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Multi-Center Investigation on the Level of Economic Toxicity in Patients with Lung Cancer and Its Mechanism Study

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Abstract

This research is to investigate the level of economic toxicity and its associated influencing factors among lung cancer patients undergoing chemotherapy, and to provide guidance for the development of an economic toxicity screening tool. This study employed a cross-sectional design, recruiting 132 lung cancer patients undergoing chemotherapy from three tertiary hospitals in Jingzhou City using convenience sampling. Data were collected on general information, economic toxicity levels, psychological resilience, and bidirectional social support of patients. Univariate analysis, correlation analysis, and linear regression analysis were conducted. The results indicated that economic toxicity is prevalent among lung cancer patients undergoing chemotherapy, with significant influencing factors including age, monthly family income, educational level, and payment method for medical expenses. Healthcare providers should develop an economic toxicity screening tool to identify early signs of economic toxicity in lung cancer patients and implement personalized interventions for high-risk patients facing substantial economic pressure, thereby reducing the overall level of economic toxicity.

Keywords

Economic Toxicity, Lung Cancer, Multi-Center Trial, Correlation Analysis

1. Introduction

Global lung cancer incidence and mortality are increasing annually, with the number of cases and deaths rising each year. Lung cancer has one of the lowest five-year survival rates among all cancers [1]-[3]. Early-stage lung cancer is primarily treated

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through surgical resection; however, most patients are diagnosed at an advanced stage. With advancements in therapeutic methods and pharmacology, treatments for advanced lung cancer now include radiotherapy, chemotherapy, gene-targeted therapies, and palliative care [4]. The high costs associated with diagnosis, treatment, and nursing for advanced lung cancer patients impose a considerable economic burden on both patients and their families. These costs also contribute to negative psychological effects, which can adversely affect patient outcomes [5] [6]. Foreign researcher Zafaf first introduced the concept of economic toxicity, which refers to the financial strain caused by cancer diagnosis and treatment that leads to subjective anxiety, worry, and unease among patients, ultimately impacting their quality of life and access to high-quality care [7]. In this study, we conducted a cross-sectional investigation to assess the level of economic toxicity experienced by lung cancer patients undergoing chemotherapy. Additionally, multiple regression analysis was used to explore factors influencing economic toxicity, providing valuable insights for the development of future economic toxicity screening tools.

2. Object and Method

2.1. Study Population

From February 2023 to February 2024, 132 lung cancer patients from the oncology departments of three tertiary hospitals in Jingzhou City were selected as study participants using a convenience sampling method. Inclusion criteria: (1) patients diagnosed with lung cancer via pathological examination; (2) patients undergoing chemotherapy; (3) aged ≥ 18 years, able to communicate with investigators through writing or speech; (4) provided informed consent and voluntarily participated in the study. Exclusion criteria: (1) patients with severe heart, lung, liver, or other organ diseases or dysfunction; (2) patients with a history of cognitive impairment or mental illness; (3) patients with other cancers or family members undergoing cancer treatment; (4) patients who voluntarily withdrew during the study.

2.2. Methods

2.2.1. Research Tools

1) General Data Questionnaire

A self-designed questionnaire based on literature review and tailored to this study's objectives was used to collect demographic and sociological data, including age, gender, education level, travel time for medical treatment, current employment status, place of residence, family monthly income, and payment methods for medical expenses.

2) Comprehensive Scores for Financial Toxicity Based on the Patient-Reported Outcome Measures (COST-PROM)

The Comprehensive Scores for Financial Toxicity (COST-PROM) was used to assess economic toxicity levels in patients receiving chemotherapy. COST-PROM, developed by American scholars in 2014, evaluates the degree of economic hardship experienced by cancer patients. It includes three dimensions and 11 items:

economic expenditure (1 item), economic resources (2 items), and psychosocial response (8 items). The scale employs a Likert 5-point scoring method, with each item scored from 0 (not at all) to 4 (very much) points. The total score is 44 points, with a score of less than 26 defined as positive. Patients rate their status over the past 7 days, with lower scores indicating more severe economic toxicity. The scale was constructed through literature review, qualitative interviews, and expert consultations, and has been validated in clinical practice [8]. The Chinese version of COST-PROM, sinicized in 2017, has demonstrated good reliability, validity and good internal consistency (Cronbach's $\alpha = 0.889$) [9], making it a common tool for measuring economic toxicity among cancer patients in China.

