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ORIGINAL RESEARCH

The Chain Mediating Role of Hope and Posttraumatic Growth Between Social Support and Psychological Distress Among Lung Cancer Patients

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Purpose: This research was designed to explore whether hope and posttraumatic growth (PTG) played a mediating role between social support and psychological distress in patients diagnosed with lung cancer.

Patients and Methods: A hospital-based cross-sectional study was carried out on 502 lung cancer patients. From September 2023 to April 2024, participants were recruited via convenience sampling from one tertiary cancer hospital and two tertiary general hospitals in Chongqing, China. Patients completed questionnaires on demographics, medical information, Distress thermometer, Perceived Social Support Scale, Posttraumatic Growth Inventory, and Herth Hope Index. Statistical analyses included Pearson's chi-squared test or Fisher's exact test for differences in patient characteristics by psychological distress level. Pearson correlation analysis explored relationships among variables. Bootstrapping in structural equation modeling (SEM) evaluated structural paths, and multi-group SEM analysis tested the moderating effect of gender.

Results: 43.6% (219/502) of lung cancer patients experience psychological distress. After controlling for cancer stage and distant metastasis, the results suggested that social support had a negative direct effect on psychological distress. In addition, social support could also influence psychological distress via three pathways: (1) the mediating effect of hope, (2) the mediating effect of PTG, and (3) the serial mediating effect of hope and PTG. The indirect effect of the three intermediary paths accounted for 72.7% of the total effect. Gender moderated the effect of social support on PTG ($\beta = -0.286$, $P = 0.001$).

Conclusion: This study found that lung cancer patients exhibit high levels of psychological distress. Social support directly impacts psychological distress and acts through multiple pathways: the mediating effects of hope and PTG, as well as their serial mediation. These findings deepen our understanding of how social support affects psychological distress in lung cancer patients and its underlying mechanisms, providing empirical support for developing interventions to alleviate distress.

Keywords: lung cancer, social support, psychological distress, hope, posttraumatic growth, serial mediation model

Introduction

The 2022 update on cancer statistics provides a staggering figure: Lung cancer, accounting for approximately 1/8 (11.4%) of diagnosed cancers and 1/5 (18.7%) of deaths worldwide.[1] As the largest developing country in the world, China bears a significant burden of lung cancer. The latest data indicate that there were 1,060,600 new cases and 733,300 new deaths of lung cancer in China.[2] Despite advancements in treatment modalities, the long-term prognosis of lung cancer remains poor, accompanied by a low 5-year survival rate (<30% in China).[3] Lung cancer populations not only endure physical symptoms directly attributable to the tumor, but also grapple with a myriad of treatment-induced discomforts.[4] Moreover, they confront alterations in family and social roles, diminished work ability, exorbitant treatment expenses and other practical dilemmas.[5,6] In conclusion, individuals with lung cancer typically encounter formidable challenges and pressures on social, psychological, and physical fronts, and these elements are intertwined to cause patients to experience varying degrees of psychological distress.[7–9]

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Psychological distress refers to a kind of unpleasant emotional experience caused by psychological, social, spiritual and/or physical factors, which exists in the whole process of cancer diagnosis and treatment.[10] As a continuum, it includes both normal feelings of vulnerability, sadness, and fear, as well as panic, depression, anxiety, social isolation, survival, and spiritual crises that can lead to psychosomatic problems.[10] The prevalence of psychological distress in Chinese patients with lung cancer is reported to be higher than that in patients with other cancers, ranging from 17.7% to 63.75%.[11–13] As a negative emotional state, psychological distress may induce or exacerbate a variety of physical symptoms, impair the physical and mental health of patients, weaken the function of the immune system, lead to deterioration of the disease, and increase the risk of secondary tumors.[9,14] What's more, psychological distress, as an intermediate variable affecting suicidal ideation, is closely related to suicidal behavior and various levels of mental pain.[15,16] When psychological distress reaches an unbearable level, individuals may resort to suicidal behavior to escape pain, which seriously increases public medical resources and social and economic burden. The clinical significance of assessing and treating psychological distress has received widespread attention from health care providers, including the recognition of distress as the sixth vital sign in cancer care.[17] Therefore, comprehensive assessment of psychological distress and its contributing factors in lung cancer populations is essential. This will enable targeted strategies to manage the condition effectively, ultimately enhancing both physiological and psychological well-being.

Relationship Between Social Support and Psychological Distress

Social support refers to the extent to which interpersonal connections fulfill particular necessities, including emotional, instrumental, and tangible forms of assistance, as well as the level of social cohesion.[18] It is widely acknowledged that positive social support constitutes a vital component of psychological adaptation, contributing to the mitigation of the deleterious impacts of negative emotions.[19,20] The stress buffering model of social support posits that robust social support can mitigate the detrimental effects of stressful occurrences and ultimately preserve both physical and mental well-being.[21] And previous investigation in healthy adults also revealed that greater social support was associated with lower levels of psychological distress.[11,22,23] These studies have plausibly anticipated a correlation between social support and psychological distress. Nonetheless, the mechanisms by which social support impacts the psychological distress experienced by lung cancer patients are yet to be comprehensively probed. Based upon the previous studies, we propose hypothesis H1: social support negatively predicts psychological distress in lung cancer patients.

The Potential Mediating Effect of Hope

Attitudes toward the future can also serve as a pertinent factor influencing individuals' responses to critical incidents or traumatic stress, thereby impacting psychological distress. According to Snyder's cognitive model of hope, hope refers to "a motivational positive state that is based on an inter-actively derived sense of successful (i) agency (goal-oriented energy) and (ii) pathways. (preparation to achieve goals)."[24] Hope is a kind of psychological capital and spiritual process that helps cancer patients cope with the physical and mental effects of the disease and maintain their psychological health and quality of life.[25] Understandably, hope plays a particularly important role in the face of the protracted treatment process and disease uncertainty associated with lung cancer. A high level of hope significantly contributes to patients' more constructive engagement with the diagnosis and treatment of their condition, as well as the management of adverse reactions that may arise during this process.[26,27] It also encompasses dealing with the inherent uncertainty throughout the treatment journey and the formulation and execution of a comprehensive long-term recovery plan.[28] Hope has protective effects on psychological distress, and patients who had high hope reported less psychological distress as compared to those with poor hope.[29,30]

Furthermore, existing research has found that social support was positively related to hope, and social support can positively predict their hope in cancer patients.[31,32] Social support, particularly family support, serves as an inherent resource that may enhance the perception of hope.[33] In accordance with the social connectedness theory, the social connection represented by "maintaining a close relationship with society" can fulfil the needs of individuals affiliation and provide support for their goal-oriented behavior, thereby enhancing the prospect of hope.[34] A study among 286 lung cancer patients in China indicated that social support exerted a positive impact on hope, and hope level partially mediated the relationship between social support and benefit finding.[32] Naturally, we put forward hypothesis H2: hope serves a mediating role between social support and psychological distress.

