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The mediating effects of coping strategies between symptom clusters and quality of life in lung cancer patients undergoing immunotherapy

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Abstract

Objective Immunotherapy has significantly improved the survival rates of lung cancer patients. However, prevalent adverse immune reactions associated with this treatment can detrimentally affect their quality of life. Coping strategies play a crucial role throughout the cancer treatment process. Consequently, this study hypothesised that coping strategies act as a mediating factor between symptom clusters and quality of life. This study intended to provide a theoretical foundation and empirical data to support the optimisation of coping strategies for lung cancer patients, thereby enhancing their overall quality of life.

Method This study consisted of a cross-sectional survey. Data were collected using the Memorial Symptom Assessment Scale, the Medical Coping Modes Questionnaire, the Quality of Life Questionnaire-Lung Cancer 43, and a self-designed General Information Evaluation Form. The data were fitted, and the model was refined using the maximum likelihood estimation method. Additionally, the Bootstrap method was employed to assess mediating effects.

Results In total, 240 participants completed the survey. During immunotherapy, lung cancer patients predominantly adopted the acceptance-resignation coping strategy, which served as a mediating factor between symptom clusters and quality of life. In contrast, the mediating effects of confrontation and avoidance coping strategies between symptom clusters and quality of life were not significant.

Conclusion Both symptom clusters and the acceptance-resignation coping strategy negatively impacted quality of life, with acceptance-resignation serving as a mediating factor between symptom clusters and quality of life. Future research should focus on developing interventions for cognitive behaviour to improve coping strategies and quality of life throughout the disease trajectory.

Keywords Lung cancer, Symptom clusters, Coping strategies, Quality of life, Mediating effect

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Introduction

Lung cancer is the world's second most common cancer based on morbidity and the first based on mortality [1]. In recent years, immunotherapy has been shown to significantly improve both progression-free survival and overall survival in patients with lung cancer [2, 3]. However, the reported incidence of immune-related adverse events (irAEs) associated with the use of single-agent immunotherapies varies considerably, ranging from approximately 15–90% [4]. Consequently, during immunotherapy, patients with lung cancer can experience a wide range of symptoms. These symptoms not only catalyse and influence one another but also coexist as symptom clusters [5]. The definition of a symptom cluster is as follows: a cluster consisting of 2 or more symptoms that are associated and co-occurring [6]. Symptom clusters are made up of stable groups of symptoms, are relatively independent of other clusters, and may reveal specific underlying dimensions of the symptoms. The relationships between the symptoms within a cluster should be stronger than the relationships between the symptoms in different clusters. Symptoms in a cluster may or may not share the same cause or aetiology [6].

Coping involves cognitive and behavioural strategies to manage symptoms and improve quality of life. A study by Mick van de Wiel et al. indicated that the adoption of active restructuring coping strategies by patients with advanced lung cancer not only helps alleviate their anxiety and depression symptoms but also can enhance their quality of life [7]. Cancer patients have various coping strategies; effective coping strategies can reduce the symptom burden and improve their quality of life, while inappropriate coping strategies can aggravate symptom distress and affect quality of life [8, 9].

Previous research has shown that coping strategies act as a mediating factor between emotional burden and quality of life in patients with advanced cancer [10]. Lung cancer patients experiencing heightened emotional burden report a significantly increased frequency and severity of physical symptom burden. In parallel, those managing a severe physical symptom burden disclose experiencing a more severe emotional burden [11]. Symptom clusters encompass both the burden of physical symptoms and the burden of emotional symptoms. However, little is known about the relationship between symptom clusters, coping strategies, and quality of life in lung cancer patients.

In light of the above, this study posits a hypothesis that, during the treatment of lung cancer patients with immunotherapy, their coping strategies serve as a mediator between symptom clusters and quality of life. Confrontation refers to an attitude of challenge, while avoidance represents an active effort to escape the demands of the illness. In contrast, acceptance-resignation is primarily characterized by passivity. Confrontation positively moderates the relationship between symptom clusters and quality of life, while avoidance negatively moderates this relationship. In contrast, acceptance-resignation negatively moderates the relationship between symptom clusters and quality of life. Figure 1 illustrates the proposed hypothetical model. This study aims to explore the pathways through which symptom clusters and coping strategies affect quality of life of lung cancer patients undergoing immunotherapy, providing a theoretical basis to improve patient quality of life.

Methods

Study design

This study was a cross-sectional study.

Samples and settings

Patients were recruited based on convenience sampling from two tertiary A hospitals in Taiyuan, Shanxi Province, from the Department of Oncology and the Department of Respiratory Medicine. Inclusion criteria were as follows: (a) pathologic diagnosis of primary lung cancer, (b) received immunotherapy more than once, including immunotherapy alone, and immunotherapy combined with antiangiogenic therapy, (c) aged 18 years and over, and (d) ability to communicate efficiently. Exclusion criteria included: (a) other serious complications such as heart disease, stroke, brain disease, and kidney disease.; and (b) concurrently participating in other clinical interventional trials. The required sample size was estimated using the following formula: $n = \frac{Z_{\alpha}^2 * (1-P) * P}{\delta^2}$, set $\alpha = 0.05$, $Z_{0.05} = 1.96$ [12]. The P value for the incidence of irAEs related to immunotherapy was determined based on prior studies (15–90%) [4]. Using a minimum value of 15% and allowing a 5% error, the estimated sample size was 196. The final required sample size was determined to be 216, taking into account a 10% attrition rate for the survey. The sample size for Structural Equation Modelling studies ranged from 200 to 500 cases [13]. A total of 240 valid questionnaires were obtained.