3) Economic Toxicity Rating Standard

Khera introduced an economic toxicity rating standard in 2014. This scale categorizes patients according to their objective economic conditions, including income, medical expenditures, and debt levels, dividing economic toxicity into four levels: mild (Level 1), moderate (Level 2), severe (Level 3), and life-threatening or disabling (Level 4). Level 1: Patients change their lifestyle due to medical costs; Level 2: Patients pay for medical expenses by selling stocks or investment products, or using savings, disability benefits, or pensions; Level 3: Patients take out loans to pay for medical care, lose their jobs due to cancer treatment, or live beyond their means to cover necessities; Level 4: Patients sell property, declare bankruptcy, or discontinue treatment due to financial burden [10]. In 2019, Chinese scholar Zhou. adapted this grading standard for Chinese use, and conducted a large-scale application study in clinical practice to verify its reliability and validity, which was found to be good [11].

4) The Brief 2-Way Social Support Scale (the Brief 2-Way SSS)

The Brief 2-Way Social Support Scale (Brief 2-Way SSS), compiled by Obst in 2019, assesses both receiving and providing social support. It consists of 12 items across four dimensions: receiving emotional support (items 1 - 3), giving emotional support (items 4 - 6), receiving instrumental support (items 7 - 9), and giving instrumental support (items 10 - 12) [12]. In 2022, Chinese scholar Cui Yu sinicized the scale, achieving Cronbach's α coefficient, retest reliability, and split-half reliability of 0.929, 0.785, and 0.800, respectively, demonstrating good reliability and validity [13].

5) Psychological Resilience Scale (Connor-Davidson Resilience Scale CD-RISC)

Psychological resilience is measured using the Connor-Davidson Resilience Scale (CD-RISC), which evaluates stress-coping ability. This scale, developed by Kathryn M. Connor and David Davidson, contains three dimensions: strength, tenacity, and optimism. It uses a Likert 5-point scoring method, with scores ranging from 0 to 4 points per item, totaling 100 points. Higher scores indicate better psychological resilience [14].

2.2.2. Data Collection Methods

Questionnaires were distributed by uniformly trained researchers, and standardized Instructional sentences were followed for each research tool. Patients com-

pleted the questionnaires independently. If patients had questions about specific items, researchers provided on-site explanations to ensure clarity. In cases where patients were unable to complete the questionnaire themselves, they could either respond orally or designate a primary caregiver to fill it out on their behalf. After completion, the questionnaires were immediately collected and checked for completeness. Any missing or incorrectly filled items were promptly addressed with the patient, ensuring accurate and complete data collection.

2.2.3. Statistical Processing

The study data were entered into an Excel database by two independent personnel, and the data were cross-checked for accuracy after entry. All statistical analyses were conducted using SPSS 26.0 software. Measurement data were tested for normal distribution using the Shapiro-Wilk test. For normally distributed data, inter-group comparisons were performed using the independent samples t-test, with results presented as $\bar{x} \pm s$). For non-normally distributed data, the Mann-Whitney U test was used for inter-group comparisons, with results reported as median and interquartile range [M (P25, P75)]. Categorical data were expressed as frequencies or percentages. The significance level was set at $\alpha = 0.05$, with $P < 0.05$ indicating statistically significant differences.

3. Results

3.1. Status of Economic Toxicity, Psychological Resilience, and Two-Way Social Support in Lung Cancer Patients Undergoing Chemotherapy

The median total score for economic toxicity in lung cancer patients undergoing chemotherapy was 20.00 (interquartile range: 18.50 to 23.50), with 117 cases (88.63%) experiencing economic toxicity. The scores for psychological resilience and two-way social support are summarized in Table 1.