The Potential Mediating Effect of PTG

Posttraumatic growth may function as an additional potential mediator that elucidates the pathway from social support to psychological distress. Posttraumatic growth (PTG) refers to the positive psychological changes experienced on account of struggling with extremely challenging circumstances or traumatic events.[35] Receiving a diagnosis of lung cancer and its consequences can be highly stressful events, and may become an ongoing, chronic trauma event for individuals.[36] It is well recognized that PTG can enhance an individual's comprehension of traumatic events, bolster their mental well-being, and empower them to extract strength from adversity, thereby enabling them to navigate an unpredictable future more intelligently.[37,38] Previous studies have suggested that higher PTG was negatively associated with lower level of psychological distress in palliative care patients and breast cancer survivors.[39,40]

However, there was limited literature on the mediating role of PTG in psychological distress. Theoretical models hold that social support can facilitate successful adaptation to life crises, thereby serving as a catalyst for personal growth, manifested through more efficacious coping strategies and more positive appraisals.[41] Additionally, from the perspective of Tedeschi and Calhoun,[42] the development cultivating PTG involves multiple pivotal elements, which encompass individual characteristics, social support, cognitive manipulation and impact of the event. A meta-analysis of 31 studies reported a highly positive correlation between social support and PTG in 6,380 breast cancer patients ($r = 0.425$).[43] And Zhang et al[44] also found that social support had a direct positive effect on PTG in lung cancer patients. According to the theoretical and empirical evidence, we propose hypothesis H3: the influence of social support on psychological distress is mediated by PTG.

The Potential Chain Mediating Effect of Hope and PTG

As noted above, both hope and PTG may serve as mediating roles between social support and psychological distress. It's worth thinking that, however, what is the relationship between hope and PTG when they are both posited as potential mediating variables of social support in distress, and which plays a more important mediating role than the other. Previous research has established a positive correlation between hope and PTGin elderly cancer patients.[45] More importantly, a research in Israel indicated that social participation predicted PTG indirectly through hope (pathways and agency) and cognitive reappraisal.[46] And Zhou et al[47] has found that social support positively predicted PTG via hope in adolescents following the earthquake through structural equation modelling analysis. While these studies demonstrate chain-mediating pathways in elderly cancer patients, disaster-affected adolescents, and cross-cultural contexts, their direct applicability to lung cancer populations remains untested given unique disease-specific stressors. Given this gap in evidence, we propose the exploratory hypothesis H4: hope and PTG have a chain-mediating effect on the correlation between social support and psychological distress among populations with lung cancer.

The Potential Moderating Role of Gender

In research exploring the link between social support and psychological distress, gender emerges as an important variable that demands consideration. Drawing from the theoretical perspective gender socialization,[48] males and females differ in the strategies used to cope with stress and in the use of social support resources. Compared to males, females tend to report greater access to emotional, functional, and informational social support.[49] Females, socialized to prioritize relational interdependence and emotional expressiveness,[50] may derive greater hope from social support due to their tendency to seek and value emotional connections. Conversely, males, socialized toward independence and emotional restraint,[50] might exhibit a weaker association between social support and hope. Previous study has shown significant differences in hope level between males and females among cancer patients.[51] Thus, we propose hypothesis H5: Gender regulates the influence of social support on hope.

Furthermore, plenty of studies have indicated that female cancer patients exhibit greater PTG than males.[52,53] Women demonstrate more frequent use of positive reappraisal and positive self-talk than men, despite exhibiting heightened stress reactivity to adversity.[54] A study from the United States implied that the relationship between social support and posttraumatic growth may vary according to the survivors gender of intimate partner violence.[55] However, this gender difference has not yet been investigated or validated within the context of lung cancer populations. Accordingly, we hypothesize that the association between social support and PTG is influenced by gender (H6).

Current Study

In conclusion, although the relationships among variables of social support, hope, PTG, and psychological distress have been examined independently, the role of hope and PTG in the influence of social support on psychological distress among lung cancer populations remains inadequately examined to date. Moreover, given that in current research, relevant studies also rarely explore whether demographic characteristics exert influences. Probing into the underlying psychological mechanisms of the relationship between social support and psychological distress is obviously of great theoretical and practical importance. Thus, this study was designed to examine a serial mediation model linking social support to psychological distress among Chinese lung cancer patients through hope and PTG. And present research put forward the following four assumptions (Figure 1). Critically, psychological research involving cancer patients necessitates rigorous ethical safeguards. Given their vulnerability to distress and potential coercion, this study adhered to the Declaration of Helsinki principles. All participants provided written informed consent after receiving detailed explanations of research procedures, with explicit assurance that non-participation would not affect clinical care. Ethical approval was granted by the Ethics Review Committee of Chongqing University Cancer Hospital (IRB No. CZLS2023047-A) prior to recruitment.

H1: Social support is negatively associated with psychological distress.

H2: Hope mediates the relationship between social support and psychological distress.

H3: PTG mediates the relationship between social support and psychological distress.

H4: Hope and PTG play serial mediating roles in the relationship between social support and psychological distress.

H5: Gender moderates the impact of social support on hope.

H6: Gender moderates the relationship between social support and PTG.

Methods

Study Design

This was a cross-sectional descriptive survey.

Participants

Convenience sampling method was applied to recruit lung cancer patients from September 2023 to April 2024 in a tertiary cancer hospital and two tertiary general hospitals in Chongqing municipality, China. The inclusion criteria were as follows: ①Patients with histologically confirmed non-small cell lung cancer or small cell lung cancer (stage I to IV); ②patients aged >18 years; ③Patients possessing the capability to read and write in Chinese; ④Patients who provided informed consent and knew their diagnosis. Patients with severe physical ailments, mental illnesses, or consciousness disorders, hindering their cooperation, were excluded from the research.

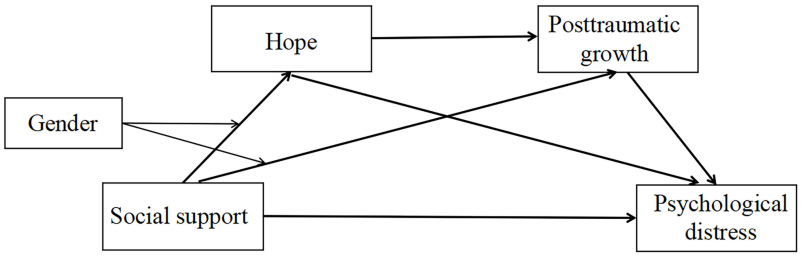

Figure 1 The Proposed Serial Mediation Model. Social support has a direct influence on hope, PTG and psychological distress. Hope and PTG have a direct negative impact on psychological distress respectively. The association between social support and psychological distress is mediated by hope and PTG respectively. And hope and PTG play serial mediating roles in the relationship between social support and psychological distress. Gender moderates the relationship between social support and hope, and social support and PTG.

Sample Size

On the one hand, Monte Carlo power analysis for indirect effect was employed to calculate the required sample size in this investigation.[56] Following questionnaire adjustments, a pilot survey was conducted with 100 lung cancer patients. The results showed that the correlation coefficients between social support and hope, PTG, and psychological distress were 0.356, 0.384, and −0.353, respectively; those between hope and PTG, and psychological distress were −0.488 and −0.383, respectively; and the correlation coefficient between hope and PTG was 0.477. With a target power of 0.9 and α set at 0.05, the calculation indicated a required total sample size of 445 cases. To account for potential non-response and errors in data collection, the original sample size was increased by 10%, resulting in a final survey sample of 495 participants.