Measures

Demographic and clinical characteristics

Demographic and clinical data were collected using the general information questionnaire. Demographic data included age (years), sex, marital status, educational level, and employment status. Clinical data included tumour diagnosis, pathological stage, financial difficulties, whether the patient knew they had been diagnosed with lung cancer, and months since diagnosis [14].

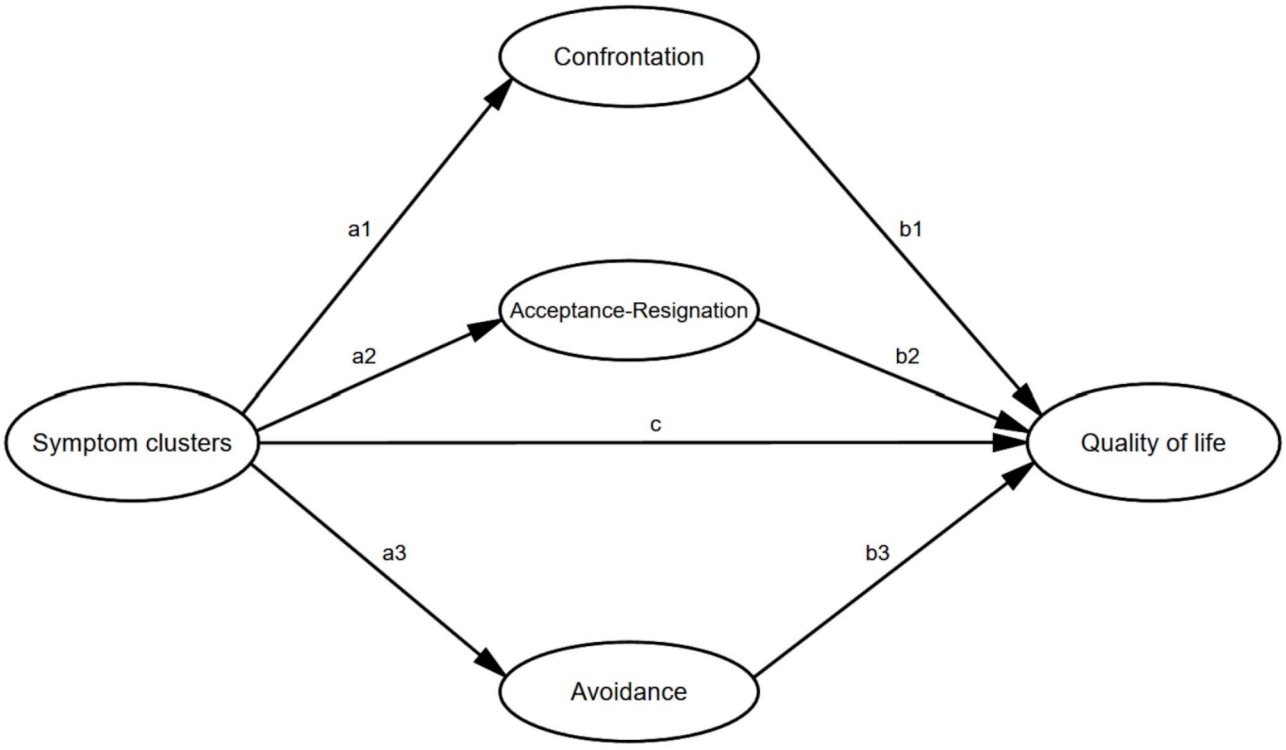

Fig. 1 Hypothesised model

Symptom clusters

Symptom clusters were identified using a modified version of the Memorial Symptom Assessment Scale (MSAS) [15, 16]. Weight gain, blurred vision, and palpitations were the three additional symptoms added to the original scale (which measures 32 symptoms). Each symptom was recorded as present or absent, and if present, was rated using a four- or five-point rating scale for frequency, severity, and associated distress during the previous seven days. Higher scores indicated a greater frequency, higher severity, and higher distress. The MSAS was utilised for the identification of symptom clusters among lung cancer patients, demonstrating good reliability and validity [14].The Cronbach α value in this study was 0.956.

Coping strategies

Coping strategies were measured using the Chinese version Medical Coping Modes Questionnaire (MCMQ) [17, 18].This scale has been primarily utilized in studies involving patients with pathogenic diseases and non-fatal chronic conditions. Additionally, it has been widely adopted in the context of cancer patient management [19]. The questionnaire consisted of 20 items and three dimensions: confrontation (8 items), avoidance (7 items), and acceptance-resignation (5 items). Each item was scored from 1 to 4. The dimension with the highest cumulative score indicated the coping strategy that patients were most likely to use [20]. Cronbach's alpha values of the three dimensions were 0.776, 0.545, and 0.712, respectively.

Quality of life

Quality of life was assessed using the Chinese version of the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Lung Cancer 43(EORTC QLQ-LC43) [21, 22], consisting of the 30-item EORTC QLQ-C30 and the 13-item QLQ-LC13. All items were scored using a four-point scale, except for global quality of life (QOL) (Q29, Q30), which was assessed using a seven-point scale. For the subsequent analysis, all scores were linearly converted to a 0–100 scale (higher scores represent a better level of functioning for the functional and global health domains and a greater degree of symptoms for the symptom domains). This has been widely used to assessquality of life in lung cancer patients [23]. The Cronbach's alpha value of the EORTC QLQ-LC43 in this study was 0.918.

Procedures

The study protocol complied with the provisions of the Declaration of Helsinki and was approved by the ethics committees of each hospital and by the Zhejiang Chinese Medicine University. All research subjects provided

informed consent and voluntarily participated in the study.