Table 1. Univariate analysis of economic toxicity in patients with chemotherapy for lung cancer (N = 132).

Items	Number of entries	Score [points, M (P25, P75)]
Total Economic toxicity score	11	20 (18.5, 23.5)
Economic outlay	1	2.00 (1.00, 2.00)
Economic resources	2	5.00 (3.00, 6.00)
Psychosocial response	8	16.50 (12.25, 16.00)
Mental resilience total	25	45.50 (40.00, 47.00)
Two-way Social support	12	53.00 (47.00, 54.00)
Get social support	6	27.00 (23.75, 35.00)
Provide social support	6	25.50 (22.50, 28.50)

3.2. Single-Factor Analysis of Economic Toxicity in Lung Cancer Patients Undergoing Chemotherapy

Statistically significant differences were observed in economic toxicity among

lung cancer patients undergoing chemotherapy across various demographic and clinical factors, including age, gender, education level, marital status, current working status, place of residence, per capita monthly family income, payment method for medical expenses, and frequency of chemotherapy (all $P < 0.05$). The degree of economic toxicity in patients is correlated with their own economic conditions. Patients who originally have poorer economic conditions will have a higher economic toxicity grade, more concerns about the economic aspect, and stronger hesitation towards treatment.

Only items with statistical significance are presented in this study, as shown in Table 2.

Table 2. Univariate analysis of economic toxicity in patients with chemotherapy for lung cancer (N = 132).

Items	Number of cases [n (%)]	Economic toxicity score [points, M (P25, P75)]	H	P
Age (years)			12.195	0.004
25 - 50	2 (1.52)	15.00 (12.00, 17.50)		
51 - 60	35 (26.5)	17.00 (15.00, 20.00)[a]		
61 - 70	58 (43.94)	20.00 (15.00, 21.00)[a]		
71 - 80	37 (15.94)	23.00 (19.00, 25.00)[ab]		
Gender			8.58	0.012
Male	108 (81.81)	21.00 (15.50, 26.00)		
Female	24 (18.18)	17.00 (13.00, 20.00)		
Literacy			25.968	<0.001
Elementary school and below	63 (47.72)	17.00 (14.00, 21.00)		
Junior high	19 (14.39)	23.00 (16.25, 27.00)[a]		
High school or technical secondary school	34 (25.75)	25.00 (20.00, 25.00)[ab]		
Associate or bachelor's degree and above	16 (12.12)	24.00 (21.00, 25.00)[abc]		
Hospital commute time (t/min)			18.341	0.001
<60	59 (44.69)	24.00 (16.00, 26.00)		
60 - 120	32 (24.24)	22.00 (19.00, 23.00)		
121 - 180	14 (10.60)	19.50 (11.00, 20.00)[a]		
>180	27 (20.45)	20.00 (14.00, 20.00)[ab]		
Work situation			29.102	<0.001
On-the-job	26 (19.69)	15.00 (9.00, 17.00)		
Unemployment	11 (8.33)	16.00 (9.00, 20.00)[a]		
Retires	95 (71.97)	22.00 (17.00, 23.00)[ab]		
Place of Residence			31.793	<0.001
Towns	71 (53.79)	11.00 (8.00, 13.00)[a]		
Rural	61 (46.21)	15.00 (8.00, 17.00)		

Continued

Per capita monthly household income (yuan)			29.873	0.001
<3000	103 (24.64)	13.00 (8.00, 18.00)		
3000 - 7999	287 (68.66)	20.00 (14.00, 23.00)		
≥8000	28 (6.70)	25.00 (19.00, 27.00)[ab]		
Method of payment for medical expenses			46.582	0.001
Medical insurance for urban workers	187 (44.74)	23.00 (18.00, 26.00)		
Medical insurance for urban residents	86 (20.57)	23.00 (16.00, 26.00)		
New Rural Cooperative Medical insurance	133 (31.82)	20.00 (15.00, 25.00)		
Commercial medical insurance	9 (2.15)	21.00 (18.00, 22.00)		
Own expense	3 (0.72)	9.00 (8.00, 10.00)[abcd]		
Number of chemo treatments			13.264	0.006
<5	63 (15.07)	19.00 (16.00, 23.00)		
5 - 9	91 (21.77)	20.00 (15.00, 24.00)		
10 - 14	83 (19.86)	19.00 (14.00, 23.00)[ab]		
≥15	181 (43.30)	21.00 (16.00, 24.00)[ab]		