On the other hand, previous literature suggests that the incidence of psychological distress among Chinese lung cancer patients is approximately 24%.[12] The calculated sample size is $n = \left(\frac{Z_{1-\alpha/2}}{d}\right)^2 p(1-p)$, where a 95% confidence interval and a margin of error of 4% (d=4%) are specified. Accounting for a 10% non-response rate, the total sample size necessary is 481. In conclusion, the requisite sample size for this investigation amounts to 495.

Instruments

Demographic and Medical Information

The general information questionnaire including age, gender, educational degree, nationality, residence, pathology type, and clinical stage, were obtained from participants.

Distress Thermometer

The distress thermometer (DT) was used to test psychological distress severity of participants. The DT, recommended by the National Comprehensive Cancer Network, is a distress screening tool,[57] consisting of a 0–10 rating scale (0 = "no distress" to 10 = "extreme distress"). A score of 4 was also indicated as the cutoff value of defining clinically significant psychological distress, and DT has acceptable overall accuracy and reliability as a screening tool for testing distress severity in Chinese cancer populations.[58]

Perceived Social Support Scale

We utilized the Perceived Social Support Scale (PSSS) to examine the social support of lung cancer patients. PSSS was created by Zimet et al[59] and revised by Huang et al[60] to form the Chinese version of PSSS. PSSS consists of 12 items, including 3 dimensions of friend support, family support and other support. Likert 7-point scoring method was adopted, and each item was scored ranging from 1 (strongly disagree) to 7 (strongly agree). Higher the score indicates greater social support perceived by an individual. PSSS total scores were categorized as low support level (12–36), medium support level (37–60), and high support level (61–84). In this study, the Cronbach's α for the whole scale, friend support subscale, family support subscale, and other important support subscale were 0.914, 0.782, 0.749, and 0.791, respectively.

Posttraumatic Growth Inventory

The Posttraumatic Growth Inventory (PTGI) was adopted to test the degree of positive psychological changes after a traumatic event. The scale was created by Tedeschi et al[35] and revised by Wang et al[61] to form the Chinese version of PTGI (PTGI-C). The PTGI-C has shown adequate internal reliability with Cronbach's α of 0.836 for the full scale and 0.637–0.703 for the separate subscales.[61] PTGI-C consists of 20 items, containing 5 dimensions (new possibilities, relating to others, spiritual change, appreciation of life and personal strength). Items were rated on a 6-point Likert-type scale ranging from 0 (no posttraumatic changes) to 5 (very large posttraumatic changes). A higher score signifies a more favorable psychological experience. The Cronbach's α was 0.946 for the whole scale, and was 0.613–0.788 for each subscale in the current sample.

Herth Hope Index

We applied the Herth Hope Index (HHI)[62] to measure participants' overall level of hope. Chan et al[63] translated the HHI into Chinese, which showed satisfactory internal reliability (full scale α=0.89) and sound content validity (Content Validity Index=0.90). The scale comprises 12 items, containing 3 dimensions (positive readiness and expectancy, temporality and future, and interconnectedness). Items were rated on a 4-point Likert-type response varying between 1

(strongly disagree) and 4 (strongly agree). Possible scores ranged from 12 to 48, with higher total scores reflecting greater level of hope. In the present study, the internal consistency is high for each subscale and the entire scale (Cronbach's $\alpha = 0.712$ to $\alpha = 0.893$).

Data Collection Procedure

The protocol of present study was approved by the Ethics Review Committee of Chongqing University Cancer Hospital (IRB No. CZLS2023047-A). This study employed an electronic questionnaire survey methodology, which were distributed in the relevant departments that admitted lung cancer patients (including thoracic surgery department, medical oncology department, radiation oncology center and geriatric department). Liaison officers were appointed at each survey hospital, who underwent comprehensive training prior to the commencement of the survey. This training encompassed the research objectives, content, guidelines for questionnaire completion, and the handling of data confidentiality. Prior to formal data collection, a preliminary survey was conducted with 20 eligible patients. Based on their feedback, minor linguistic adjustments were implemented: ① The term "pathological type" was revised to "lung cancer type"; ② The categorization of "educational level" was adjusted from a tripartite structure (high school or below, bachelor's/junior college, graduate or above) to a more granular four-category structure (primary school or less, junior high school, high school or technical secondary school, junior college or higher). These modifications were strictly cosmetic without altering core constructs or adding/removing items.

In the formal investigation, investigators used unified guidelines to explain relevant concepts, meanings, filling methods and precautions for each part of the content, and promised to keep the survey results confidential. All participants were required to sign an informed consent prior to their participation. For the respondents who could not give their own answers or had a low education level, the researchers repeated the questions one by one, filled them out according to the answers of the respondents, and verified them again. To guarantee the authenticity and reliability of the outcomes, each mobile phone number or IP address was entitled to respond only once. The submission of all answer options is conditional upon the completion of the entire questionnaire. Furthermore, based on the precedent survey's average response duration, questionnaires completed in less than 8 minutes, along with responses demonstrating discernible patterning, were categorized as invalid and subsequently excluded from the dataset.

In the current investigation, a total of 518 electronic questionnaires were distributed. And 16 participants elected to discontinue their participation due to personal requests for withdrawal or scheduling conflicts with medical examinations. Finally, the research yielded an effective recovery of 502 questionnaires, corresponding to an efficacy rate of 96.9%.

Statistical Analysis

IBM SPSS version 25.0 and AMOS version 23.0 were employed for the analysis of statistical data. First of all, we used the variance inflation factor (VIF) to test multicollinearity, and applied Harman's single factor to examine the common method biases caused by self-reported scales. Collinearity diagnostics indicated the VIF for social support, posttraumatic growth and hope ranged from 1.366 to 1.657, which was below the threshold of 5. Thus, no serious multicollinearity problem exists in this research. The first factor accounted for 33.46% of the total variation, which was lower than the value of 40%. It suggested that the common method biases might not affect our estimates. Descriptive statistics were utilized to examine demographic and clinical characteristics, with means and standard deviations (SD) employed to quantify the scores for each scale. Quantitative data are presented as percentages (%). Comparisons between psychological distress and non-psychological distress groups were performed using the Pearson's chi-squared test (x^2) or Fisher's exact test. Demographic and/or clinical variables that demonstrated statistical significance in univariate analysis were incorporated as confounding variables into the path analyses. Secondly, Pearson correlation coefficient was computed to investigate the interrelationships between social support, hope, posttraumatic growth and psychological distress.

Lastly, SEM was applied to examine the mediating role of hope and posttraumatic growth between social support and psychological distress, and the moderating role of gender. The parameters of covariance matrix are estimated by maximum likelihood method. The following indexes were used to evaluate the applicability of the data to the model: χ^2/df (<3.0), root mean square error of approximation (RMSEA<0.08), comparative fit index (CFI>0.90), normed fit index (NFI>0.90), Tucker-Lewis index (TLI>0.90), goodness of fit index (GFI>0.90), incremental fit index (IFI>0.90),

parsimonious normed fit index (PNFI>0.50) and parsimonious goodness fit index (PGFI>0.50).[64] A total of 5,000 replicate samples were reinserted to obtain 95% confidence intervals (CI) for the mediating effects. The indirect effect is considered statistically significant if 95% CI of the mediating path excludes 0.