Statistical analysis

The IBM SPSS 26.0 software was used for data analysis. Descriptive statistics and frequency distributions were generated for the demographic and clinical characteristics. Structural Equation Modelling was developed using AMOS 24.0, which applied the maximum likelihood estimation to fit and revise the model. Mediating effects were assessed using the Bootstrap method, with 2000 resamples. The presence of significant mediating effects was determined using a 95% Confidence Interval (CI) excluding zero. The threshold for statistical significance was established at $\alpha = 0.05$.

Results

Sample characteristics

A total of 240 lung cancer patients receiving immunotherapy completed the survey, as shown in Table 1. The mean age was 62.40 years (SD = 9.17, min 28, max. 82). Most patients were males (77.5%), and knew of their medical condition (70%).

Symptom clusters, coping Strategies, and quality of life

Five symptom clusters were identified in lung cancer patients undergoing immunotherapy: emotion-related symptom cluster, lung cancer-related symptom cluster, physical symptom cluster, skin symptom cluster, and neural symptom cluster. For further information, please refer to the published article [24]. The mean scores of confrontation, avoidance, and acceptance-resignation were 16.42(SD = 4.45), 13.34 (SD = 3.07), and 9.22 (SD = 2.89), respectively. Comparing scores from three dimensions of coping strategies during immunotherapy in lung cancer patients with those of healthy individuals showed that the scores in the acceptance-resignation dimension were higher in lung cancer patients ($P = 0.029$). In comparison, the scores in confrontation and avoidance dimensions were lower than healthy individuals ($P < 0.001$), as shown in Table 2. The mean scores for the physical, role, emotional, cognitive, and social functioning domains were 72.72, 70.97, 76.56, 81.81, and 70.21, respectively. The mean score for QoL was 66.94.

Multiple linear regression analysis of coping strategies

Factors influencing the coping strategies assessed in this study were identified through multiple linear regression analyses. Demographic and clinical characteristics showing significant difference ($p < 0.05$) based on a univariate analysis were used as independent variables. Significant variables associated with the confrontation dimension included average monthly income (RMB 1001–3000), pathological stage, employment status (farmer), and whether the diagnosis was known (Adjusted $R^2 = 0.150$, $F = 4.503$, $p < 0.001$). Factors associated with the avoidance dimension included gender, average monthly income (RMB 1001–3000, 3001–5000), and financial difficulty (Adjusted $R^2 = 0.076$, $F = 3.814$, $p < 0.001$). Contributing factors to the acceptance-resignation dimension included average monthly income (RMB 1001–3000), excessive financial difficulty (very much), duration since diagnosis (months), and prior targeted therapy (Adjusted $R^2 = 0.135$, $F = 3.493$, $p < 0.001$), as shown in Table 3.

The discriminant validity of latent variables

Discriminant validity refers to a low correlation or significant difference between traits represented by one latent variable and those represented by other latent variables. It assumes that the square root of the Average Variance Extracted (AVE) for each latent variable is greater than the correlation coefficients between that latent variable and other latent variables. In this case, it indicates good discriminant validity, signifying significant differences among the latent variables reflected by the indicator variables. In this study, the various dimensions of medical coping strategies, symptom clusters, and quality of life generally exhibited discriminant validity, as detailed in Table 4.

Hypothetical model test

The fitting of the hypothetical model was satisfactory ($\chi 2/df = 1.747$, GFI = 0.793, IFI = 0.875, CFI = 0.873, and RMSEA = 0.056). According to the structural equation model, the path analysis results are presented in Table 5. The path analysis revealed that symptom clusters did not significantly influence confrontation ($\beta = 0.126$, $P = 0.127$) or avoidance ($\beta = 0.112$, $P = 0.190$), but significantly influenced acceptance-resignation ($\beta = 0.554$, $P < 0.001$). Confrontation did not significantly impact quality of life ($\beta = -0.046$, $P = 0.411$), while acceptance-resignation significantly impacted quality of life negatively ($\beta = -0.189$, $P = 0.014$). Avoidance did not significantly impact quality of life ($\beta = -0.028$, $P = 0.624$). Additionally, symptom clusters significantly negatively impacted quality of life ($\beta = -0.745$, $P < 0.001$).

Testing the mediating effects of confrontation, avoidance, and Acceptance-resignation

This study employed the Bias-corrected Bootstrap method to test mediating effects within the structural equation model, using a sample size of 2000 and a 95% confidence interval [25]. The results indicated that the mediating effect of acceptance-resignation was significant ($P = 0.022$), whereas the mediating effects of confrontation ($P = 0.231$) and avoidance ($P = 0.35$) were not significant. Details are shown in Table 6.

Table 1 Demographic and clinical characteristics, as well as univariate analyses of different coping strategies ($N = 240$)

