Asian Journal of Current Research in Clinical Cancer
ISSN: 3062-4444
2026, Volume 6, Issue 1, Page No: 212-224

Available online at: www.galaxypub.co/page/journals

Galaxy Publication

Galaxy Publication

Adherence to Pulmonary Rehabilitation after Lung Cancer Surgery: A Cross-Sectional Survey of Clinical and Sociodemographic Predictors

Oliver Grant[1], David Clark[1]*, Sophia Nguyen[2]

[1]Department of Clinical Oncology and Translational Cancer Research, Faculty of Medicine, University of Glasgow, Glasgow, United Kingdom.
[2] Department of Cancer Informatics and Clinical Therapeutics, Faculty of Medicine, National University of Singapore, Singapore.

***E-mail** ✉ david.clark@gmail.com

Received: 12 January 2026; **Revised:** 18 May 2026; **Accepted:** 21 May 2026

ABSTRACT

Pulmonary rehabilitation is essential for maximizing recovery after lung cancer surgery, yet its clinical impact is frequently undermined by inadequate patient adherence. This investigation was designed to evaluate postoperative adherence to pulmonary rehabilitation among lung cancer patients and to identify its main determinants. A cross-sectional questionnaire-based survey was administered to individuals who had undergone lung cancer surgery, using a validated tool to gauge their rehabilitation adherence. Associations and independent predictors were examined using correlation analyses and multivariate linear regression. A cohort of 262 patients participated (87.9% response rate). The composite score for pulmonary rehabilitation adherence fell within the moderate range (57.08 ± 9.84), with notable discrepancies across the three assessed dimensions; the "active advice-seeking" dimension recorded the lowest mean item rating (3.48 ± 1.04). Correlation analyses demonstrated significant links between adherence and age ($r = -0.621$, $P = 0.024$), educational attainment ($r = -0.598$, $P = 0.017$), marital status ($r = 0.602$, $P = 0.040$), residential setting ($r = 0.647$, $P = 0.001$), per capita monthly household earnings ($r = -0.591$, $P = 0.031$), and tumor histological subtype ($r = -0.574$, $P = 0.045$). Multivariate linear regression confirmed that advanced age, limited education, being unmarried/widowed/divorced, inhabiting a rural area, reduced household income, and particular lung cancer subtypes independently forecasted weaker adherence. The model provided a solid fit to the data ($R^2 = 0.591$, $F = 28.558$, $P < 0.001$). Considerable potential remains to improve postoperative pulmonary rehabilitation adherence among lung cancer patients, calling for nuanced, multifaceted strategies to strengthen compliance.

Keywords: Pulmonary rehabilitation, Compliance, Lung cancer, Nursing, Care

How to Cite This Article: Grant O, Clark D, Nguyen S. Adherence to Pulmonary Rehabilitation after Lung Cancer Surgery: A Cross-Sectional Survey of Clinical and Sociodemographic Predictors. Asian J Curr Res Clin Cancer. 2026;6(1):212-24. https://doi.org/10.51847/Swa8iooUMT

Introduction

Globally, lung cancer stands among the malignancies with the gravest incidence and death rates. For those diagnosed at early or intermediate stages, surgical excision remains the principal curative approach [1]. Still, typical postoperative challenges—including deterioration in lung function, loss of respiratory muscle power, and reduced exercise tolerance—often arise. Beyond eroding quality of life, these challenges may also heighten the risk of post-surgical complications and worsen the long-term outlook [2]. As an all-encompassing multidisciplinary strategy, pulmonary rehabilitation integrates structured exercise, breathing retraining, nutritional supplementation, and psychosocial support [3]. It has demonstrated clear benefits in boosting lung function, relieving breathlessness, and strengthening both physical capacity and well-being after lung cancer surgery, solidifying its role in sustained postoperative care [4, 5]. Practical experience, however, reveals that adherence to prescribed rehabilitation is typically weak; data suggest that roughly 30%–50% of patients stray from the recommended regimen, negating the hoped-for treatment gains [6]. Hence, mapping the prevailing reality of

rehabilitation adherence and decoding its mechanistic drivers stands as a necessary first step toward refining intervention design and amplifying therapeutic returns.

While consensus has built around the clinical worth of pulmonary rehabilitation within postoperative lung cancer trajectories, its large-scale uptake remains stalled by one central impediment: chronically poor patient follow-through. Available evidence [7, 8] indicates that adherence is forged through a convergence of forces operating simultaneously on multiple planes. On a personal plane, bodily postoperative distress (pain, exhaustion, etc.) can fuel activity-avoidance anxieties, while a shallow grasp of rehabilitation's long-term value can erode commitment. On an interpersonal and caregiving plane, the depth of family caregiver participation and the rigor of clinical teams' follow-up shape the stability of rehabilitation activities. At the institutional level, factors such as the tailoring of rehabilitation prescriptions and equitable access to community-based resources constitute additional constraints. Yet, the prevailing research emphasis remains fixed on efficacy verification, leaving systematic depictions of adherence levels wanting [9]. Even when determinants are probed, investigations tend to remain within narrow, single-factor silos, forgoing integrative, multifactorial perspectives—thereby producing a thin evidence pool ill-equipped to inform precisely targeted countermeasures.

As oncology care moves decisively into the age of whole-process management, elevating postoperative recovery quality and extending life expectancy have crystallized as central ambitions in holistic lung cancer therapy—with adherence to rehabilitation serving as the indispensable conduit from clinical activity to real patient benefit [10]. The systematic rollout of postoperative pulmonary rehabilitation for lung cancer across China is, by comparison, still in a formative phase [11]. The design of rehabilitation protocols and the architecture of follow-up oversight vary markedly across healthcare organizations, amplifying pre-existing disparities in adherence driven by personal circumstances and geography [12]. At the same time, nursing interventions commonly default to generic guidance rather than being sculpted around individuals' unique contexts and expressed needs, limiting their capacity to effect change. Set against this landscape, this study pursues three aims: to survey actual postoperative rehabilitation adherence systematically; to identify its decisive determinants rigorously; to build a robust evidence base for personalized clinical interventions; and to advance the standardization and nuanced sophistication of postoperative rehabilitation nursing for lung cancer.

Materials and Methods

Study design

Using a cross-sectional design, this investigation collected data via structured questionnaires. The intent was to impartially assess the real-world adherence to pulmonary rehabilitation following lung cancer resection, identify its predictors, and formulate corresponding nursing strategies.