Note: [a]: P < 0.05, compared with layer 1; [b]: P < 0.05, compared with the second layer; [c]: P < 0.05, compared with the third layer; [d]: P < 0.05, compared with the fourth layer.

3.3. Correlation Analysis of Economic Toxicity with Psychological Resilience and Social Support in Lung Cancer Patients Undergoing Chemotherapy

The correlation analysis between economic toxicity (COST-PROM scores), psychological resilience scale scores, and two-way social support scale scores in lung cancer patients undergoing chemotherapy is presented in Table 3.

Table 3. Correlation between mental resilience, social support and economic toxicity in lung cancer patients undergoing chemotherapy (r).

Scores	Psychology Resilience	Understanding society Support	Family Support	Friend Support	Other Support	COST-PROM
Mental resilience	1	—	—	—	—	—
Two-way social support	0.058	1	—	—	—	—
Get Social support	0.193[b]	0.608[a]	1	—	—	—
Give social support	0.271[b]	0.564[a]	0.172[b]	1	—	—
COST-PROM	0.290[a]	0.244[a]	0.077[b]	0.033	0.024	1

Note: [a]: P < 0.001; [b]: P < 0.05.

3.4. Multivariate Analysis of Economic Toxicity in Lung Cancer Patients Undergoing Chemotherapy

A multivariate analysis was conducted with the total economic toxicity score (COST-PROM) as the dependent variable and the variables that showed statistical significance in univariate and correlation analyses as independent variables. The results indicated that age, per capita monthly family income, education level, payment method for medical expenses, psychological resilience, and social support were included in the regression equation, accounting for 52.1% of the total variance, as shown in Table 4.

Table 4. Results of multiple linear regression analysis of factors influencing economic toxicity in patients with lung cancer chemotherapy (n = 132).

Items	b	Sb	b'	t	P
Constant term	23.451	1.925	—	11.406	<0.001
Mental resilience	0.358	0.058	0.28	4.318	<0.001
Social support	0.276	0.661	0.301	5.136	<0.001
Age	0.473	0.247	0.218	5.213	0.027
Per capita monthly household income	3.613	0.316	0.371	3.413	<0.001
Literacy	0.359	0.763	0.423	2.531	0.013
Method of payment for medical expenses	0.247	0.217	0.298	5.237	<0.001

Note: $F = 77.452$, $P < 0.001$; $R^2 = 0.537$, adjusted $R^2 = 0.521$.

4. Discussion

4.1. Economic Toxicity Status of Lung Cancer Patients Undergoing Chemotherapy

This study revealed that the median economic toxicity score for lung cancer patients undergoing chemotherapy was 20.00 (interquartile range: 18.50 to 23.50), with 88.75% of patients experiencing economic toxicity. The underlying reasons are as follows: (1) Lung cancer chemotherapy is currently one of the most effective treatments for controlling cancer progression. Multiple rounds of chemotherapy and associated examinations impose a significant economic burden on patients. (2) Treatment-related complications pose an additional risk, further increasing the economic burden due to extended or more intensive medical interventions. (3) Both direct and indirect costs contribute to the overall financial strain. Direct costs encompass treatment, nursing, and examination expenses, while indirect costs include travel, accommodation, food, and other related expenses incurred during the course of treatment. (4) Objective economic pressure negatively impacts patients' psychological well-being, leading to negative emotions that can hinder disease recovery. The exacerbation of the disease subsequently increases medical costs.