Variable	Categories	N	%	Confrontation Z/H(P*)	Avoidance Z/H(P*)	Acceptance-resignation Z/H(P*)
Age Range, (28 ~ 82), years	28–44	9	(3.7)	3.839[a](0.279)	2.832[a](0.418)	1.945[a](0.584)
	45–59	76	(31.7)			
	60–79	151	(62.9)			
	≥ 80	4	(1.7)			
Gender	Male, N (%)	186	(77.5)	-0.105[b](0.916)	-2.732[b](0.006)	-0.102[b](0.919)
	Female, N (%)	54	(22.5)			
Education	Master's degree or above, N (%)	1	(0.4)	5.228[a](0.625)	1.572[a](0.814)	10.379[a](0.035)
	University, N (%)	34	(14.2)			
	Senior high school, N (%)	68	(28.3)			
	Junior high school, N (%)	88	(36.7)			
	Primary school or below, N (%)	49	(20.4)			
Financial difficulty	Not at all, N (%)	41	(17.1)	5.031[a](0.170)	10.624[a](0.014)	21.676[a](< 0.001)
	A little, N (%)	32	(13.3)			
	Somewhat, N (%)	129	(53.8)			
	Very much, N (%)	38	(15.8)			
Pathological stage	II, N (%)	15	(6.3)	9.575[a](0.008)	4.215[a](0.122)	5.565[a](0.062)
	III, N (%)	52	(21.7)			
	IV, N (%)	173	(72)			
Marital status	Married, N (%)	225	(93.8)	0.377[b](0.845)	0.211[b](0.900)	-0.924[b](0.351)
	Single, N (%)	1	(0.4)			
	Divorced or widowed, N (%)	14	(5.8)			
Duration since diagnosis (months)	≤ 6, N (%)	66	(27.5)	-1.023[b](0.306)	-0.694[b](0.488)	2.014[b](0.044)
	> 6, N (%)	174	(72.5)			
Whether the diagnosis was known	Yes, N (%)	168	(70)	4.723[b](< 0.001)	-1.896[b](0.058)	-0.758[b](0.449)
	No, N (%)	72	(30)			
Type of immunotherapy	PD-1 inhibitor, N (%)	173	(72)	2.727[a](0.604)	2.710[a](0.607)	6.131[a](0.190)
	PD-L1 inhibitor, N (%)	24	(10)			
	PD-1 + Anlotinib Hydrochloride, N (%)	9	(3.8)			
	PD-L1 + Anlotinib Hydrochloride, N (%)	3	(1.3)			
	PD-1 + Antiangiogenic therapy, N (%)	31	(12.9)			
Employment	Employed, N (%)	44	(18.3)	8.713[a](0.033)	7.584[a](0.055)	2.639[a](0.451)
	Unemployed, N (%)	27	(11.3)			
	Retired, N (%)	111	(46.3)			
	Farmer, N (%)	58	(24.1)			
Average monthly income (RMB)	≤ 1000, N (%)	65	(27.1)	11.769[a](0.008)	8.180[a](0.042)	9.492[a](0.023)
	1001~3000, N (%)	60	(25)			
	3001~5000, N (%)	78	(32.5)			
	≥ 5000, N (%)	37	(15.4)			
Payment method of medical expenses	Medical insurance for urban workers, N (%)	106	(44.1)	10.449[a](0.015)	6.199[a](0.102)	9.492[a](0.023)
	Medical insurance for urban residents, N (%)	38	(15.8)			
	New rural cooperative medical system, N (%)	93	(38.8)			
	Medical insurance for retired cadres, N (%)	3	(1.3)			
History of targeted therapy	Yes, N (%)	38	(15.8)	-0.188[b](0.851)	-0.621[b](0.535)	-2.624[b](0.009)
	No, N (%)	202	(84.2)			

Note: [a] H, statistic of the Kruskal–Wallis H test

[b] Z, statistic of the Mann–Whitney U test

Table 2 Comparison between lung cancer patient coping scores during immunotherapy with healthy individuals ($n = 240$)

Variable	$\bar{X} \pm S$	Standard	t	*P*
Confrontation	16.42 ± 4.44	19.48 ± 3.81	-10.625	**< 0.001**
Avoidance	13.34 ± 3.07	14.44 ± 2.97	-5.534	**< 0.001**
Acceptance-resignation	9.22 ± 2.89	8.81 ± 3.17	2.195	**0.029**

Note: The scores for the dimensions of confrontation, avoidance, and acceptance-resignation ranged from 0 to 32, 0 to 28, and 0 to 20, respectively

Discussion

This study found that the primary coping strategy adopted by lung cancer patients during immunotherapy was acceptance-resignation. Symptom clusters negatively impacted quality of life, with acceptance-resignation acting as a mediator between these. Furthermore, the study identified several factors influencing confrontation, including average monthly income, pathological stage, employment, and whether the diagnosis was known. Avoidance coping was influenced by average monthly income and financial difficulty. Factors influencing acceptance-resignation included average monthly income, financial difficulty, duration since diagnosis, and prior targeted therapy.

Coping strategies

This study demonstrates that during immunotherapy, lung cancer patients primarily adopt the acceptance-resignation coping strategy. This finding aligns with the survey results on coping strategies among lung cancer patients undergoing immunotherapy, as reported by Hong Wang et al. [26]. In this study, the Cronbach's alpha values for the confrontation and acceptance-resignation dimensions were higher than 0.7. In contrast, the avoidance dimension demonstrated a lower Cronbach's alpha value. Similarly, a Chinese study also reported a lower Cronbach's alpha for the avoidance dimension [20], which may be attributed to a lower number of patients adopting an avoidance coping strategy.