Ethical considerations

Ethical clearance was secured from the ethics committee of The Fourth Affiliated Hospital of Soochow University (approval number: 220095). Written informed consent was obtained from every participant. Robust privacy safeguards were enforced throughout: questionnaires bore only code numbers, omitting name-based or other identifying details; all information resided on password-protected devices accessible solely by the investigative team; and participants retained the absolute right to exit at any stage, with no repercussions for their ongoing medical management.

Sample size estimation

The sample size was calculated using the multivariate formula $n = k \times (10–15)$, where k is the number of independent variables [13]. Drawing on pilot work and published literature, the present study encompassed 14 such variables, spanning sociodemographic traits, clinical disease parameters, rehabilitation-related knowledge, and supportive relationships. Applying the upper multiplier of 15, the projected requirement was 210 subjects (14×15). Factoring in a 10% allowance for non-usable or lost responses, the floor for adequate statistical power in the regression analyses was set at 231 participating patients.

Study participants

Sampling frame and methodology

Consecutive sampling was used to recruit individuals from the pool of patients who had undergone lung cancer surgery (lobectomy, segmentectomy, or wedge resection) at our hospital's Thoracic Surgery Department between March 2023 and May 2025. A starting group of 298 patients met the initial eligibility requirements set by the study's inclusion and exclusion boundaries. Of this group, 262 patients consented to participate (response rate = 87.9%), while 36 declined (12.1%). The chief reasons cited for declining were a lack of available time (n = 21) and a disinclination to complete the study questionnaires (n = 15). Apart from the pre-established criteria, no systematic filtering was performed, thereby helping to curtail the risk of selection bias.

Inclusion criteria

(1) A diagnosis of primary lung cancer confirmed through pathological assessment and receipt of scheduled surgical treatment; (2) A minimum postoperative survival period of 1 month paired with a stable clinical picture (i.e., free from severe postoperative sequelae such as ongoing pleural effusion or infection); (3) Alert mental status and an ability to grasp the nature of the study; (4) Voluntary agreement to join the study and the provision of signed informed consent.

Exclusion criteria

(1) Co-occurrence of major cardiovascular or cerebrovascular illness, liver or kidney insufficiency, or other health problems likely to hinder rehabilitation activity; (2) Cognitive deficits, psychiatric conditions, or communicative difficulties severe enough to prevent meaningful questionnaire completion; (3) Onset of serious adverse responses (e.g., grade III or worse myelosuppression) in the course of postoperative adjuvant treatment (e.g., radiotherapy, chemotherapy).

Study instruments

A broad-scope questionnaire was assembled by integrating a general information section designed in-house with well-established scales, split into two halves:

General information questionnaire

Covered sociodemographic attributes (sex, age, level of schooling, marital situation, residential area, work status, per person monthly household income, healthcare payment route) together with disease-specific details (smoking background, surgical technique, anatomical location of tumor removal, clinical stage, lapse after surgery, presence of accompanying chronic disorders (chronic obstructive pulmonary disease, COPD)). Its role was to map the sample's baseline profile and serve as a source of potential explanatory variables for the analysis phase.

Pulmonary rehabilitation compliance assessment scale

The tool used was an adapted version of the previously published Weng [14] Exercise Compliance Scale, tailored to fit precisely within the postoperative pulmonary rehabilitation landscape of people living with lung cancer. The revision of items was overseen by a team of three thoracic surgery experts alongside two rehabilitation therapists; they altered 4 original entries to deepen clinical relevance—for instance, broad phrasing like "general exercise" was replaced by context-attuned wording ("pulmonary rehabilitation exercises"), and questions tied to breathing function training (a cornerstone of post-surgical pulmonary rehabilitation in lung cancer) were woven in. Given that the source scale was originally formulated in Chinese, a careful forward/backward translation cycle was carried out to guard semantic fidelity: two bilingual team members independently rendered the scale from Chinese into English (forward translation), after which a separate bilingual specialist, with no prior exposure to the original instrument, converted it back into Chinese (backward translation). Any inconsistencies that arose were settled through team-based discussion involving both the research group and clinical advisors.

Ahead of the main data-gathering wave, a trial run was executed with 30 postoperative lung cancer patients (who were not part of the final study sample) to test the scale's comprehensibility, workability, and acceptability. Guided by remarks from these pilot participants—particularly those who struggled with reading—small refinements were made to ease syntactically heavy sentences and lift overall legibility.

The finalized adapted scale keeps 15 items distributed over three dimensions: ① Physical exercise compliance (6 items, e.g., "Able to perform daily pulmonary rehabilitation exercises as instructed by medical staff" and "Complete respiratory preparation before each exercise"); ② Exercise monitoring compliance (4 items, e.g., "Monitor own respiratory rate or blood oxygen saturation during exercise" and "Record the duration and feelings

of each rehabilitation training session"); ③ Active advice-seeking compliance (5 items, e.g., "Proactively consult medical staff when encountering rehabilitation difficulties" and "Communicate rehabilitation experience with other postoperative patients"). Answers are scored on a 5-point Likert scale (1 = completely unable to do, 2 = mostly unable to do, 3 = half able to do, 4 = mostly able to do, 5 = completely able to do), producing a total score band of 15 to 75; a higher tally signals stronger pulmonary rehabilitation adherence [15]. The adapted scale's psychometric credentials were subjected to thorough evaluation: for reliability, pre-survey findings returned a Cronbach's α coefficient of 0.91 for the overall instrument and 0.83–0.88 for its three dimensions, pointing to superior internal consistency; in terms of content validity, five experts (3 thoracic surgeons, 1 rehabilitation therapist, and 1 methodologist) rated each item via a 4-point Likert scale (1 = irrelevant, 2 = slightly relevant, 3 = moderately relevant, 4 = highly relevant), giving an item-level content validity index (I-CVI) range of 0.80–1.00 and a scale-level content validity index (S-CVI) of 0.92, which together affirmed robust content validity; and regarding construct validity, exploratory factor analysis (EFA) deploying principal component extraction with varimax rotation on the study sample isolated three factors that jointly accounted for 68.3% of total variance, with every item loading between 0.65 and 0.89 (above the standard 0.60 cutoff), thereby confirming solid construct validity for the reworked scale in the context of assessing pulmonary rehabilitation compliance among postoperative lung cancer patients.