These findings suggest that healthcare providers, particularly nursing staff, should pay close attention to both the objective economic burden and subjective economic distress experienced by patients. Strengthening communication regard-

ing treatment costs and providing support to alleviate patients' subjective economic distress are crucial. Future clinical practices may consider incorporating economic toxicity assessment into routine admission evaluations, utilizing validated tools to accurately gauge the level of economic toxicity faced by patients. This evaluation will serve as a reference for subsequent treatment decisions and alert healthcare providers to monitor and address potential delays in treatment and care progression caused by economic toxicity.

4.2. Influencing Factors of Economic Toxicity in Lung Cancer Patients Undergoing Chemotherapy

4.2.1. Age

This study found that age significantly influenced the level of economic toxicity in lung cancer patients undergoing chemotherapy, with younger patients experiencing higher levels of economic toxicity. The reasons may include: (1) Younger patients are often the primary breadwinners for their families, bearing dual responsibilities of raising children and supporting elderly relatives. Their inability to work normally due to illness results in substantial economic pressure. (2) Older patients may perceive lower recurrence rates and five-year survival rates, leading to concerns about the value of spending significant resources on cancer treatment. This fear and deliberation can contribute to increased economic distress. (3) Elderly patients frequently adhere to traditional beliefs, such as "the less I spend, the more I can leave for my children" and "I do not want to impose additional financial burdens on my children".

This prompts nursing staff to recognize these age-related differences and provide individualized care to help patients of all ages identify resources and coping strategies, thereby enhancing their confidence in managing the disease.

4.2.2. Education Level

The study revealed that education level impacted the level of economic toxicity in lung cancer patients undergoing chemotherapy, with lower education levels correlating with higher economic toxicity. Possible reasons include: (1) Patients with higher education levels tend to have better salaries and financial stability. (2) Higher education is associated with greater health literacy, enabling patients to understand disease-related information more effectively and communicate efficiently with healthcare providers. This leads to more informed and cost-effective decision-making regarding treatment plans. (3) Conversely, patients with lower education levels may be less proactive in treatment decisions and face challenges in navigating the healthcare system. It is recommended that nursing staff build trust with patients, provide comprehensive economic and medical cost information, facilitate efficient communication, and promote shared decision-making between patients and healthcare providers.

4.2.3. Payment Method for Medical Expenses

This study demonstrated that a higher proportion of out-of-pocket payments was associated with increased economic toxicity among lung cancer patients. Alt-

hough medical insurance coverage has improved in terms of types, reimbursement rates, and population coverage, the integration between healthcare policies and insurance policies remains inadequate. This results in complex reimbursement processes, further exacerbating the economic burden on patients. In the future, efforts should be directed toward optimizing policies related to treatment costs for cancer patients. This includes disseminating information about national reimbursement ratios and subsidy policies to patients, as well as assisting them in understanding and accessing various formal social assistance channels.

4.2.4. Place of Residence

The study showed that a higher proportion of patients lived in rural areas compared to urban areas, and lung cancer patients residing in rural areas experienced higher levels of economic toxicity. The reasons may include: (1) Family composition: Rural patients often rely on their children for financial support, while urban patients typically have pensions or past savings as their primary sources of income. (2) Uneven distribution of medical resources: Urban areas generally have better access to medical facilities and services, whereas rural areas are relatively underdeveloped. (3) Economic income differences: Rural patients often have limited income sources, primarily from agriculture, while the majority of urban patients are retired workers who receive pensions.

4.2.5. Psychological Resilience

This study demonstrates that psychological resilience significantly influences the level of economic toxicity, with higher psychological resilience correlating with lower levels of economic toxicity. Psychological resilience is a dynamic process involving the interaction between individuals and their environment. When faced with an ever-changing external environment, individuals can better adapt by enhancing their psychological resilience. Medical staff can dynamically assess patients' psychological resilience levels upon admission and during hospitalization. Based on these assessments, nursing measures can be formulated using the "advantage perspective" theory to improve patients' psychological resilience.