Confrontation is a positive coping strategy adopted by patients who actively engage in treatment to prolong their lives. This proactive attitude is maintained as the disease is managed, such as through symptom relief or stabilisation [27, 28]. However, in this study, scores for the confrontation dimension were low, potentially because the majority of patients were over 60 years old (approximately 62.6%), and their access to information was limited. Additionally, the "family-centred model" of disease disclosure, widely adopted in our country, may have also influenced patients' coping strategies. Typically, physicians first informed family members about the patient's condition, who then decided whether to relay this information to the patient [29]. Research has shown that spirituality and religious beliefs positively influence coping strategies for illnesses, including emotional and physical symptoms [30]. Traumatic events, such as cancer, can significantly impact the rate and intensity of spiritual development [31]. In religious cultures, including Islam and Christianity, practices such as meditation and prayer are commonly used to cope with illness, offering psychological comfort and hope to patients [31]. In contrast, in secular cultures, patients tend to rely more on rational thinking and health system supports [32]. In countries with religious beliefs, a higher proportion of patients maintain faith, whereas in China, the majority of patients are atheists [31]. In many cultures, there are significant differences in emotional expression and coping strategies [33]. In East Asian cultures, emotional control and anxiety are often seen as markers of maturity, with individuals tending to adopt implicit coping strategies, especially when under stress. In contrast, in Western cultures, expressing emotions is considered a healthy coping mechanism, and individuals are more likely to release stress through external means, such as emotional outbursts. A study revealed [34] that Online Patient-Provider Communication (OPPC) can elicit perceptions of patient-centred communication (PCC) and help patients adopt adaptive coping strategies, including problem-oriented and emotion-oriented coping, thus alleviating the psychological distress among patients with chronic diseases. Another study [35] showed that cancer patients with a "high mindfulness" profile often reported better psychological outcomes and employed more effective coping strategies. Furthermore, a study [36] showed that fatalism is a key component of mental adjustment for the elderly, helping them develop positive coping skills based on their life experiences. This concept may also help the elderly experiencing despair accept their current situation naturally [36]. Therefore, by integrating patients' religious beliefs and spiritual needs, providing psychological support, promoting positive coping strategies, enhancing social support and access to information, and developing personalized treatment and rehabilitation plans, the coping strategies of patients can be effectively adjusted.

Multiple qualitative studies on advanced lung cancer patients have shown that avoidance is a coping strategy employed by patients and their families. Due to their illness, patients often avoid social interactions, are reluctant to engage in conversations with acquaintances, and refrain from discussing their condition with family members [37]. Additionally, patients and their families often avoid discussing disease progression and death, seeking to suppress negative emotions by diverting attention [28]. In the current study, 30% of families concealed the lung cancer diagnosis from the patient to allow them to face life more comfortably and without fear. Conversely, patients who were aware of their condition reported that they did not avoid discussing their illness, expressing a desire to forget about their illness, but finding it

Table 3 Multiple linear regression analysis of coping strategies

	B	SE	Beta	t	*P*
Confrontation					
(Constant)	22.491	1.556		14.451	< 0.001
Average monthly income (RMB)					
≤ 1000	Refence group				
1001~3000	1.938	0.804	0.189	2.409	0.017
3001~5000	0.984	0.884	0.104	1.113	0.267
≥ 5000	0.785	1.010	0.064	0.777	0.438
Payment method of medical expenses					
Medical insurance for urban workers	Refence group				
Medical insurance for urban residents	1.438	0.870	0.118	1.653	0.100
New rural cooperative medical system	0.376	0.835	0.041	0.451	0.652
Medical insurance for retired cadres	1.942	2.473	0.049	0.785	0.433
Pathological stage					
II	Refence group				
III	-2.548	1.245	-0.237	-2.046	0.042
IV	-2.905	1.151	-0.294	-2.524	0.012
Employment					
Be employed	Refence group				
Be unemployed	-0.886	1.061	-0.063	-0.835	0.404
Be retired	-1.471	0.774	-0.165	-1.901	0.059
Farmer	-2.066	0.920	-0.199	-2.247	0.026
Whether the diagnosis was known	-2.668	0.602	-0.276	-4.433	< 0.001
Adjusted R^2	0.150				
F	4.503(< 0.001)				
Avoidance					
(Constant)	9.698	0.815		11.893	< 0.001
Gender	1.06	0.469	0.144	2.26	0.025
Average monthly income (RMB)					
≤ 1000	Refence group				
1001~3000	1.403	0.529	0.198	2.65	0.009
3001~5000	1.206	0.517	0.184	2.332	0.021
≥ 5000	1.15	0.649	0.135	1.772	0.078
Financial difficulty					
Not at all	Refence group				
A liitle	1.978	0.713	0.219	2.776	0.006
Somewhat	1.588	0.56	0.258	2.836	0.005
Very much	1.942	0.708	0.231	2.745	0.007
Adjusted R^2	0.076				
F	3.814(0.001)				
Acceptance-resignation					
(Constant)	7.270	1.196		6.077	< 0.001
Average monthly income (RMB)					
≤ 1000	Refence group				
1001~3000	1.334	0.530	0.200	2.516	0.013
3001~5000	0.766	0.571	0.124	1.340	0.182
≥ 5000	1.002	0.688	0.125	1.458	0.146
Education					
Primary school or below	Refence group				
Master's degree or above	1.386	2.807	0.031	0.494	0.622
University	-0.641	0.707	-0.077	-0.906	0.366
Junior high school	-0.461	0.541	-0.072	-0.852	0.395
Primary school or below	0.304	0.498	0.051	0.610	0.542

Table 3 (continued)

	B	SE	Beta	t	*P*
Payment method of medical expenses					
Medical insurance for urban workers	Refence group				
Medical insurance for urban residents	0.761	0.566	0.096	1.345	0.180
New rural cooperative medical system	0.221	0.510	0.037	0.432	0.666
Medical insurance for retired cadres	1.442	1.660	0.055	0.868	0.386
Financial difficulty					
Not at all	Refence group				
A liitle	0.920	0.649	0.108	1.419	0.157
Somewhat	0.977	0.525	0.169	1.862	0.064
Very much	2.657	0.652	0.336	4.076	< 0.001
Duration since diagnosis (months)	-0.819	0.411	-0.127	-1.993	0.047
History of targeted therapy	1.242	0.496	0.157	2.504	0.013
Adjusted R^2	0.135				
F	3.493(< 0.001)				

Note: (< 0.001) is the *p*-value

B, unstandardized beta; SE, standard error; Beta, standardized beta; PD-1, Programmed Cell Death Protein 1; PD-L1, Programmed Death Ligand 1

Variable Assignment Method: Whether the diagnosis was known: 1 = Yes, 2 = No; Gender: 1 = Male, 2 = Female; History of targeted therapy: 1 = No, 2 = Yes; Duration since diagnosis (months):1 = ≤ 6 months, 2 = > 6 months

impossible to do so. Consequently, their scores on the avoidance dimension were low. This could also explain why avoidance did not serve as a mediator between symptom clusters and quality of life.