Data collection

Three uniformly prepared researchers (all thoracic surgery nurses with more than 5 years of hands-on clinical experience) took charge of distributing and retrieving questionnaires. Before the formal collection phase, the study team completed standardized training sessions that included revisiting the research protocol, practicing administering the questionnaire, and checking inter-rater concordance: 10 pilot questionnaires were scored separately by the three researchers, yielding a Cohen's kappa coefficient of 0.86, indicating strong inter-rater reliability. To keep interviewer-related bias to a minimum—especially when dealing with patients who had restricted literacy abilities—tested, uniform scripts were used throughout every encounter, encompassing consistent language for describing the study aim, voicing questionnaire items, and noting responses; these scripts were trialed during the pilot phase to confirm neutrality and to weed out any leading phrasing. Furthermore, researchers were kept in the dark about patients' clinical trajectories (e.g., postoperative setbacks, survival status) to avoid outcome-influenced bias during data collection.

The survey was conducted at the patients' 1-month postoperative check-in, either in a hushed examination room or in a screened-off alcove near the ward (to ensure seclusion during bedside data recording). Before setting off, researchers outlined the study's objectives, the steps for completing the questionnaire, and the privacy assurances to each individual, and collected written informed consent before participation. For those who could manage the task independently, paper questionnaires were provided alongside standardized guidance (e.g., "Please select the option that best reflects your actual situation over the past month following surgery"). The completed forms were collected immediately upon completion. For patients facing reading and writing hurdles, researchers enunciated each item precisely as printed in the standardized script and inscribed answers based on patients' spoken replies, thereby ensuring the authenticity of the information. Every returned questionnaire was promptly examined for completeness immediately after collection; researchers encouraged patients to fill any gaps or rectify any indistinct entries on the spot to ensure data integrity. To ensure confidentiality, patient responses were not communicated to ward personnel or relatives, and completed questionnaires were sealed in opaque envelopes immediately after inspection.

Data analysis

Data capture was handled with EpiData 3.1, using a double-entry system with built-in logic checks to safeguard fidelity, and the full battery of statistical tests was run in SPSS 26.0. Continuous variables (e.g., age, composite score for pulmonary rehabilitation compliance) are reported as mean ± standard deviation. In contrast, grouped variables (e.g., gender, operative approach) appear as counts and proportions (n, %). To screen for candidate predictors among continuous measures, independent-samples t-tests or one-way ANOVA were used for between-group comparisons, and χ^2 tests served the same purpose for categorical data; any variable with a screening P-value below 0.10 was retained for potential entry into the multivariate stage. The strength and direction of relationships between compliance scores and the array of patient characteristics were examined using Pearson or Spearman correlation, as appropriate. A multiple linear regression framework was then built, using entry and

removal thresholds of α-in = 0.05 and α-out = 0.10, to disentangle the independent effects of each factor. Use of the summed ordinal Likert-scale score (range recorded in the data: 32–72; skewness = -0.12, kurtosis = 0.08, both indicating near-normal shape) as the dependent variable was considered legitimate because it represents a continuous latent trait (degree of compliance behavior), an approach substantiated by earlier psychometric work with instruments of this kind.

Before interpreting the regression output, a series of diagnostic checks was carried out. The linearity assumption was assessed by inspecting scatter plots. The normality of the model residuals was verified using Q-Q plots and a formal Shapiro-Wilk test, which yielded a non-significant p-value (P = 0.231). Constant error variance was examined with residual plots alongside a Breusch-Pagan test (P = 0.187), confirming homoscedasticity. Potential multicollinearity among predictors was scrutinized using the Variance Inflation Factor (VIF) and Tolerance metrics; VIF values ranged narrowly from 1.12 to 1.35, and Tolerance values ranged from 0.74 to 0.89, all comfortably within conventionally accepted limits (VIF < 2, Tolerance > 0.5). The absence of missing data was guaranteed by the on-the-spot questionnaire completeness review at the time of collection. Further checks of model stability—including influence diagnostics (Cook's distance) and leverage statistics—revealed no individual case exerting undue pull on the estimates. The final fitted regression model accounted for 59.1% of the variance in rehabilitation compliance, with strong overall significance ($R^2 = 0.591$, $F = 28.558$, $P < 0.001$). The threshold for declaring statistical significance throughout the analysis was set at $P < 0.05$.

Results and Discussion

The process began with 298 patients who met the pre-set eligibility criteria. Of this group, 262 individuals agreed to participate, yielding a response rate of 87.9%, while 36 potential participants (12.1%) opted out. The predominant reasons for refusal were conflicting time commitments (n = 21) and an expressed unwillingness to complete the questionnaire set (n = 15). The final analytic sample comprised 262 eligible lung cancer patients.

The participants' foundational sociodemographic and clinical profiles, along with their bivariate associations with compliance, are presented in **Tables 1 and 2,** respectively. Within the cohort, 32 individuals (12.2%) were recorded as having concomitant COPD, and 48 (18.3%) had already embarked upon adjuvant therapy.

Table 1. Sociodemographic characteristics of patients with lung cancer (n = 262).

Characteristic	Categories	P	Effect size	Statistic (t/F)	Pulmonary rehabilitation compliance score [mean (95% CI)]	Cases (%)
Gender	Male	0.105	Cohen's d=0.32	5.396	56.01 (53.98–58.04)	158 (60.30%)
	Female				59.24 (57.12–61.36)	104 (39.70%)
Age (years)	< 60	*0.013	Cohen's d = 0.82	6.453	60.17 (58.23–62.11)	148 (56.49%)
	≥ 60				52.06 (50.09–54.03)	114 (43.51%)
Educational level	Junior high school or below	**0.009	η^2 = 0.18	2.004	51.19 (49.25–53.13)	146 (55.73%)
	Senior high school				58.62 (56.31–60.93)	77 (29.39%)
	College or above				62.31 (59.47–65.15)	39 (14.88%)
Marital Status	Married	*0.014	η^2 = 0.15	1.163	59.10 (57.45–60.75)	215 (82.06%)
	Unmarried				55.27 (50.83–59.71)	9 (3.44%)
	Divorced				53.09 (50.01–56.17)	23 (8.78%)
	Widowed				50.12 (46.58–53.66)	15 (5.73%)