Results

General Characteristics of the Participants

A total of 502 lung cancer patients participated in this study. As summarized in Table 1, the majority were male (65.3%) and aged >60 years (58.6%). Ethnically, 78.9% were of Han nationality. Regarding education, 37.6% attained junior high school level, while only 11.4% held junior college or higher degrees. Most participants were married (94.2%). Clinically, adenocarcinoma was the predominant pathological type (50.4%), followed by squamous cell carcinoma (29.1%). Over one-third were diagnosed at stage IV (39.8%), and 60.8% presented with distant metastasis. The duration since diagnosis varied: 46.4% were diagnosed within ≤6 months, while 32.5% exceeded 12 months.

Table 1 Demographic Characteristics of the Participants

Variables	n (%)
Sex	
Male	328 (65.3)
Female	174 (34.7)
Age (years)	
≤40	12 (2.4)
41–60	196 (39.0)
>60	294 (58.6)
Nationality	
Han	396 (78.9)
Minority	106 (21.1)
Education	
Primary school or less	174 (34.7)
Junior high school	189 (37.6)
High school or technical secondary school	82 (16.3)
Junior college or higher	57 (11.4)
Residence	
City	133 (26.5)
Town	156 (31.1)
Country	213 (42.4)
Marital status	
Married	473 (94.2)
Others (divorced/ widowed/unmarried)	29 (5.8)
Family per capita monthly income (Yuan)	
<3000	200 (39.8)
3000–6000	233 (46.4)
>60,000	69 (13.8)
Pathology type	
Small cell	94 (18.7)
Adenocarcinoma	253 (50.4)
Squamous cell carcinoma	146 (29.1)
Big cell	9 (1.8)

(*Continued*)

Table 1 (Continued).

Variables	n (%)
Cancer stage	
Stage I	55 (11.0)
Stage II	62 (12.3)
Stage III	185 (36.9)
Stage IV	200 (39.8)
Time since cancer diagnosis	
≤6 months	233 (46.4)
7–12 months	106 (21.1)
>12 months	163 (32.5)
Distant metastasis	
No	197 (39.2)
Yes	305 (60.8)

Note: Yuan (¥; ¥ 1 equivalent to 0.15 United States dollars); "Han" refers to the Han Chinese ethnic group, which constitutes over 90% of China's population; "Minority" encompasses 55 state-recognized ethnic minority groups. The categories "City" "Town" and "Country" reflect China's urban-rural hierarchy and socioeconomic gradients. City: Urban areas with dense populations, advanced healthcare infrastructure, and higher economic development levels. Town: Administrative towns at the county level, serving as regional hubs for surrounding rural areas. These towns typically have moderate populations, basic healthcare facilities, and economic activities centered on local industries. Country: Rural regions with limited medical resources, traditional lifestyles, and reliance on agricultural activities.

Univariate Analysis of Factors in Psychological Distress

The psychological distress group and non-psychological distress group were significantly different in cancer stage (P=0.005), and distant metastasis (P=0.028). Table 2 displays that patients with late-stage lung cancer were more likely to experience distress than those with early-stage cancer. And distant metastasis demonstrated a significant association with elevated psychological distress levels in participants. No differences were observed in age, gender, nationality, education level, residence, marital status, pathology type or time since cancer diagnosis between the two groups (P>0.05) (Table 2).

Table 2 Univariate Analysis of Factors in Psychological Distress

Variables	Non PD (n=283)	PD (n=219)	χ^2/Fisher's	*P*
Sex, n **(%)**			3.642[a]	0.056
Male	195 (59.5)	133 (40.5)		
Female	86 (49.4)	88 (50.6)		
Age (years), n **(%)**			2.659[a]	0.265
≤40	4 (33.3)	8 (66.7)		
41–60	112 (57.1)	84 (42.9)		
>60	167 (56.8)	127 (43.2)		
Nationality, n **(%)**			1.895[a]	0.169
Han	217 (54.8)	179 (45.2)		
Minority	66 (62.3)	40 (37.7)		

(*Continued*)

Table 2 (Continued).

Variables	Non PD (n=283)	PD (n=219)	χ^2/Fisher's	*P*
Education, n **(%)**			3.924[a]	0.270
Primary school or less	105 (60.3)	69 (39.7)		
Junior high school	99 (52.4)	90 (47.6)		
High school or technical secondary school	43 (52.4)	39 (47.6)		
Junior college or higher	36 (63.2)	21 (36.8)		
Residence, n **(%)**			3.213[a]	0.201
City	73 (54.9)	60 (45.1)		
Town	97 (62.2)	59 (37.8)		
Country	113 (53.1)	100 (46.9)		
Marital status, n **(%)**			0.271[a]	0.603
Married	268 (56.7)	205 (43.3)		
Others (divorced/ widowed/unmarried)	15 (51.7)	14 (48.3)		
Family per capita monthly income (Yuan)			1.499 [a]	0.473
<3000	119 (59.5)	81 (40.5)		
3000–6000	125 (53.6)	108 (46.4)		
>60,000	39 (56.5)	30 (43.5)		
Pathology type, n **(%)**			2.144[b]	0.543
Small cell	54 (57.4)	40 (42.6)		
Adenocarcinoma	138 (54.5)	115 (45.5)		
Squamous cell carcinoma	84 (57.5)	62 (42.5)		
Big cell	7 (77.8)	2 (22.2)		
Cancer stage, n **(%)**			13.064[a]	0.005
Stage I	35 (63.6)	20 (36.4)		
Stage II	46 (74.2)	16 (25.8)		
Stage III	103 (55.7)	82 (44.3)		
Stage IV	99 (49.5)	101 (50.5)		
Time since cancer diagnosis, n **(%)**			4.971[a]	0.083
≤6 months	121 (51.9)	112 (48.1)		
7–12 months	59 (55.7)	47 (44.3)		
>12 months	103 (63.2)	60 (36.8)		
Distant metastasis, n **(%)**			4.845[a]	0.028
No	123 (62.4)	74 (37.6)		
Yes	160 (52.5)	145 (47.5)		

Note: [a] for results of Pearson chi-square test, [b] for results of Fisher's exact test.
Abbreviation: PD, psychological distress.

Descriptive Statistics and Correlations Among the Main Variables

In this study, 219 patients (43.6%) suffered from clinically distress. The mean distress score was 3.92 with a standard deviation of 1.94, varying between 0 and 10. The scores of PSSS, PTGI, and HHI were 59.06±10.43, 73.51±16.05 and 34.72±5.97, respectively. The scores of three dimensions of PSSS were 19.97±3.60, 19.79±3.69 and 19.31±3.94, respectively (Table 3). Consistent with the expectations, the PSSS, PTGI, HHI and DT were all significantly correlated with each other. PSSS exhibited significant correlations with HHI, PTGI, and DT ($r = 0.566$, $r = 0.419$, $r = -0.404$, all $P < 0.01$). DT was negatively related to HHI and PTGI ($r = -0.502$, $r = -0.456$, all $P < 0.01$). In addition, HHI was positively correlated with PTGI ($r = 0.488$, $P < 0.01$) (Table 4).

