quality in non-small cell lung cancer patients.
Abbreviations: PSQI, Pittsburgh Sleep Quality Index; GAD-7, the Generalized Anxiety Disorder 7-item scale.; PHQ-9, the Patient Health Questionnaire; NSCLC, non-small cell lung cancer; OSA, obstructive sleep apnea; BMI, Body Mass Index; 6MWT, Six-minute walk test; 6MWD, Six-minute walk distance, IQR, interquartile range; FEV1, the first second of exhalation; BMI, body mass index; LOS, longer hospital stays.

mortality.[42] Therefore, an accurate assessment of factors leading to poor post-operative sleep quality is crucial for risk stratification and planning of post-operative care of NSCLC patients. However, post-operative sleep quality is often overlooked by healthcare professionals and few studies have explored the association between poor sleep quality and disease-related factors, exercise capacity, and psychological factors in NSCLC patients after surgery. Therefore, in this study, we developed a novel predictive nomogram to predict the post-operative sleep quality in NSCLC patients based on sociodemographic variables, disease-related factors, exercise capacity, and psychological factors.

Our findings indicate that 74.6% of the patients with NSCLC experience poor sleep quality after surgery. The median PQSI score was 8 (IQR 5–12). These findings are consistent with previous research that has reported varying rates of poor sleep quality among lung cancer patients, ranging from 44.7% to 86.4%.[43–45] However, it is interesting to note that the incidence of poor sleep quality was higher when compared with that in patients with other types of cancer. Fekih-Romdhane et al reported that 66% of breast cancer patients experienced poor sleep quality (PSQI scores >5).[46] Zhu et al[47] reported a mean global PSQI score of 6.57 (SD, 4.28) following a liver transplant. These findings collectively highlight the significant impact of cancer and surgery on sleep quality. Consistent with previous longitudinal studies on post-operative sleep quality after lung cancer surgery, the "falling asleep" and "poor sleep efficiency" domains of the PSQI received the highest score after surgery.[11,48] These findings are particularly important because sleep latency and sleep efficiency are affected by poor post-operative pain control and other symptoms.

Consistent with previous work, various demographic factors have been linked with poor sleep quality in cancer patients. Similarly to the study of Halle et al,[11] female patients were more likely to experience poor sleep quality than male patients. However, actigraphy data shows that women tend to have deeper and longer sleep than men.[49] Therefore, further research using objective assessment tools is needed to investigate sleep quality in lung cancer patients. The poor sleep quality in women with lung cancer may be attributed to changes in circadian rhythms. Women's circadian rhythms of melatonin and body temperature are set earlier than men's.[50]

Consistent with previous studies, higher education levels were associated with better sleep quality among cancer patients.[20,51,52] We believe that patients with higher education often possess better health literacy, enabling them to make more informed decisions about their medical conditions, which can reduce anxiety and improve sleep. Studies have shown that patients with higher education are more likely to comprehend the prescribed treatment, leading to greater treatment adherence, for example, with pain medications.[53] However, not all studies found an association between education and sleep.[54] Conversely, a study by Wang et al found that highly educated cancer patients were more likely to suffer from sleep disorders.[55] Therefore, further research is needed to understand the factors that may lead to poor sleep quality in the educated population.

Patients with lung cancer who underwent surgical treatment experienced both pain and disturbed sleep during the disease trajectory.[56] Similarly to the findings of Nishiura et al, we also observed a significant correlation between sleep and pain scores.[9] Pain can disrupt the mechanisms of sleep onset and maintenance. A lack of sleep can further exasperate the perception of pain.

Poor sleep was found to be significantly associated with cough in this study. Harle et al reported that 15% of lung cancer patients experienced disturbed sleep due to coughing.[57] Additionally, 62% of lung cancer patients reported severe painful coughs that required treatment. In our own study, 80.78% of patients reported coughing, with a pain score of 1. Patients tended to report pain during coughing and not when taking deep breaths. These findings suggest that coughing may cause pain, which in turn interferes with sleep. Although coughing is a common, distressing symptom in lung cancer patients, this symptom is often overlooked by healthcare professionals and poorly managed. Therefore, further research is needed to develop effective interventions to manage this symptom.

Previous studies found a strong correlation between comorbidities and sleep.[11,43] However, in our analysis, we did not find an association between hypertension, diabetes mellitus, heart disease, and obstructive sleep apnea. Although we did not include these factors in the final model, we still believe that these comorbidities should be closely monitored as they may have an indirect effect on sleep quality.

Poor sleep quality has been linked with various psychological factors. The GAD7 and PHQ9 assessment showed that 45% of NSCLC patients undergoing surgery exhibited symptoms of depression and anxiety. These findings highlight the need for comprehensive assessment and management of depression and anxiety in lung cancer patients to improve sleep quality after surgery.

We did not identify any significant association between sleep quality and the type of thoracic surgery. This observation may be due to the similarity in symptom burden experienced during the early post-operative period for both thoracoscopic segmentectomy and lobectomy procedures.[58]

Exercise has shown promising results in improving sleep in cancer survivors[59] and is recommended by various oncology guidelines.[60] However, these studies did not focus on lung cancer patients who may find it difficult to engage in exercise due to poor lung function. In our study, we did not find any association between exercise and sleep quality.

Strength of the Study

Study participants were outpatients at Shanghai Pulmonary Hospital, China's largest specialized pulmonary hospital. The study encompassed a diverse patient population originating from various regions of China, leading to a reduction in the required sample size. Consequently, the potential for generalizing the findings was enhanced. A nomogram was devised and validated to provide personalized estimations of the probability of experiencing poor sleep quality, considering factors such as gender, education level, presence of comorbidities, pain severity, and cough. Consequently, healthcare practitioners can employ risk stratification to evaluate and implement timely interventions for sleep-related issues in their patients.

Limitation of the Study

This study has some limitations that have to be acknowledged. The sample size of this study was small and the data were collected from a single center. Due to the cross-sectional nature of our study, we did not assess the changes in sleep quality over time. Moreover, since we did not have the pre-surgical sleep quality assessment data, we could not compare the impact of surgery on sleep quality. Therefore, further larger multicenter longitudinal studies are required to obtain a more realistic picture of the findings. Moreover, this study was based on qualitative assessments of sleep quality and exercise. In future studies, we recommend the use of more objective indicators to measure these parameters, such as actigraphy, exercise trackers, and smart wearable devices.

Conclusion

A high frequency of lung cancer patients had poor sleep quality during the first month after surgery. Furthermore, sociodemographic variables, comorbidities, and pain may also exhibit an association with sleep quality. Consequently, it is advisable to regularly screen for poor sleep among lung cancer patients, identify those at heightened risk of experiencing poor sleep, and offer specialized supportive care.

Ethics Statement

The study was approved by the institutional ethics committee of Shanghai Pulmonary Hospital (No. Q23-347). Survey responses were anonymous, except for demographics, and no personal information was disclosed. Furthermore, the study was conducted in accordance with Helsinki Declaration principles.

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Author Contributions

All authors made a significant contribution to the work reported; including, the study design, execution, acquisition of data, analysis and interpretation, drafting, revising and critically reviewing the article. All authors have endorsed the final version of the manuscript and agreed to publish the article in Cancer Management and Research. Furthermore, we collectively accept responsibility for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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