Place of residence	Rural area	*0.025	Cohen's d = 0.68	6.056	53.94 (51.72–56.16)	90 (34.35%)
	Urban area				60.62 (59.03–62.21)	172 (65.65%)
Occupation Status	Employed	0.108	Cohen's d = 0.25	5.744	57.05 (55.18–58.92)	154 (58.78%)
	Unemployed				59.58 (57.46–61.70)	108 (41.22%)
Average monthly household income per capita (CNY)	< 5000	**0.004	Cohen's d = 1.09	6.828	51.30 (49.37–53.23)	134 (51.15%)
	≥ 5000				62.46 (60.51–64.41)	128 (48.85%)
Medical expense payment method	Public medical insurance	0.087	η^2 = 0.03	1.055	57.89 (56.36–59.42)	220 (83.97%)
	Commercial insurance				60.33 (56.79–63.87)	18 (6.87%)
	Self-payment				55.21 (51.98–58.44)	24 (9.16%)

CI, Confidence Interval; CNY, Chinese Yuan; Cohen's d for binary variables (0.2 = small, 0.5 = moderate, 0.8 = large effect); η^2 for categorical variables (0.01 = small, 0.06 = moderate, 0.14 = large effect); P < 0.05, P < 0.01.

Table 2. Clinical characteristics of patients with lung cancer (n=262).

Characteristic	Categories	P	Effect size	Statistic (t/F)	Pulmonary rehabilitation compliance score [mean (95% CI)]	Cases (%)
History of smoking	Yes	0.190	Cohen's d = 0.38	5.923	55.17 (53.21–57.13)	136 (51.91%)
	No				59.01 (56.98–61.04)	126 (48.09%)
Time since lung cancer diagnosis	< 1 month	0.115	η^2 = 0.02	2.003	58.36 (56.54–60.18)	155 (59.16%)
	1~6 months				57.03 (54.67–59.39)	87 (33.21%)
	> 6 months				55.12 (51.53–58.71)	20 (7.63%)
Histological type	Squamous cell carcinoma	0.103	Cohen's d = 0.15	6.232	57.19 (55.82–58.56)	253 (96.56%)
	Adenocarcinoma				55.75 (50.92–60.58)	9 (3.44%)
Clinical stage of lung cancer	Stage I	*0.040	η^2 = 0.04	1.284	58.82 (57.35–60.29)	208 (79.39%)
	Stage II				56.34 (53.68–59.00)	52 (19.85%)
	Stage III				52.05 (48.21–55.89)	2 (0.76%)
Location of lesion resection	Left upper lobe	0.067	η^2 = 0.03	1.881	57.58 (55.31–59.85)	94 (35.88%)
	Left lower lobe				54.43 (50.61–58.25)	19 (7.25%)
	Right upper lobe				57.82 (55.27–60.37)	66 (25.19%)
	Right middle lobe				55.09 (51.24–58.94)	15 (5.73%)
	Right lower lobe				56.97 (54.56–59.38)	68 (25.95%)
Complicated with chronic diseases	Yes	0.109	Cohen's d = 0.16	6.382	58.50 (56.18–60.82)	88 (33.59%)

(hypertension/diabetes/hyperlipidemia)	No				56.86 (55.23–58.49)	174 (66.41%)
Complicated with COPD	Yes	0.346	Cohen's d = 0.08	0.927	56.73 (53.51–59.95)	32 (12.21%)
	No				57.12 (55.78–58.46)	230 (87.79%)
Adjuvant therapy status	Yes	0.063	Cohen's d = 0.22	4.159	54.92 (52.01–57.83)	48 (18.32%)
	No				57.65 (56.27–59.03)	214 (81.68%)

COPD, Chronic Obstructive Pulmonary Disease; Cohen's d for binary variables (0.2 = small, 0.5 = moderate, 0.8 = large effect); η^2 for categorical variables (0.01 = small, 0.06 = moderate, 0.14 = large effect); $P < 0.05$.

Several sociodemographic and clinical factors showed meaningful ties with adherence behavior. More favorable compliance patterns were observed among younger patients who had attained higher educational levels, were married, lived in urban settings, reported higher household incomes, and had been diagnosed at an earlier clinical stage (all $P < 0.05$); **(Tables 1 and 2).** Distributions of compliance did not differ significantly across categories of gender, employment, method of healthcare payment, smoking history, anatomical location of lesion removal, or the presence of co-occurring chronic disease (all $P > 0.05$).

According to **Table 3**, the general standard of pulmonary rehabilitation compliance was moderate, with a per-item mean of 3.85 ± 1.01 (95% CI: 3.69–4.01). Breaking this down by dimension, "active advice-seeking" was the lowest-performing area, with a mean item score of 3.48 ± 1.04. The instrument demonstrated strong psychometric cohesion, reflected in a total-scale Cronbach's α of 0.91 and subscale α values ranging from 0.83 to 0.88. Supplementary subgroup analyses confirmed that compliance levels diverged by age band, disease stage, and residential setting, mirroring the univariate patterns.

Table 3. Scores and psychometric properties of pulmonary rehabilitation compliance dimensions (n = 262).

Dimension	Number of items	Cronbach's α	Compliance level[1]	Average item score [mean ± SD (95% CI)]	Total score [mean ± SD (min–max)]
Physical exercise compliance	6	0.86	Moderate	3.78 ± 0.98 (3.60–3.96)	22.45 ± 4.20 (12–30)
Exercise monitoring compliance	4	0.83	Moderate	3.95 ± 0.95 (3.79–4.11)	15.66 ± 3.07 (8–20)
Active seeking of advice on compliance	5	0.88	Moderate	3.48 ± 1.04 (3.30–3.66)	17.18 ± 3.79 (5–25)
Total score	15	0.91	Moderate	3.85 ± 1.01 (3.69–4.01)	57.08 ± 9.84 (32–72)

[1]Compliance level definition: Low ≤ 3.0 points/item; Moderate = 3.1–4.0 points/item; High ≥ 4.1 points/item; SD, Standard Deviation; CI, Confidence Interval; Cronbach's α > 0.8 indicates good internal consistency.

The correlation matrix **(Table 4)** identified robust relationships between the overall compliance score and age, educational attainment, marital status, residential locality, household earnings, and histological classification of lung cancer ($|r/\rho| > 0.5$, all $P < 0.05$). In essence, being younger, having more years of education, and residing in an urban area were associated with higher compliance ratings. No statistically reliable correlations were observed for gender, occupation, or COPD comorbidity (all $P > 0.05$).