Table 3 Descriptive Statistics of Each Measure

Variables	Minimum	Maximum	Mean	SD
DT	0	10	3.92	1.94
PSSS	15	84	59.06	10.43
PSSS 1	5	28	19.97	3.60
PSSS 2	5	28	19.79	3.69
PSSS 3	4	28	19.31	3.94
PTGI	20	100	73.51	16.05
HHI	14	48	34.72	5.97

Abbreviations: SD, standard deviation; DT, Distress Thermometer. PSSS, Perceived Social Support Scale; PSSS 1, family support; PSSS 2, friend support; PSSS 3, other support. PTGI, Posttraumatic Growth Inventory. HHI, Herth Hope Index.

Table 4 Correlation Coefficients Between the Variables

Variables	DT	PSSS	PSSS-1	PSSS-2	PSSS-3	PTGI	HHI
DT	1						
PSSS	−0.404**	1					
PSSS-1	−0.396**	-	1				
PSSS-2	−0.382**	-	-	1			
PSSS-3	−0.351**	-	-	-	1		
PTGI	−0.456**	0.419**	0.377**	0.397**	0.392**	1	
HHI	−0.502**	0.566**	0.538**	0.538**	0.501**	0.488**	1

Note: **$P < 0.01$.
Abbreviations: SD, standard deviation. DT, Distress Thermometer. PSSS, Perceived Social Support Scale; PSSS-1, family support; PSSS-2, friend support; PSSS-3, other support. PTGI, Posttraumatic Growth Inventory. HHI, Herth Hope Index.

Construction and Testing of Structural Equation Model of Mediating Effect

We utilized AMOS 23.0 to establish and examine the chain mediation models of the correlations between psychological distress, social support, PTG and hope. The structural equation model was exhibited in Figure 2. After controlling for cancer stage and distant metastasis, this model displayed a favorable fit with the following data: $\chi^2/df = 2.668$, RMSEA = 0.058, CFI = 0.975, NFI = 0.961, TLI = 0.968, GFI = 0.949, IFI = 0.975, PGFI = 0.633 and PNFI = 0.739.

The deviation-corrected percentile Bootstrap method (5000 repeated extractions) was used to test the mediation effect. Table 5 displayed the standardized direct, indirect, and total effects. To be more specific: ① Hope mediated the effect of social support on psychological distress with the mediating effect being −0.213, accounting for 50.1% of the total effect. Thus, Hypothesis 2 (social support→hope→psychological distress) was supported. ② PTG mediated the influence of social support on psychological distress with the mediating effect being −0.038, accounting for 8.9% of the total effect and supporting hypothesis 3 (social support→PTG→psychological distress). ③The chain mediating effect was significant, with a value of −0.058, which represented 13.7% of the total effect. Hence, this finding provided support for Hypothesis 4 (social support→hope→PTG→psychological distress). The absence of 0 within the 95% bootstrap confidence intervals of all three paths confirmed that the three mediating effects were statistically significant.

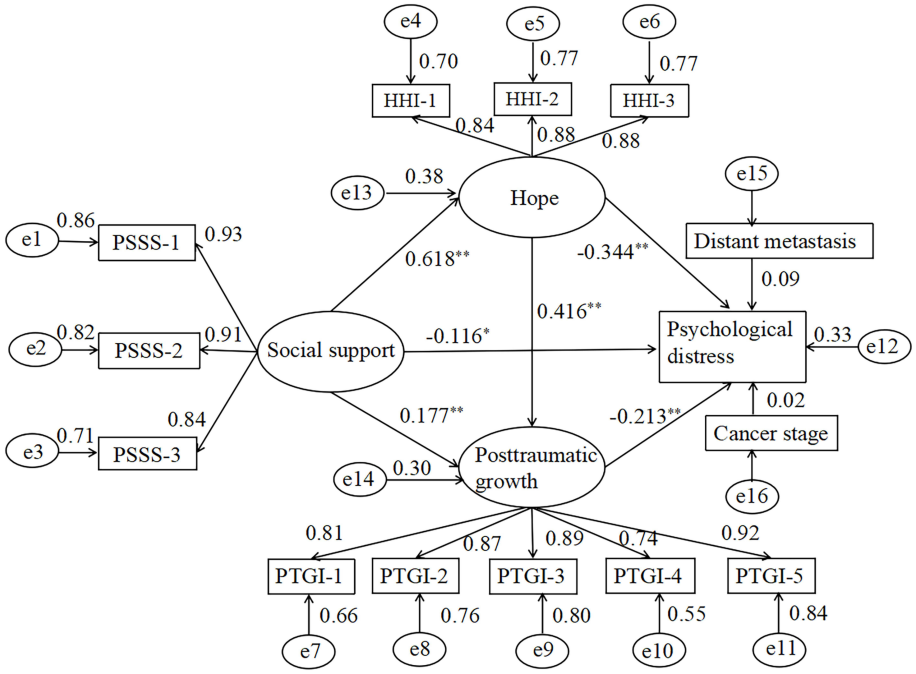

Figure 2 Serial-multiple Mediation of Hope and PTG in the Relationship Between Social Support and Psychological Distress.
Note: All path coefficients were standardized. Statistical significance: *$P < 0.05$; **$P < 0.01$.
Abbreviations: PSSS-1, family support; PSSS-2, friend support; PSSS-3, other support; HHI-1, positive readiness and expectancy; HHI-2, temporality and future; HHI-3, interconnectedness; PTGI-1, new possibilities; PTGI-2, relating to others; PTGI-3, spiritual change; PTGI-4, appreciation of life; PTGI-5, personal strength.

Moderation Effect Testing

Using multi-group analysis within SEM to test the moderating effect of gender, the results for the effect of social support on PTG showed a path coefficient of $\beta = -0.086$ ($P = 0.187$, Figure 3) in the male group, and $\beta = 0.367$ ($P < 0.001$, Figure 4) in the female group. The difference test indicated a significant difference between the female and male groups (difference value = −0.286, $P = 0.001$), signifying that social support has a stronger effect on PTG for females lung cancer patients compared to males. Thus, Hypothesis 6 was supported.

Table 5 Bootstrap Analysis of the Significance Test of the Mediation Effect

Path	Effect size	SE	95% CI		P	Percent (%)
			Lower	Upper		
Total effects	−0.425	0.034	−0.302	−0.191	0.001	100
Standardized direct effects						
Social support →PD	−0.116	0.030	−0.221	−0.010	0.026	27.3
Hope →PD	−0.344	0.062	−0.451	−0.220	<0.001	–
PTG →PD	−0.213	0.041	−0.304	−0.126	<0.001	–
Social support →Hope	0.618	0.026	0.542	0.686	<0.001	–
Social support →PTG	0.177	0.037	0.076	0.284	0.001	–
Hope →PTG	0.416	0.073	0.304	0.519	<0.001	–

(*Continued*)

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Table 5 (Continued).

