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ORIGINAL RESEARCH

Network Analysis of Fear of Recurrence and Sleep Disorders in Ovarian Cancer Patients Undergoing Chemotherapy

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Background: This quantitative study aimed to analyze the internal association mechanism between the core symptoms of fear of recurrence and sleep disturbances among ovarian cancer chemotherapy patients in Western Region of China.

Methods: From October 2024 to July 2025, a convenience sampling method was used to administer a questionnaire to ovarian cancer chemotherapy patients at a gynecology center within a university hospital situated in the Northwest region of China. The investigation employed general information questionnaires, Pittsburgh Sleep Quality Index (PSQI) and Fear of Cancer Recurrence-Short Form (FCR-Q-SF) to conduct the survey. Use R language to construct a network visual map, calculate centrality indicators, and describe the relationships among symptoms.

Results: This study included a total of 248 patients with ovarian cancer undergoing chemotherapy. The incidence rates of fear of recurrence and sleep disorders were 54.3% and 66.2%, respectively. Univariate analysis showed a positive correlation between patients' fear of cancer recurrence and sleep disorders ($P<0.05$). The core symptom in the fear of cancer recurrence network is "F10 worrying that medications will harm my body". The bridging node connecting symptoms across different dimensions is "F11 worrying about what will happen to my family if something happens to me". In the network of fear of recurrence and sleep disorders, the core symptoms are "F10 worrying that medications will harm my body", "S1 sleep latency", and "S6 sleep problems" in sequence. Additionally, "sleep problems" serves as the bridging node connecting symptoms of fear of recurrence and sleep disorders.

Conclusion: The network structure of disease symptoms helps to gain an in-depth understanding of the mechanism of fear of cancer recurrence and its relationship with sleep disorders in ovarian cancer patients. Based on this, it is recommended that clinical practitioners prioritize the prevention and alleviation of patients' anxiety about medication-induced harm, and strengthen attention to sleep problems, so as to better improve their overall mental health.

Keywords: ovarian cancer, fear of recurrence, sleep disorders, network analysis

Introduction

In 2022, according to data from the National Cancer Center, there were 61,100 new cases of ovarian cancer and 32,600 deaths in our country.[1] As one of the most malignant tumors of the female reproductive system, ovarian cancer is characterized by prominent malignancy, strong invasive ability, and high risk of recurrence,[2] which seriously threatens women's health and life safety. Although standardized therapy significantly improves patient outcomes, most patients relapse and become resistant to chemotherapy 2 to 3 years after completing standard initial therapy.[3] Therefore, chemotherapy for ovarian cancer patients throughout the treatment of the disease brings a heavy psychological and economic burden to patients, and the fear of cancer recurrence is particularly prominent. Fear of Cancer Recurrence (FCR) refers to the fear, worry, or concern related to the possibility of cancer recurrence or progression.[4] Domestic and foreign studies show[5,6] that at least 65% of ovarian cancer patients reported moderate to severe fear of recurrence. A certain level of fear of cancer recurrence can increase patients' vigilance against cancer metastasis or recurrence, but

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when it continues to rise over time and left untreated, it can lead to negative psychological (ie, depression and anxiety), physical (ie, pain, fatigue, and sleep disturbancing) health outcomes.[7]

Cancer-related sleep disorders (CRSD), also known as cancer-related insomnia, refer to sleep disturbances caused by cancer itself, anticancer treatments (such as chemotherapy, radiotherapy, or targeted therapy), or disease-related psychosocial stress. Clinically, they are characterized by difficulty falling asleep, fragmented sleep, early morning awakening, and non-restorative sleep, often accompanied by daytime functional impairment.[8] Studies have shown that fear of recurrence is often accompanied by the emergence of mental symptoms such as sleep disorders. A large number of empirical studies and clinical investigations have shown[9–11] that fear of cancer recurrence is closely related to psychological symptoms such as sleep disorders, and sleep disorders are an independent risk factor for the aggravation of FCR. For every 1-point increase in the PSQI score, the risk of FCR aggravation increases by 4.257 times.

Current researchers have mostly investigated and studied the information-related variables of the two from the perspective of traditional latent variable theory and local independent hypothesis, that is, the symptoms of mental disorders are regarded as the result of common latent variables, and the overall situation of the score is used to explain the severity of psychological symptoms, which leads to the ignorance of the interaction between symptoms,[12] which is not conducive to identifying targets and key pathways for intervention from highly correlated symptom nodes. The emergence of psychopathological network theory provides a completely new perspective for understanding the relationship between psychopathological disorders and symptoms.

Network analysis is based on psychopathological theory, which constructs a network model in the form of nodes and connections based on the internal characteristics of a system, effectively identifies the core variables and clarifies the key nodes of the connection between variables, and visualizes the interaction between symptoms to deeply analyze the complex associations between variables,[13] which has a certain reference value for intervention research.