Table 4. Correlation between pulmonary rehabilitation compliance score and patient characteristics (n = 262).

Category	Characteristic	Correlation coefficient (test type [2])	95% CI	Correlation strength[3]	P
Sociodemographic	Gender	0.161 (Pearson's r)	(-0.012, 0.326)	Weak	0.093
	Age	-0.621 (Pearson's r)	(-0.712, -0.508)	Strong	*0.024
	Educational level	-0.598 (Spearman's ρ)	(-0.694, -0.481)	Strong	*0.017
	Marital Status	0.602 (Spearman's ρ)	(0.485, 0.698)	Strong	*0.040
	Place of residence	0.647 (Spearman's ρ)	(0.542, 0.733)	Strong	**0.001

	Occupation Status	0.184 (Spearman's ρ)	(-0.003, 0.359)	Weak	0.096
	Average monthly household income per capita	-0.591 (Pearson's r)	(-0.688, -0.473)	Strong	*0.031
	Medical expense payment method	0.150 (Spearman's ρ)	(-0.025, 0.315)	Weak	0.116
Clinical	History of smoking	0.108 (Spearman's ρ)	(-0.068, 0.276)	Weak	0.094
	Time since lung cancer diagnosis	0.115 (Spearman's ρ)	(-0.061, 0.282)	Weak	0.103
	Histological type	-0.574 (Spearman's ρ)	(-0.673, -0.452)	Strong	*0.045
	Clinical stage of lung cancer	-0.489 (Spearman's ρ)	(-0.592, -0.365)	Moderate	*0.038
	Location of lesion resection	0.119 (Spearman's ρ)	(-0.057, 0.286)	Weak	0.101
	Complicated with chronic diseases	0.205 (Spearman's ρ)	(0.032, 0.368)	Weak	0.079
	Complicated with COPD	0.095 (Pearson's r)	(-0.081, 0.263)	Weak	0.152

COPD, Chronic Obstructive Pulmonary Disease; ²Pearson's r for normally distributed continuous variables; Spearman's ρ for ordinal/categorical variables. ³Correlation strength (r/ρ): Weak = 0.1–0.3; Moderate = 0.3–0.7; Strong = 0.7–1.0. CI, Confidence Interval; COPD, Chronic Obstructive Pulmonary Disease; $P < 0.05$, $P < 0.01$.

When all variables were entered into a multivariate linear regression **(Table 5)**, several factors emerged as independent predictors of compliance, collectively explaining 59.1% of the variance ($R^2 = 0.591$, $F = 28.558$, $P < 0.001$). Specifically, increasing age, lower educational background, a marital status of unmarried/widowed/divorced, rural residence, diminished household income, and particular lung cancer histological types each independently predicted poorer adherence (all $P < 0.05$). Multicollinearity was not a concern, as evidenced by VIF values within the 1.12–1.28 range.

Table 5. Multivariate linear regression analysis of factors influencing pulmonary rehabilitation compliance score among patients with lung cancer (n = 262).

Predictor	Tolerance	VIF	P	t	95% confidence interval	Standardized β	SE	Unstandardized β
Constant	-	-	0.034	-28.306	(-160.42, -139.70)	-	5.319	-150.06
Age (years)	0.89	1.12	*0.012	-1.847	(-5.803, -0.299)	-0.092	1.406	-3.051
Educational level	0.74	1.35	*0.016	-2.772	(-5.187, -0.629)	-0.106	1.161	-2.908
Marital Status	0.78	1.28	*0.037	2.150	(0.685, 4.643)	0.124	1.009	2.664
Place of residence	0.84	1.19	**0.008	2.309	(0.571, 6.781)	0.130	1.582	3.676
Average monthly household income per capita (CNY)	0.80	1.25	*0.010	-2.115	(-5.401, -0.669)	-0.127	1.204	-3.035
Classification of lung cancer	0.85	1.18	*0.042	-2.066	(-4.743, -0.109)	-0.112	1.179	-2.426

Reference categories for categorical variables: Educational level (college or above vs. senior high school/junior high school or below); Marital status (married vs. unmarried/divorced/widowed); Place of residence (urban vs. rural); Average monthly household income per capita (≥ 5000 CNY vs. < 5000 CNY); Classification of lung cancer (squamous cell carcinoma vs. adenocarcinoma); Significance markers: $P < 0.05$, $P < 0.01$.

In the work reported here, postoperative pulmonary rehabilitation adherence was conceptualized across three standalone dimensions: carrying out prescribed exercises, tracking one's own symptoms, and proactively seeking professional advice. What the data made plain was that adherence, viewed in its entirety, sat at a middling level, with the dimension capturing how actively patients pursue expert guidance registering the weakest performance by a clear margin. The essence of this dimension goes beyond a simple measure of whether patients are inclined to approach clinicians; it also serves as a proxy for whether they can secure timely medical input when novel symptoms surface or when they hit a wall in their rehabilitation efforts. The subdued scores in this area point to a specific disconnect: education delivered in the postoperative window is reasonably effective at underscoring why "doing the exercises" and "keeping track of symptoms" matter, yet it largely neglects to equip patients with the higher-order self-regulatory capacities needed to judge "under what circumstances, and through what channels, should I reach out?" Framed another way, what the current system manages is a one-directional flow of facts, but

it stops short of cultivating a genuinely patient-owned, iterative exchange between individuals and their care teams—a gap that represents a prime target for strengthening future interventions [16].