Path	Effect size	SE	95% CI		*P*	Percent (%)
			Lower	Upper		
Standardized indirect effects						
Ind1: Social support →Hope →PD	−0.213	0.029	−0.171	−0.078	0.001	50.1
Ind2: Social support →PTG →PD	−0.038	0.010	−0.043	−0.008	0.003	8.9
Ind3: Social support →Hope →PTG →PD	−0.058	0.010	−0.053	−0.018	<0.001	13.7
Total indirect effect	−0.309	0.029	−0.226	−0.132	0.001	72.7

Note: All the coefficients are standardized.
Abbreviations: PTG, posttraumatic growth; PD, psychological distress; SE, standard error; CI, confidence interval.

For the effect of social support on hope, the path coefficient was $\beta = 0.405$ ($P < 0.001$) in the male group and $\beta = 0.781$ ($P < 0.001$) in the female group. However, the difference test for the paths between the two groups showed a non-significant difference (difference value = −0.113, $P = 0.059$), indicating no gender difference in the effect of social support on hope. Therefore, Hypothesis 5 was not supported. The results are shown in Table 6.

Discussion

Prevalence and Influencing Factors of Psychological Distress

Our study revealed a worrying fact that present participants reported a 43.6% (DT≥4) prevalence of psychological distress, which is much lower than the result from Anhui, China (63.75%).[13] Previous studies reported the following incidence of psychological distress in lung cancer populations: 35.6% in Spain, 25.8% in Germany, and 68.7% in America.[14,65,66] It is difficult and impractical to compare the incidence of psychological distress between countries due to different measurement tools and cut-off, evaluation criterion, analysis time and sociodemographic diversity of the target

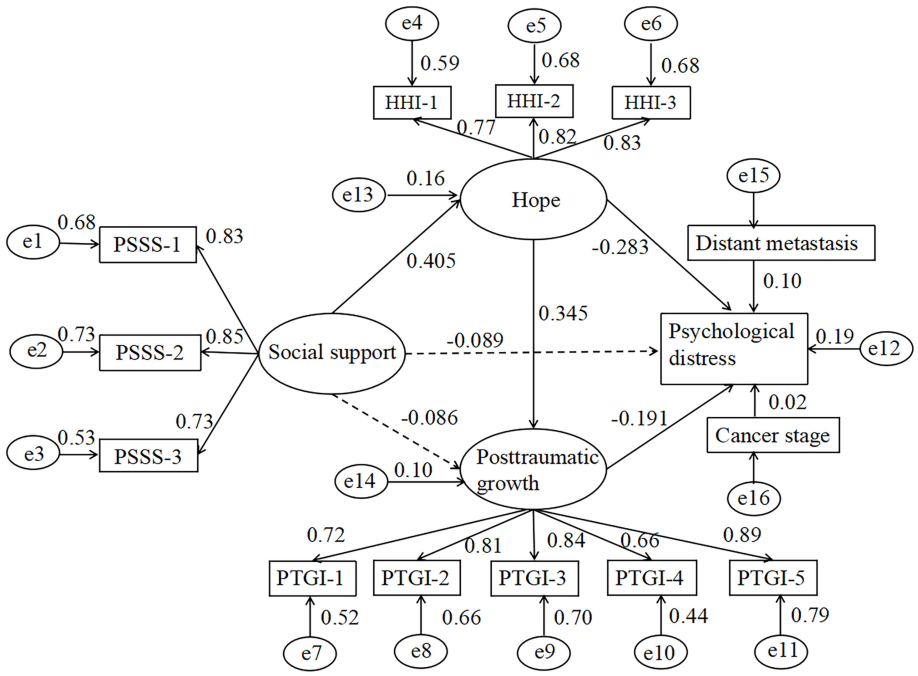

Figure 3 Path Model with Male Lung Cancer Patients. The path coefficient of social support on PTG was non-significant in the male group ($\beta = -0.086$, $P = 0.187$).
Note: Dashed lines represent non-significant paths. All path coefficients were standardized.

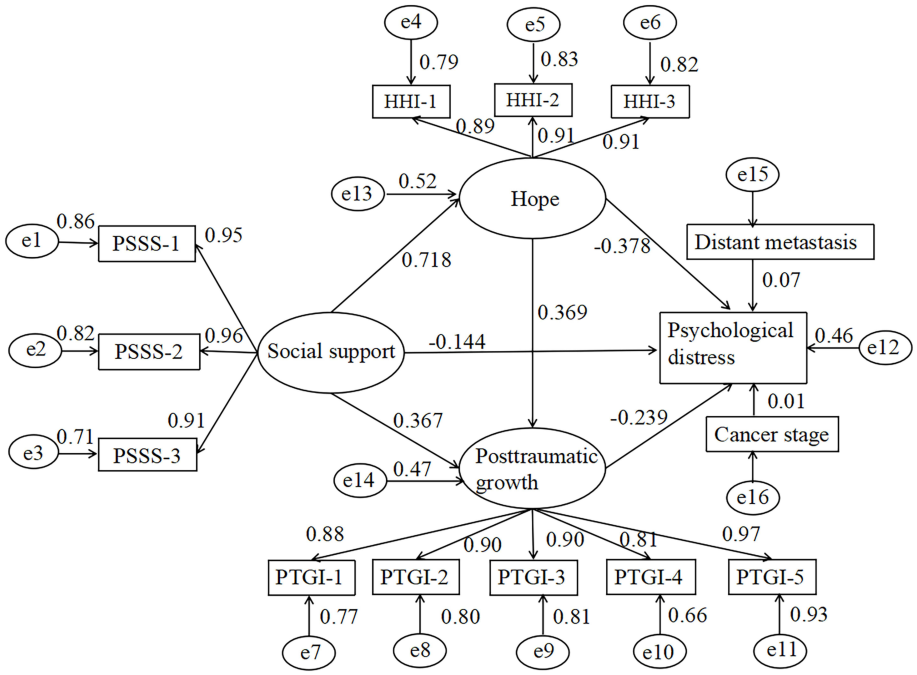

Figure 4 Path Model with Female Lung Cancer Patients. The path coefficient of social support on PTG was significant in the female group (β = 0.367, P < 0.001).
Note: All path coefficients were standardized.

population. Yet it is certain that psychological distress is a prevalent psychiatric issue among lung cancer patients within our country. Psychological distress is integrally linked to the management and care of lung cancer patients, necessitating a comprehensive understanding of such distress among medical personnel. It is recommended that suitable instruments be employed to conduct dynamic psychological assessments of these patients, with the aim of early identification of potential factors contributing to their psychological distress.

Moreover, the present data also showed that advanced-stage (III–IV) cancer patients exhibited significantly higher rates of psychological distress compared to those diagnosed at earlier stages (I–II). This finding is consistent with the result of prior research conducted in Ethiopia and India.[67,68] This might be related to the fact that an increased tumour stage was significantly associated with increased pain, appetite loss, and severe symptoms as well as diminished physical function in cancer patients,[69] which were related to greater psychological distress. Moreover, a significant relationship was uncovered between cancer metastasis and increasing distress scores. In line with this study, a meta-analysis of 34 studies involving 13,828 cancer patients also revealed that patients with distant metastases had higher levels of

Table 6 Results of Multi-Group Path Analysis: Effects of Social Support on PTG and Hope Stratified by Gender

Path	Group	B	β	SE	CR	P
Social support →PTG	Male	−0.067	−0.086	0.051	−1.32	0.187
	Female	0.219	0.367	0.044	4.927	<0.001
	Diff	–	−0.286	0.067	–	0.001
Social support →Hope	Male	0.248	0.405	0.039	6.403	<0.001
	Female	0.361	0.781	0.033	10.969	<0.001
	Diff	–	−0.113	0.06	–	0.059

Note: All the coefficients are standardized.
Abbreviations: PTG, posttraumatic growth; SE, standard error; CR, critical ratio.