With the continuous advancement of medicine and the evolution of lung cancer treatment methods, many patients have developed a resistant attitude towards their disease and actively engage in treatment. Despite this, they remain acutely aware that they are suffering from a malignant tumour and that current medical interventions cannot completely cure them. This awareness often leaves patients feeling helpless, compelling them to accept their current circumstances. Frequent hospitalisations further cause many patients to prioritise their "patient role," making it difficult to attend to other aspects of life. These factors likely contribute to the high scores observed in the acceptance-resignation dimension among patients. During immunotherapy, the acceptance-resignation coping strategy was the primary approach adopted by lung cancer patients, aligning with previous research findings [26]. However, research conducted abroad indicates that confrontation is the most commonly adopted coping strategy among lung cancer patients, with acceptance-resignation being rarely chosen, differing from the findings of this study [38]. Cultural differences between domestic and international contexts [39], as well as variations in the age, social status, and educational levels of the study participants [40], may account for the discrepancies in these findings.

Factors influencing coping strategies

The results of this study indicated that factors influencing the confrontation dimension included average monthly income, pathological stage, employment status, and whether the diagnosis was known. Factors influencing the avoidance dimension included gender, average monthly income, and financial difficulty, which aligns with the findings of Diehl et al. [40]. The high cost of immunotherapy drugs, some of which are not subsidised by insurance, places a significant financial burden on patients. Therefore, patients with a higher household income were more likely to adopt a confrontational coping strategy, while those with a heavier financial burden tended to adopt an avoidant strategy. Patients with stage III and IV lung cancer, due to the larger size of their tumour, invasion of surrounding tissues, or distant metastasis, experienced worse physical symptoms as they progressed, which in turn affected their proactive coping attitudes. Li Yanqun et al.'s research found that as the condition worsens, patients lose confidence in treatment and recovery, which is consistent with the findings of this study [41]. Patients employed in agriculture scored significantly lower in the confrontation dimension compared to those employed in other sectors, as occupation directly influenced income and cognitive levels, thereby affecting coping strategies. Research [42] indicates that female patients are at a higher risk of depression, which in turn affects their coping strategies. Women are more likely to acknowledge and address negative emotions such as anger, feelings of helplessness, a desire for solitude, and pain resulting from loneliness [43]. This study found that female patients were more likely to choose avoidance, which may stem from the overwhelming emotional and psychological burdens associated with their diagnosis and treatment. These patients may distance themselves from their emotions and avoid confronting

Table 4 Comparison of the square root of AVE and inter-construct correlations

	Avoidance	Acceptance-resignation	NSC	SSC	PSC	LCRSC	ERSC	Confrontation	QoL	SF	CF	EF	RF	PF
Avoidance	**0.681**													
Acceptance-resignation	0.413	**0.743**												
NSC	0.154	0.433	**0.576**											
SSC	0.073	0.165	0.287	**0.784**										
PSC	-0.045	0.277	0.718	0.354	**0.650**									
LCRSC	0.130	0.571	0.762	0.347	0.771	**0.594**								
ERSC	0.115	0.481	0.607	0.213	0.579	0.707	**0.692**							
Confrontation	0.361	0.381	-0.045	0.042	0.008	0.089	0.154	**0.681**						
QoL	-0.123	-0.473	-0.431	-0.126	-0.427	-0.706	-0.517	-0.197	**0.668**					
SF	-0.201	-0.488	-0.467	-0.282	-0.359	-0.581	-0.474	-0.226	0.526	**0.839**				
CF	-0.164	-0.557	-0.750	-0.397	-0.780	-0.784	-0.545	-0.189	0.559	0.761	**0.608**			
EF	-0.248	-0.601	-0.540	-0.228	-0.522	-0.725	-0.814	-0.173	0.585	0.685	0.883	**0.761**		
RF	-0.123	-0.528	-0.579	-0.268	-0.486	-0.688	-0.480	-0.297	0.542	0.741	0.746	0.671	**0.832**	
PF	-0.090	-0.386	-0.527	-0.119	-0.611	-0.748	-0.461	-0.022	0.564	0.555	0.736	0.554	0.789	**0.746**

Note: The bold diagonal elements are the square roots of each AVE; construct correlations are shown off-diagonal.

Abbreviations: NSC, neural symptom cluster; SSC, skin symptom cluster; PSC, physical symptom cluster; LCRSC, lung cancer-related symptom cluster; ERSC, emotion-related symptom cluster. QoL, global quality of life; SF, social functioning; CF, cognitive functioning; EF, emotional functioning; RF, role functioning; PF, physical functioning

the harsh realities of their condition to protect themselves from further emotional distress.

Factors influencing the acceptance-resignation included average monthly income, financial difficulty, duration since diagnosis (months), and prior targeted therapy, which aligns with the findings of Zheng Rujun et al. [146]. This study found that patients with a disease duration greater than 6 months scored lower on acceptance-resignation compared to those with a duration of less than 6 months. For newly diagnosed patients, sudden stressors, lack of knowledge about the disease, and symptom burden may lead to feelings of helplessness and despair. After a period of treatment, as symptoms alleviated and patients came to accept their condition, their submission coping strategies may be influenced. Patients who have previously undergone targeted therapy may adopt a submission coping strategy due to disease progression or drug resistance.