A central pattern to emerge from the dataset was that older adults, people with minimal formal education, those without a spouse (whether single, divorced, or bereaved), individuals residing outside urban centers, households with constrained financial resources, and patients diagnosed with more advanced tumor stages all registered compliance levels that were substantially lower. These determinants do not function as isolated risk flags; rather, they stack and reinforce one another along a logical chain that runs from "material and social disadvantage → circumscribed ability to interpret health information → brittle or missing interpersonal safety nets → concrete hurdles that block action." Ageing brings a contraction of physiological headroom and a clustering of concurrent illnesses, both of which compress how much exertion a patient can comfortably accept; a thin educational background and narrow avenues for acquiring health knowledge leave the notion of "rehabilitation pays off" too abstract to be translated into daily routine [17]; the absence of a marital partner or close family strips away the daily nudges, the shared presence, and the affective reinforcement that help sustain motivation; coming from a rural base and living on a low income compounds structural frictions such as the cost and logistics of getting to appointments, paying for devices, and attending follow-up sessions; and those shouldering a heavy disease load, owing to an oppressive symptom experience and a sombre reading of their own future, can readily slide into a resigned belief that "engaging in rehabilitation won't alter the outcome anyway," prompting them to withdraw from the rehabilitation arc of their own accord [18, 19]. What becomes visible, then, is that adherence is far from a straightforward matter of personal discipline; it is better understood as a multilayered disruption embedded within a broader social-ecological system—a recognition that pushes intervention thinking well past the dated formula of "teach and check" [20].

A further nuance worth foregrounding is the likelihood that the convergence of socioeconomic strain with late-stage disease acts as an amplifier of health inequality. There is already a body of evidence [10, 21] establishing that patients from low-resource and rural backgrounds are considerably more apt to receive a stage III–IV lung cancer diagnosis because their first medical contact happens later in the disease trajectory; from that point, living with advanced malignancy further depletes the very financial and psychological reserves needed to stay engaged with rehabilitation, locking patients inside a self-perpetuating trap of "scarcity → late presentation → poor adherence → worse prognosis." Barring purposeful policy disruption, this dynamic is expected to keep widening the chasm in survival outcomes, separating urban populations from rural ones and higher socioeconomic strata from lower ones. Accordingly, adherence to pulmonary rehabilitation deserves repositioning. Rather than being treated as a narrow gauge of treatment quality, it should be woven into the analytical lenses of "health equity" and addressed through coordinated structural responses.

The orthodox playbook for managing adherence—built on the twin pillars of supplying information and dispatching regular prompts—has demonstrated scant efficacy among these higher-need groups. Handing someone facts is not the same as catalyzing durable behavior change, particularly when that person is simultaneously navigating a thicket of practical impediments such as transport shortages, financial precarity, and the hollowing-out of social connection [22-24]. This reality underscores the need to reimagine the nursing contribution, extending far beyond the conventional boundaries of "educator" and encompassing the functions of "connector to resources" and "architect of care coordination" [25]. As a concrete illustration, a brief vulnerability screen administered before hospital departure could single out a "high-adversity cluster" (grouping older patients, those who live by themselves, rural inhabitants, and individuals with advanced malignancy); an interprofessional case management structure—linking up community nursing staff, rehabilitation practitioners, social welfare professionals, and non-profit organisations—could then be activated to co-design rehabilitation plans that these patients can genuinely afford, physically reach, and realistically sustain over the longer term [26-28].

Building directly on what the data revealed, we outline a set of clinical nursing responses pitched at several interacting levels, each shaped to meet the specific obstacles uncovered: the first strand involves creating educational resources deliberately designed to bypass literacy demands by relying on pictorial sequences and short video clips, combined with a teach-back step to confirm that patients have internalised the rehabilitation logic [29, 30]; the second strand entails deploying body-worn sensors that give moment-to-moment feedback on physiological effort, thereby directly countering the fear of overdoing things that commonly holds older patients back [31, 32]; the third strand calls for the creation of decentralised "spoke" rehabilitation venues in partnership with grassroots health facilities, operating a mixed model that pairs virtual supervision with periodic in-person group work to erode the access gap between town and countryside [33, 34]; the fourth strand involves rolling out

transport stipends and shared-equipment pools to relieve the cost squeeze that falls hardest on low-income households; and the fifth strand consists of weaving a triadic "patient–kin–volunteer" support fabric, deliberately pairing patients who lack a family buffer with a dedicated "rehabilitation ally" to guard against the drift out of care that social isolation invites [35-37].

A balanced reading of this study requires keeping several constraints firmly in view. To begin with, the cross-sectional snapshot can only flag associations between adherence and its putative determinants; causal ordering cannot be inferred, and the fingerprints of unmeasured confounders (such as deeply held health beliefs or differing skill in seeking out information) remain a possibility. Second, the fact that recruitment occurred within the confines of a single tertiary hospital opens the door to selection biases that limit how faithfully the findings capture the circumstances of more marginalized subgroups—among them rural-dwelling patients, economically disadvantaged families, and those managing concurrent illnesses like chronic obstructive pulmonary disease (COPD). The relatively modest share of COPD patients in the cohort, just 12.2% (n = 32), sits conspicuously below the 30%–40% prevalence figures typically reported in wider cancer populations [38, 39]. This under-representation may well have curtailed the analytic power to detect real effects of COPD on adherence, thereby contributing to the null finding registered in the regression output. The practical upshot is that the results cannot be directly projected onto patient streams in primary care settings, community-based hospitals, or other regional contexts. Third, the adherence metric relied entirely on what patients themselves reported (covering the initial month after surgery), without triangulation through any external benchmark (such as recordings from wearable trackers), which leaves the data vulnerable to memory lapses or the impulse to give socially approved answers; it also warrants noting that 18.3% (n = 48) of participants had already started adjuvant therapy (radiotherapy/chemotherapy) by the point of assessment. While the small numerical footprint of this subset tempers its impact on the overall picture, treatment-attributable side effects (fatigue being a prime example) may still have exerted a modest downward tug on adherence within these individuals. Fourth, the analysis did not formally model interactions among factors (for instance, the compound effect of living rurally on a low income), nor did it pursue mechanistic dissection, leaving the inner workings of adherence behavior less than fully illuminated. Future research that spans multiple centres, follows cohorts over time, folds in objective adherence monitoring, tests mediation and moderation pathways to disentangle causal architecture, and tracks the imprint of adjuvant treatment across a longer postoperative window (for example, the 2–12 week stretch, during which adherence levels are known to oscillate) will be essential to fortify both the relevance and the portability of the insights generated.

Conclusion

Bringing the threads together, the present study establishes that postoperative pulmonary rehabilitation adherence in the lung cancer population sits, as a whole, at a moderate plateau, with the dimension that captures proactive pursuit of professional guidance returning the most subdued figures—a finding that throws a spotlight on a neglected corner of current rehabilitation pedagogy: the systematic failure to cultivate in patients both the sensitivity to recognise when they are in difficulty and the repertoire of strategies to seek timely support. Of particular concern, the groups in whom adherence frays most severely include older adults, individuals with truncated educational histories, those who are unmarried or widowed, rural residents, low-income earners, and patients confronting advanced-stage disease. These forces align along a cascading pathway that runs from "socioeconomic vulnerability," through "restricted health literacy" and "attenuated support structures," to "concrete barriers to behavioral enactment." On top of this, the dynamic interplay between socioeconomic position and disease severity threatens to compound health disparities, stretching the gap in recovery trajectories between differently situated segments of the population.