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psychological distress.[70] Healthcare providers should prioritize screening for psychological distress and assessment of unmet care needs in lung cancer populations, as this constitutes a fundamental step toward implementing targeted interventions. Cancer stage and distant metastasis represent critical sociodemographic and clinical factors significantly associated with variations in psychological distress among lung cancer patients. These findings underscore the necessity for clinicians to recognize the specific vulnerabilities and challenges experienced by these patient subgroups.

Social Support and Psychological Distress in Lung Cancer Patients

This research examined lung cancer patients to explore the pathway through which social support affects psychological distress. Correlation analyses showed that social support was negatively associated with psychological distress. On this basis, present data also suggested another pathway for the correlation between social support and psychological distress: social support is indirectly correlated with psychological distress through hope and PTG, which is mainly manifested as partial mediating effect of hope, partial mediating effect of PTG, and a chain mediating effect of hope and PTG. Additionally, The mediation effect of hope was about 50%, and the partial mediating effect of PTG and chain mediating effect of hope and PTG were relatively small. Therefore, hope played the most important mediating role in social support and psychological distress.

Direct Effect of Social Support on Psychological Distress

It was found that social support could exert its negatively direct effect on psychological distress in our findings, the direct effect was −0.116 (accounting for 27.3%). This is aligned with findings from young adult cancer patients and lung cancer patients.[23,71] The enhancement of social support levels facilitates individuals in overcoming challenges posed by the external environment and strengthens their motivation to manage stressful events, thereby serving as a recognized protective resource that mitigates distress and fosters psychosocial adaptation.[72] Furthermore, among the three components of social support, both family support (r = -0.396), friend support (r = -0.382), and other support (r = -0.351) demonstrated significant negative associations with psychological distress. Of them, support provided by family members and close friends played a pivotal role in mitigating psychological distress, aligning with prior findings in oncology populations.[73] Unlike healthcare professionals or community resources, lung cancer patients typically spend the majority of their time with family members and friends during treatment and recovery periods. They often provide continuous, personalized support tailored to patients' daily needs, including medical accompaniment, symptom management, and material or emotional support.[74] Friends, in turn, may reduce social isolation by engaging patients in distraction activities or facilitating access to informal support networks.[75] These supports enable patients to access superior treatment options and receive more attentive care, thereby empowering them to cultivate hope and pursue meaning in life, ultimately buffering against long-term psychological deterioration. Thus, interventions aimed at strengthening familial and peer support systems may yield substantial benefits in improving psychosocial outcomes for lung cancer patients.

Mediating Effect of Hope

The present data suggested that hope mediated the relationship between social support and psychological distress, and the proportion of indirect effect was 50.1%, which is much higher than the other two paths. Therefore, as a mediator, hope plays the most important role in the relationship between social support and psychological distress. Empirical evidence from a study involving prostate cancer patients also found that hope played a mediating role in the association between social support and psychological state.[76] As an internal strength, hope facilitates patient coping with suffering, goal attainment, and significantly impacts clinical outcomes, prognosis, and psychological health.[77] Patients with higher hope levels exhibit reduced rumination on disease-related suffering when encountering obstacles, further accompanied by positive psychological transformations such as discovering renewed life purpose, deepening spiritual convictions, and engaging in meaningful activities.[78] A positive close association between hope and psychological distress has been well identified by the previous studies.[29,30]

Social support serves as a foundational element in hope construction. Within Snyder's theory of hope, social support serves as an important factor influencing hope.[24] For example, support from family and friends offers emotional

reassurance and tangible assistance, enhances psychosocial belongingness, and fosters a supportive environment that facilitates hope development in lung cancer patients.[79] Prior research has also confirmed a significant positive correlation between social support and hope.[31,32] The mediating effect may arise from heightened receipt of healthcare-related assistance and interpersonal support among individuals with robust social networks; Such encouragement and company foster patients' confidence in therapeutic efficacy, enhance adherence to clinical protocols, facilitates hope for recovery, and consequently mitigate psychological distress.

Mediating Effect of PTG

Furthermore, PTG acts as a mediating role between social support and psychological distress in lung cancer patients. Although the size and proportion of this effect was small (β=−0.038, accounting for 8.9%), the result demonstrated statistical significance. As posited by Tedeschi and Calhoun's seminal theory on PTG,[42] social support serves as a crucial catalyst for facilitating positive psychological transformation in the face of adversity. The combined challenges of cancer therapy and symptom management present a considerable obstacle for lung cancer patients as they undergo the processes of acceptance, adaptation, and adjustment, which might lead to positive or negative life trajectories. Lung cancer patients embedded in better social support networks are more likely to receive instrumental assistance, such as practical help with daily tasks or financial support, and emotional validation from family, friends, and healthcare providers. These forms of support create a secure and nurturing environment that encourages patients to reflect on their experiences, reframe their challenges, and identify newfound strengths.[44] Once established, PTG equips patients with enhanced coping strategies, such as a more positive outlook and increased self-efficacy. These adaptive resources, in turn, buffer the detrimental impact of psychological distress.[80] Notably, current research is the first to reveal that the mediating effect of PTG in lung cancer patients, which offered us a new perspective and helped us to understand how social support influences psychological distress in populations with lung cancer.

Chain Mediating Effect of Hope and PTG

Most important of all, our findings reveal a critical sequential mediation pathway "social support→hope→PTG→psychological distress" among lung cancer patients (accounting for 13.7%). Specifically, an increase in social support leads to higher hope, which in turn enhance PTG, resulting in psychological distress decline. This key point carries theoretical implications for advancing our understanding of the intricate relationship between social support and psychological distress.

Hope plays a pivotal role in fostering PTG. Many studies has probed the connection between hope and PTG, recognizing hope as a safeguard against the detrimental impacts of trauma[81] and a key mediator linking PTG to self-efficacy.[82] Firstly, hope fosters beliefs and positive attitudes about the posttraumatic world, prompting cognitive and positive reappraisals.[52] This process allows individuals to reevaluate the differences between their pre-trauma and post-trauma perspectives, enabling them to rebuild existing worldviews by integrating trauma-related information, which in turn propels the development of PTG through accommodation.[83] Secondly, individuals with higher hope tend to demonstrate greater self-efficacy and a stronger sense of personal strength,[82] which empower individuals to actively confront and adapt to post-traumatic challenges, thereby facilitating the emergence and development of PTG. So, confronted with the distressing experiences of lung cancer diagnosis and therapy, high hope level can assist patients in redirecting their concentration from challenging circumstances and the apprehension of adverse outcomes of cancer to beneficial problem-resolution strategies, as well as to a reevaluation of pessimistic situations, thereby facilitating the emergence of alternative and purposeful objectives that promote their development of PTG. Naturally, the psychological distress of patients is relieved.