Symptom clusters as direct negative predictors of quality of life

The results of this study indicated that during immunotherapy, symptom clusters in lung cancer patients directly and negatively predict their quality of life, accounting for 86.8% of the total effect, consistent with previous research findings [44, 45]. The research findings of Yunhuan Li and colleagues indicated that each symptom cluster in lung cancer patients is significantly negatively correlated with overall quality of life, general health status, and the five functional dimensions of quality of life [44]. Additionally, Choi et al. demonstrated that symptom clusters and depression in advanced lung cancer patients can predict their quality of life [45].

The mediating effect of coping strategies between symptom clusters and quality of life

The results of the current study indicate that during the treatment of lung cancer patients with immunotherapy, the mediating effect of the confrontation coping strategy between symptom clusters and quality of life was not significant, as the 95% confidence interval includes zero. According to the stress and coping theory, coping strategies are a dynamic process that continually interacts with stressors and serves as a form of self-regulation [46]. In this study, symptom clusters were identified as the primary stressors for lung cancer patients during immunotherapy. Additionally, coping strategies were influenced by personality traits and environmental factors [47]. Consequently, the findings of this study revealed that only a minority of patients were able to self-regulate and adopt a confrontational coping strategy in response to the ongoing stressors of cancer. The impact of the confrontational coping strategy on quality of life did not reach statistical significance, consistent with previous research

Table 5 Test results of the path relationship

Path			Standard estimate	S.E.	C.R.	P	Label
Confrontation	←	Symptom clusters	0.126	0.146	1.525	0.127	a1
Acceptance-resignation	←	Symptom clusters	0.554	0.144	5.344	< 0.001	a2
Avoidance	←	Symptom clusters	0.112	0.050	1.312	0.190	a3
Quality of life	←	Confrontation	-0.046	0.044	-0.823	0.411	b1
Quality of life	←	Acceptance-resignation	-0.189	0.078	-2.47	0.014	b2
Quality of life	←	Avoidance	-0.028	0.138	-0.491	0.624	b3
Quality of life	←	Symptom clusters	-0.745	0.186	-5.671	< 0.001	c
PF	←	Quality of life	0.770				
RF	←	Quality of life	0.856	0.156	8.345	< 0.001	
EF	←	Quality of life	0.839	0.099	7.559	< 0.001	
CF	←	Quality of life	0.958	0.115	6.035	< 0.001	
SF	←	Quality of life	0.778	0.15	7.578	< 0.001	
QoL	←	Quality of life	0.682	0.223	7.532	< 0.001	
ERSC	←	Symptom clusters	0.704				
LCRSC	←	Symptom clusters	0.993	0.238	6.011	< 0.001	
PSC	←	Symptom clusters	0.776	0.174	5.726	< 0.001	
SSC	←	Symptom clusters	0.338	0.199	3.106	0.002	
NSC	←	Symptom clusters	0.785	0.221	4.998	< 0.001	

Abbreviations: C.R., critical ratio; S.E., standard error. NSC, neural symptom cluster; SSC, skin symptom cluster; PSC, physical symptom cluster; LCRSC, lung cancer-related symptom cluster; ERSC, emotion-related symptom cluster. QoL, global quality of life; SF, social functioning; CF, cognitive functioning; EF, emotional functioning; RF, role functioning; PF, physical functioning

Table 6 Bootstrapping mediation effect

Path relationship	Point estimate	Product of coefficient		Bootstrapping 2000 times 95% CI					
				Bias-corrected			Percentile		
		SE	Z	Lower	Upper	P	Lower	Upper	P
Indirect Effects									
Symptom clusters → Acceptance-resignation → Quality of life	-0.148	0.072	-2.056	-0.314	-0.024	0.022	-0.308	-0.021	0.026
Symptom clusters → Confrontation → Quality of life	-0.008	0.015	-0.533	-0.06	0.007	0.231	-0.042	0.016	0.517
Symptom clusters → Avoidance → Quality of life	-0.004	0.012	-0.333	-0.041	0.011	0.35	-0.029	0.022	0.718
Total indirect effect	-0.160	0.069	-2.319	-0.327	-0.044	0.01	-0.312	-0.037	0.015
Direct Effects									
Symptom clusters → Quality of life	-1.055	0.253	-4.170	-1.668	-0.634	0.01	-1.667	-0.633	0.001
Total Effects									
Symptom clusters → Quality of life	-1.215	0.272	-4.467	-1.867	-0.780	0.001	-1.868	-0.780	0.001
Proportion of mediating effect									
TIE/TE	0.132	0.051	2.588	0.038	0.025	0.011	0.03	0.234	0.015
DE/TE	0.868	0.051	17.02	0.755	0.962	0.002	0.766	0.970	0.001

Abbreviations: SE, standard error; TIE, total indirect effect; TE, total effects; DE, direct effects; CI, confidence interval

findings [48]. Research indicates that the confrontational coping strategy has dual effects on lung cancer patients. Regarding positive emotions, the confrontational coping strategy indirectly enhances mobility, daily activities, pain management, and overall quality of life. Conversely, through negative emotions, this coping strategy negatively affects mobility, pain, anxiety, and overall quality of life. These positive and negative indirect effects counterbalance each other, resulting in an overall insignificant impact [48]. However, other studies [7, 49, 50] have reported that positive coping strategies contribute to reducing anxiety and depression levels in patients. By accepting reality, actively addressing issues, and seeking solutions, patients can better regulate their emotions and enhance their overall mental health, positively impacting their quality of life [7]. Consequently, in the treatment and care of lung cancer patients, it is essential to consider these psychological and emotional factors to provide comprehensive support.