What the findings point toward, in practical terms, is that genuinely moving the needle on postoperative pulmonary rehabilitation adherence demands a clean break from the entrenched habit of delivering undifferentiated advice to all comers, and a decisive pivot toward multi-component, individually calibrated strategies. On the clinical front line, the immediate priority should be a stratified approach to managing those at highest risk: educational tools that lean on visual storytelling (blending illustrations with video) can cut through literacy barriers to deepen health comprehension; wearable technology that streams real-time exertion data back to the patient can neutralize the fear of excessive strain that frequently immobilizes older adults. Running alongside, the construction of an integrated "clinical–community–domestic" scaffolding network is

indispensable—this means, concretely, erecting satellite rehabilitation points to neutralize the resource gradient between city and country, supplying transport and equipment subsidies to take the edge off financial duress, and assigning "rehabilitation companions" to unaccompanied patients to fill the void where informal social support should be. Such a multilayered package of measures carries a genuine prospect of substantially improving adherence, transforming pulmonary rehabilitation from a narrow transaction of "information transfer" into deeply rooted behavioral change, and, in so doing, elevating the overall standard of post-surgical recovery while advancing the agenda of health equity.

Acknowledgments: None

Conflict of Interest: None

Financial Support: The author(s) declared that financial support was received for this work and/or its publication. This study was supported by the Suzhou Science and Technology Program (Grant No. SZM2023030).

Ethics Statement: This study has obtained approval from the ethics committee of The Fourth Affiliated Hospital of Soochow University (approval number: 220095). All patients signed written informed consent forms. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

References

1. Smolarz B, Lukasiewicz H, Samulak D, Piekarska E, Kolacinski R, Romanowicz H. Lung cancer: epidemiology, pathogenesis, treatment and molecular aspect (review of literature). Int J Mol Sci. 2025;26:2049. doi:10.3390/ijms26052049
2. Zhong J, Trinh I, Raju S, Hsu M. Pulmonary rehabilitation in patients with operable non-small cell lung cancer. J Clin Med. 2025;14:770. doi:10.3390/jcm14030770
3. Sisi Y, Yao C, Yajuan K, Suting S, Du J, Qu H, et al. Pulmonary rehabilitation for patients receiving lung cancer radiotherapy: a scoping review. BMJ Open. 2025;15:e091749. doi:10.1136/bmjopen-2024-091749
4. Li G, Zhou X, Deng J, Wang J, Ai P, Zeng J, et al. Digital therapeutics-based cardio-oncology rehabilitation for lung cancer survivors: randomized controlled trial. JMIR Mhealth Uhealth. 2025;13:e60115. doi:10.2196/60115
5. Alzahrani M, Mehta R, Kadiri S, Algaeed S, Osman A, Alsanad M, et al. Effect of pulmonary rehabilitation on lung cancer surgery outcomes: a matched-case analysis. Perioper Med (Lond). 2025;14:35. doi:10.1186/s13741-025-00510-2
6. Lee JH, Cha S, Ko EJ, Kim W, Kim SS, Song SY, et al. Clinical effect of pulmonary rehabilitation during radiotherapy in lung cancer: a randomized controlled trial. Lung Cancer. 2025;204:108546. doi:10.1016/j.lungcan.2025.108546
7. Wang Y, Song J, Zhang F. Effect of Hogan's theoretical nursing model on psychological fear and postoperative rehabilitation exercise compliance in patients undergoing thoracoscopic partial lobectomy. Clin Med Res Pract. 2025;10:117-20.
8. Zhu H, Pang J, Sun S. Qualitative study on factors influencing lung rehabilitation behavior in elderly lung cancer patients during postoperative transitional period. Chin J Nurs. 2024;59:15-21.
9. Chen L, Li X, Deng B. Effect of Green's model based lung rehabilitation training on home rehabilitation of patients with lung cancer combined with COPD after surgery. Qilu Nurs J. 2024;30:13-17.
10. Qiao Y, Yang H, Chen R. Research progress on management strategies for exercise rehabilitation compliance in postoperative lung cancer patients. Nurs Rehabil. 2023;22:94-8.
11. Yang X, Tang W, Xu L. Research progress on compliance of home lung rehabilitation in lung cancer patients. China Rehabil. 2024;39:686-90.
12. Lu L, Chen Y, Ye L. Effect of lung rehabilitation exercise program based on behavioral transformation theory in lung cancer patients undergoing chemotherapy. China Pharm Herald. 2024;21:176-80.
13. Wang X. Research on the effectiveness of questionnaire segmentation and optimal sample size allocation method. Math Stat Manage. 2023;42:611-25.