4.2.6. Two-Way Social Support

The results indicate that the degree of social support, both received and provided, significantly affects the level of economic toxicity. Higher levels of social support correlate with lower economic toxicity. The reasons for this may include: (1) Both receiving and providing social support offer patients emotional comfort and buffer the impact of stress and adverse events. (2) Social support provides external resources necessary for coping with negative events, thereby enhancing patients' self-confidence and adaptability. (3) Strong social support networks promote patients' ability to maintain well-adapted roles in their personal and social lives. Medical staff should recognize the impact of social support on economic toxicity and enhance patients' two-way sense of social support. Family members play a crucial role as social supports and should be encouraged to provide more care and attention to patients, thereby mitigating the negative effects of economic toxicity.

4.3. The Limitations of This Study

(1) This study focused exclusively on lung cancer patients undergoing chemotherapy and did not collect data on the economic toxicity experienced by those treated with surgery. (2) The study was limited to a cross-sectional design, which precludes the identification of temporal trends or causal relationships; future research should build on these findings to propose feasible interventions based on comprehensive current situation investigations. (3) The study did not consider the potential benefits of longitudinal research, thereby overlooking the possibility of sample attrition over time, which is common in long-term studies of cancer patients.

4.4. Operable Recommendations

In light of the detrimental effects of economic toxicity on patients and society, implementing specific and practical measures is crucial to mitigate its adverse impact.

4.4.1. Individualized Support and Nursing

For young patients, provide vocational rehabilitation support and financial assistance to alleviate the burden of family responsibilities. For elderly patients, enhance psychological counseling to correct misconceptions about the value of treatment, encourage active participation in treatment, and offer increased care and support. For patients with low educational levels, simplify medical information to ensure effective communication and facilitate access to financial assistance. For rural patients, optimize the allocation of medical resources, provide transportation and accommodation subsidies, and improve overall medical conditions.

4.4.2. Psychological and Social Support Interventions

To bolster patients' psychological resilience, conduct dynamic assessments of their psychological state upon admission and during hospitalization. Utilize the "strengths perspective" theory to develop personalized psychological interventions. Strengthen social support by encouraging family members to participate in patient care, providing emotional support, and establishing patient mutual aid groups to enhance social support networks.

4.4.3. Policy Optimization and Resource Integration

To improve medical insurance policies, streamline the reimbursement process, increase reimbursement rates, expand coverage, and promote balanced distribution of medical resources. Simultaneously, popularize national subsidy policies and social assistance channels, and provide one-stop financial support services to ensure timely access to necessary financial assistance.

4.4.4. Economic Toxicity Assessment and Management

Incorporate economic toxicity assessment into routine admission evaluations, using validated scales such as the COST scale for regular assessments. Enhance economic cost communication between medical staff and patients to promote shared

decision-making. Dynamically monitor changes in economic toxicity during treatment and adjust treatment plans and economic support measures accordingly.

4.4.5. Multidisciplinary Collaboration

Establish a multidisciplinary team (including doctors, nurses, social workers, psychologists, etc.) to provide comprehensive economic, psychological, and social support, ensuring the effective implementation of all support measures.

5. Summary

This study demonstrates that economic toxicity is prevalent and significant among lung cancer patients undergoing chemotherapy. The primary causes of economic toxicity encompass high treatment costs, the risk of complications, the burden of both direct and indirect expenses, and the adverse effects of financial stress on mental health. Key influencing factors include patient age, family income, education level, type of medical insurance, psychological resilience, and social support. Healthcare providers should identify economic toxicity in its early stages and implement screening and intervention strategies for lung cancer patients. Future research could focus on developing and validating an economic toxicity screening tool using large, multi-center samples. At the same time, future research should consider longitudinal studies of economic toxicity in lung cancer patients. Such studies could investigate which stage of the treatment process is associated with the highest level of economic toxicity, whether economic toxicity fluctuates over the course of treatment, and the primary factors influencing these fluctuations.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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