The results of this study revealed that during immunotherapy in lung cancer patients, the mediating effect of the avoidance coping strategy between symptom

clusters and quality of life was insignificant. This finding is inconsistent with previous research [47, 50]. Research [47] indicated that patients who adopt avoidance coping strategies typically experience lower levels of social support and exhibit symptoms of depression. These depressive symptoms may, in turn, increase the use of avoidance coping strategies, thus becoming potential stressors. Moreover, avoidance coping strategies are ineffective at regulating negative emotions and may even exacerbate the severity of depressive symptoms. Consequently, a vicious cycle may emerge where depressive symptoms, such as feelings of sadness, can lead patients to distance themselves from friends and family. Such increased social isolation and lack of emotional regulation can further intensify depressive and possibly anxiety symptoms. However, Chinese scholars have found that in gastrointestinal cancer patients, the psychological symptom burden can indirectly alleviate the functional dimensions of quality of life through avoidance coping strategies [50]. This may be related to cultural differences. In summary, the impact of avoidance coping strategies on patients' quality of life is a complex issue influenced by multiple factors, including cultural background, levels of social support, and individual psychological conditions.

Outcomes from the current study indicated that during immunotherapy for lung cancer, the mediating effect of the acceptance-resignation coping strategy between symptom clusters and quality of life was significant, with an estimated value of -0.148. This finding is consistent with previous research results [48, 50, 51, 52]. In this study, symptom clusters were identified as the primary stressors for lung cancer patients during immunotherapy. Under the prolonged influence of these stressors, patients may gradually lose confidence and determination, ultimately leading to the acceptance-resignation coping strategy. The acceptance-resignation coping strategy may lead to a decrease in positive emotions and an increase in negative emotions, thereby affecting the patient's quality of life [48]. Additionally, the acceptance-resignation coping strategy may lead patients to avoid social interactions, resulting in social isolation, adversely affecting their relationships with family, friends, and support systems, intensifying feelings of loneliness and reducing quality of life. Overall, the acceptance-resignation coping strategy can negatively impact patients' quality of life across physiological, psychological, and social dimensions.

Clinical implications

The current study revealed that during immunotherapy for lung cancer, patients utilised a variety of coping strategies. Notably, the acceptance-resignation coping strategy negatively mediated the relationship between symptom clusters and quality of life. In contrast, positive coping strategies helped patients manage the emotional and psychological challenges associated with their disease more effectively, thereby enhancing their overall well-being.

External environments significantly influenced the selection of coping strategies, with support from friends, family, and the community being crucial for patients. By sharing their feelings with family and friends, patients can not only alleviate their psychological burdens but also gain the courage and motivation to face their illness and receive help and support. Moreover, specialised cancer health education centres and psychological counselling services in hospitals and communities play an essential role. These services provide disease-related information, nutrition and exercise guidance, and psychological support, all of which aid patients to address the psychological challenges posed by their illness and to adopt positive coping strategies.

Research findings [53, 54, 55] report that cognitive behavioural therapy significantly reduces symptoms of depression and anxiety in patients, thereby improving their quality of life and emotional functioning. Consequently, healthcare providers should develop tailored treatment plans based on the specific circumstances of each patient, offering appropriate psychological support and coping strategy training. This approach helps patients manage the physiological and psychological challenges posed by their illness more effectively, thereby improving their quality of life.

Study limitations

Despite the many strengths and benefits of the current study, it also has limitations. Firstly, this study employed a convenience sampling method. Future research should consider extending the study duration, increasing the sample size, and expanding the geographical scope to include hospitals of various levels across a wider range of regions, as well as incorporate diverse religious beliefs and substance use. Additionally, adopting a stratified sampling method would enhance the representativeness and generalisability of the results, thereby increasing their applicability and value for broader dissemination. Secondly, this study uses a cross-sectional design. Future research would benefit from a longitudinal study design, which would facilitate the analysis and understanding of trends in symptom clusters, coping strategies, and quality of life over time. This approach would also allow determining whether the relationships between these variables change over time. Finally, coping strategies were influenced by cultural background, levels of social support, and individual psychological conditions. Therefore, further research is essential to explore in depth how these factors collectively influence the impact of coping strategies on patients' quality of life.

Conclusions

This study explores the relationships among symptom clusters, coping strategies, and quality of life in lung cancer patients during immunotherapy. Patients predominantly adopted an acceptance-resignation coping strategy. Both symptom clusters and the acceptance-resignation coping strategy negatively impacted quality of life, with acceptance-resignation serving as a mediating factor. The present findings support the potential value of developing interventions involving cognitive behaviour to improve coping strategies and quality of life throughout the disease trajectory.

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Author contributions
Xuying Yang and Jingcui Bai were responsible for the paper conception, article selection, quality assessment and drafting of the manuscript. Xiaohong Zhang was involved in data collection. All authors read and approved the final manuscript.

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No.

Data availability
The datasets generated and/or analysed during the current study are not publicly available but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study protocol complied with the provisions of the Declaration of Helsinki and was approved by the ethics committees of Shanxi Bethune Hospital (code: YXLL-2022-142) and Second hospital of Shanxi medical university(code: 2022YX258) and by the Zhejiang Chinese Medicine University (code:20221028-2). All research subjects provided informed consent and voluntarily participated in the study. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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