14. Weng G. Investigation on compliance with exercise prescriptions in patients with cancer-related fatigue [thesis]. Fuzhou: Fujian Medical University; 2014.
15. Dai F, Mao S, Zhang Y. Effect of self-efficacy gas station combined with ACBT training on lung rehabilitation of patients with non-small cell lung cancer after thoracoscopic surgery. Chin Gen Pract Med. 2024;22:1584-7.
16. Lu T, Deng T, Long Y, Li J, Hu A, Hu Y, et al. Effectiveness and feasibility of digital pulmonary rehabilitation in patients undergoing lung cancer surgery: systematic review and meta-analysis. J Med Internet Res. 2024;26:e56795. doi:10.2196/56795
17. Liu YY, Lu HB, Li YJ, Wang ZY, Liu YH, Qiao S, et al. Effects of mindful breathing training combined with diary-based rehabilitation guidance in lung cancer patients undergoing surgery: a randomized controlled trial. Complement Ther Clin Pract. 2024;55:101849. doi:10.1016/j.ctcp.2024.101849
18. Toohey K, Mizrahi D, Hart NH, Singh B, Lopez P, Hunter M, et al. Exercise in cancer care for people with lung cancer: a narrative synthesis. J Sci Med Sport. 2025;28:16-25. doi:10.1016/j.jsams.2024.08.002
19. Doyle D, O'Brien M, Murphy R, O'Brien A, McGrath D, Kelly D. Exploring patient perspectives of barriers and facilitators to participating in hospital-based pulmonary rehabilitation in patients diagnosed with non-small-cell lung cancer treated with curative intent. Ir J Med Sci. 2025;194:205-10. doi:10.1007/s11845-024-03855-7
20. Chen X, Li Z, Zhang J. A novel approach to cancer rehabilitation: assessing the influence of exercise intervention on postoperative recovery and survival rates. Int J Surg. 2025;111:3373-85. doi:10.1097/JS9.0000000000002323
21. Ma X, Song B, Pan G. Impact of progressive rehabilitation nursing model guided by protective motivation theory on lung cancer patients undergoing radiotherapy. Qilu Nurs J. 2024;30:131-4.
22. Jiao W, Zhao L, Mei J, Zhong J, Yu Y, Bi N, et al. Clinical practice guidelines for perioperative multimodality treatment of non-small cell lung cancer. Chin Med J (Engl). 2025. doi:10.1097/CM9.0000000000003635
23. Ohde Y, Ueda K, Okami J, Saito H, Sato T, Yatsuyanagi E, et al. Guidelines for preoperative pulmonary function assessment in patients with lung cancer who will undergo surgery (The Japanese Association for Chest Surgery). Gen Thorac Cardiovasc Surg. 2025;73:385-404. doi:10.1007/s11748-025-02120-7
24. Zhang R, Wu M, Cheng Y, Xu Y, Xia L. An evidence-based medical review on preoperative exercise prehabilitation in lung cancer patients. J Multidiscip Healthc. 2025;18:4849-58. doi:10.2147/JMDH.S528534
25. Salvado S, Grilo E, Henriques H, Ferraz I, Gaspar F, Baixinho C. Pulmonary rehabilitation nursing interventions promoting self-care in elderly people with chronic obstructive pulmonary disease (at home). Healthcare (Basel). 2025;13:2176. doi:10.3390/healthcare13172176
26. Baldi BG, das Posses Bridi G, Heiden GI, Salge JM, Queiroz DS, Ribeiro Carvalho CR, et al. Mechanisms of exercise limitation and pulmonary rehabilitation in patients with cystic lung diseases. Expert Rev Respir Med. 2025;19:811-25. doi:10.1080/17476348.2025.2501277
27. Gu Y, Wang Y, Zhou H, Qi A, Wu G, Li J, et al. Efficacy of Chinese medicine on postoperative rehabilitation of non-small cell lung cancer (NSCLC): a randomized controlled study. Integr Cancer Ther. 2025;24:15347354251314529. doi:10.1177/15347354251314529
28. Wang Q, Tang H, Zhang M. The clinical nursing effect of empowerment-based continuing nursing combined with pulmonary rehabilitation for chronic obstructive pulmonary disease. BMC Pulm Med. 2025;25:315. doi:10.1186/s12890-025-03683-0
29. Yang J, Ge L, Ju XX, Liu XX. Status and influencing factors of discharge readiness in day surgery lung cancer patients under a fast-track rehabilitation pathway. J Clin Nurs. 2025;34. doi:10.1111/jocn.17743
30. Colaço AJ, Castro C, Hall S, Fernandes JB. Preoperative rehabilitation interventions for lung cancer: a scoping review. Front Rehabil Sci. 2025;15:1665955. doi:10.3389/fragi.2025.1665955
31. Kocamaz D, Demircioglu Karagoz A, Atasavun Uysal S. YouTube videos as an information source about aerobic exercise in rehabilitation of lung cancer. Integr Cancer Ther. 2025;24:15347354251331461. doi:10.1177/15347354251331461
32. Wenjie W, Yifan J, Li W, Xiaomin G, Linlin Z, Yuhan C, et al. Virtual reality-assisted pulmonary rehabilitation enhances early lung function recovery after thoracoscopic surgery in lung cancer patients: a non-concurrent controlled study. Front Med (Lausanne). 2025;12:1643688. doi:10.3389/fmed.2025.1643688

33. Yang Y, Tian X, Zhou H, Wang Y, Gu Y, Qi A, et al. A score prediction model for predicting the heterogeneity symptom trajectories among lung cancer patients during perioperative period: a longitudinal observational study. Ann Med. 2025;57:2479588. doi:10.1080/07853890.2025.2479588
34. Zou H, Qu J, Li Y, Wang F, Chen P, Zhang L, et al. Construction of a postoperative home-based pulmonary rehabilitation program protocol for lung cancer patients delivered using the internet: a Delphi-based study. Support Care Cancer. 2025;33:905. doi:10.1007/s00520-025-09916-6
35. He X, Ji J, Pei Z, Zhou T, Fan H, Guo L. Efficacy of pulmonary rehabilitation on health-related quality of life in patients with interstitial lung disease as assessed by SF-36: a systematic review and meta-analysis. Eur J Phys Rehabil Med. 2025;61:313-34. doi:10.23736/S1973-9087.25.08778-7
36. Heredia-Ciuro A, Raya-Benitez J, Calvache-Mateo A, Martin-Nunez J, Cabrera-Martos I, Lopez-Lopez L, et al. Proactive physical activity programs in lung cancer surgical patients at short and mid-term: a systematic review and meta-analysis. Patient Educ Couns. 2025;130:108454. doi:10.1016/j.pec.2024.108454
37. Yin J, Zhou J, Cao L, Chen G. Associations between postoperative pulmonary interventions based on enhanced recovery programs and outcomes in patients with lung cancer: a retrospective propensity score matching study. Eur J Oncol Nurs. 2025;75:102817. doi:10.1016/j.ejon.2025.102817
38. Qi C, Sun SW, Xiong XZ. From COPD to lung cancer: mechanisms linking, diagnosis, treatment, and prognosis. Int J Chron Obstruct Pulmon Dis. 2022;17:2603-21. doi:10.2147/COPD.S380732
39. Obeng-Nyarkoh PI, Valentin-Figueroa ME, Cadham CJ, Cobb NK, Han MK, Levy DT, et al. Lung cancer risk in US adults with COPD: a systematic review and meta-analysis. Int J Chron Obstruct Pulmon Dis. 2025;20:3399-421. doi:10.2147/COPD.S531972