The Moderating Effect of Gender

Interestingly enough, our findings suggested that in the social support→psychological distress pathway, gender moderates the impact of social support on PTG (β=−0.286, SE=0.067), specifically indicating that compared to males, female lung cancer patients are more likely to experience an increase in PTG as social support increases. This gender-related divergence can be elucidated by multiple underlying mechanisms.

First of all, specific gender-related cultural norms and expectations play an important role. China has a masculine culture,[84] in which males are encouraged from an early age to be independent, confident, and learn self-exploration. In contrast, females are expected to focus more on family and kinship relationships. They are taught to be sensitive and to cultivate close, dependent interpersonal connections. Consequently, during the process of socialization, women are cultivated to be more attuned to emotional cues and are encouraged to seek and offer support within their family and friendship circles. This enhances their ability to utilize available social support. This higher receptiveness to social support enables female lung cancer patients to better integrate the emotional and practical assistance they receive into the processes of lung cancer treatment and rehabilitation, thereby facilitating a greater degree of PTG. And in the second place, in contrast to men, women tend to adopt more emotion-focused coping strategies when confronting life adversities, and are inclined to ruminate on the trauma and understand its meaning or value.[85] This enables them to process traumatic experiences more effectively through communication and sharing, thereby promoting cognitive restructuring and growth. Men, on the other hand, often suppress their emotions and adopt a more self-reliant coping style,[52] which may limit their ability to fully benefit from social support and impede the development of PTG. Thus, these sociocultural and psychological factors collectively contribute to the observed gender-based differences in the relationship between social support and PTG among lung cancer patients in our study.

Limitations and Future Directions

Several limitations inherent in present study should be stated. First of all, a cross-sectional survey was conducted in the present study, which had difficulty in drawing casual associations among these variables. Thus, longitudinal or experimental studies are warranted to validate and extend these findings in future research. Second, it is crucial to exercise caution when generalizing the results of this study, as all participants were recruited from hospitals in Chongqing Municipality. Thus, the cultural and contextual factors specific to this setting may influence the generalizability of our findings. Third, our study's reliance on convenience sampling may lead to an imbalanced distribution of variables such as histological types, disease stages, potentially limiting the generalizability of our findings. Future research should adopt random or stratified sampling to ensure a more representative and balanced sample. Fourth, as data were solely obtained from metropolitan area, the sample may not fully represent the broader spectrum of lung cancer patients, particularly those in rural or resource-limited areas. These findings should therefore be interpreted with caution when generalizing to underserved populations. Fifth, the use of self-reported scales to measure hope, PTG, and psychological distress might result in recall bias. Future research should incorporate effective process control measures to mitigate these potential biases. Sixth, despite examining the moderating role of gender, other potentially influential variables like age, cancer stage, and comorbidities were not explored as moderators. Additionally, although some confounding variables were controlled in the SEM, unmeasured confounders may still affect the results. Future research should focus on investigating these additional factors to better understand the relationships. Finally, a key limitation lies in our treatment of hope and PTG as independent pathways (social support→hope/PTG→distress). Conceptually, these constructs may share overlapping cognitive-emotional processes. Statistically, our cross-sectional design precludes inferences about causality or directionality. Hence, we propose that subsequent research should adopt this model as a theoretical foundation to conduct longitudinal investigations, aiming to disentangle these dynamics and clarify the interactive effects among variables.

Clinical Implications

Given that 43.6% of lung cancer patients in the study sample experience psychological distress, and social support demonstrates multiple significant pathways influencing psychological distress, targeted clinical interventions are imperative.

First, enhancing social support should serve as the cornerstone of interventions. Oncology medical staff can regularly organize structured group meetings, where patients can share their treatment experiences, exchange practical coping strategies for daily life during illness, and offer emotional support to one another. Meanwhile, family members should be actively guided to participate in the care process, helping them understand the significance of both emotional support and practical assistance. This includes assisting patients with medication management, accompanying them during rehabilitation exercises, and creating a warm and inclusive home environment. Such comprehensive social support can not only directly alleviate psychological distress but also act as a catalyst for cultivating hope and promoting PTG.

Second, considering that the mediating effect of hope in the social support-psychological distress relationship accounts for 50.1% of the total effect, psychological interventions should prioritize cultivating patients' hope. Therapists can adopt hope therapy-based training[86] to help patients reframe negative thinking patterns, set achievable goals, and enhance their sense of control over the disease. In addition, the single-session hope intervention,[87] which focuses on helping patients identify personal goals, develop pathways to achieve them, and enhance their agency in pursuing these goals, can be readily incorporated into clinical practice. Additionally, the "Promoting Resilience in Stress Management" program,[88] which combines cognitive-behavioral techniques with positive psychology principles, offers a structured approach to foster hope.

Third, specific interventions for promoting PTG should be integrated into clinical practice. Mindfulness-based stress reduction techniques, such as meditation and deep-breathing exercises, can help patients stay present and find meaning in their experiences; Commercially available mindfulness programs, which are accessible and user-friendly, can also be recommended to patients for continuous practice at home, promoting gradual growth after trauma.[89]

Last but not least, since the effect of social support on PTG is moderated by gender, with a stronger impact observed in female patients, clinical strategies need to be gender-sensitive. According to the report released by the National Cancer Center in 2024,[2] lung cancer has emerged as the most prevalent cancer among Chinese women, highlighting the urgency of addressing this issue. For female patients, more emphasis can be placed on strengthening social support systems, such as organizing female-specific support groups or providing gender-tailored counseling services.

In summary, these clinical implications provide actionable strategies for healthcare providers, aiming to effectively reduce psychological distress among lung cancer patients by leveraging social support, hope, and PTG, while also considering gender differences.

Conclusion

43.6% of lung cancer patients in study sample experience psychological distress. Social support can not only directly influence psychological distress but also act through three indirect pathways in lung cancer patients: the mediating effects of hope and PTG, the sequential mediating effects of hope and PTG, and the mediating effect magnitudes accounted for 50.1%, 8.9%, and 13.7% of the total effect, respectively. The indirect pathway of hope (social support→hope→psychological distress) contributed the largest proportion to the total effect, underscoring its pivotal role in the social support- psychological distress relationship. In addition, what is also a worth noticing point is that gender moderated the effect of social support on PTG. The findings of our research not only offer a new theoretical framework on the relationship between social support and psychological distress, but also supply practical guidelines for the formulation of psychological intervention programs, the planning of mental health promotion policies, and the guidance of individual psychological adjustment for lung cancer patients.

Abbreviations

PTG, posttraumatic growth; SD, standard deviations; VIF, variance inflation factor; SEM, structural equation modelling; RMSEA, root mean square error of approximation; CFI, comparative fit index; NFI, normed fit index; IFI, incremental fit index; TLI, Tucker-Lewis index; GFI, goodness of fit index; PNFI, parsimonious normed fit index; CI, confidence intervals.

Ethics Statement

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the ethics review institution of Chongqing University Cancer Hospital. And written informed consent for the investigation was obtained from each participant.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically

reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Data Sharing Statement

The datasets generated and analyzed during the current study are not publicly available due to promises of participant anonymity and confidentiality but are available from the corresponding author on reasonable request.

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Disclosure

The authors declare no competing interests.

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