Network analysis has been applied to depict and explore the relationships within and between mental disorders,[14,15] such as the internal network relationships of fear of recurrence,[7] the network structure of anxiety-depression and fear of recurrence,[16] and the network relationships between sleep disorders, anxiety, and loneliness.[17] Jing et al found that sleep problems were the core symptom in the network structure of anxiety, loneliness, and sleep disorders among community-dwelling elderly individuals;[17] Yang et al identified that "Having trouble relaxing" was the core symptom in the network structure of anxiety-depression and fear of recurrence.[16] Previous studies have emphasized intervening in this core symptom could improve the overall status of all symptoms in the network, and the intervention effect was superior to that of intervening in other non-core symptoms.[17]

Based on the above, this study conducted a network analysis of the core symptoms of fear of recurrence in ovarian cancer patients and their interaction with sleep disorders, in order to provide more targeted mental health support and provide scientific basis for related prevention and intervention.

Methods

Study Design and Setting

This cross-sectional study was conducted at a gynecology center within a university hospital situated in the Northwest region of China, from September 2024 to July 2025. This study adhered to the guidelines outlined in the "Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)" statement.[18]

Participants

The sample consisted of individuals who met the inclusion criteria for ovarian cancer, including those with a history of surgical treatment and currently receiving chemotherapy (either as inpatients or outpatients), were over 18 years old, and were able to understand and speak Chinese, volunteering to participate and consenting to provide information for the study; without cognitive disabilities. The exclusion criteria included a diagnosis of any communication barrier, impaired consciousness or mental disorders, termination of questionnaire completion due to medical activities, and patients who were unaware of their disease. Additionally, patients who dropped out and were missing more than 20% of their information were excluded from the study.

Study Size

According to the sample size requirements of network analysis,[19] the sample size is at least higher than the threshold parameter and the pairwise association parameter. In this study, a total of 19 nodes need to be constructed, with pairwise association parameters=19×18/2=171, total parameters=171+19=190, and the minimum sample size is 190.

Instruments

Demographic Characteristics

The collected socio-demographic data included age, type of medical insurance residence, education level and disease-related information such as FIGO staging, recurrence status, and family history of tumors.

Chinese Version of the Simplified Scale for Progression of Fear Disorders (FCR-Q-SF)

In 2006, German scholar Mehnert[20] developed the Fear of Progression Questionnaire - Short Form (FoP-Q-SF) by revising the original scale. The abbreviated version comprises 12 items, designed to efficiently measure individuals' fear of disease progression. Later, it was localized by Chinese scholars and applied to liver cancer patients.[21] The scale employs a Likert 5-point rating system, When the score is greater than or equal to 34 points, it indicates that the fear of recurrence psychological function is disordered.[22] In this study, the scale demonstrated excellent reliability, with a Cronbach's α coefficient of 0.801, confirming its validity for measuring fear of progression.

Pittsburgh Sleep Quality Index (PSQI)

Developed by Buysse[23] in 1989, it contains 18 self - assessment items and is composed of seven parts: subjective sleep quality, sleep disturbances, sleep latency, sleep efficiency, sleep duration, daytime dysfunction, and the use of hypnotic drugs. A 4 - level scoring method from 0 to 3 points is adopted, with a cumulative score range of 0–21 points. A score of ≥ 8 points indicates that the patient has sleep disorders. The Cronbach's α coefficient of this scale in the study is 0.724.

Data Sources/Measurement

The investigator used unified guidance language to explain the purpose, significance and precautions of this study to the patients before distributing the questionnaire, and signed the informed consent form after obtaining the patient's consent. Questionnaires were collected on the first day of admission (hospitalized patients) or before chemotherapy drug injection (outpatients). During the filling process, if the survey subjects are illiterate or elderly and cannot successfully complete the questionnaire, the researcher will ask one by one according to the questionnaire content, check the correct options, and check the corresponding options. The questionnaire is uniformly distributed by the researcher and collected on site, and then checked whether the questionnaire is completed. If any deficiencies are found, they should be supplemented in time.

A total of 260 questionnaires were distributed in this study. After excluding 5 questionnaires with too short completion time (less than 3 minutes), 3 questionnaires with regular options, and 4 questionnaires with more than half of the questions unanswered, a total of 248 valid questionnaires were retrieved, with a valid response rate of 95%.

Ethical Considerations

This study protocol has been meticulously reviewed and unanimously approved by the Medical Ethics Committee of the Affiliated Cancer Hospital of Xinjiang Medical University (approval number: K-2024214). The review process adhered strictly to the standards set forth in the Helsinki Declaration. Prior to their participation, all study participants provided informed consent.

Statistical Analysis

Statistical analyses were performed using Excel and SPSS 26.0 software. Categorical data were described with frequencies and percentages. Spearman correlation analysis and multiple linear regression analysis were employed to explore the association between fear of recurrence and sleep disorders. A P-value < 0.05 was considered statistically significant.

A Gaussian graphical model (GGM) was used to fit and construct the network. In the network structure, nodes represent item symptoms, and the thickness of the between nodes indicates the strength of the association.[19] Model selection was performed by combining the extended Bayesian information criterion (EBIC) and the least absolute shrinkage and selection operator (LASSO) to obtain a more robust sparse partial correlation network. Among them, LASSO, as a regularization algorithm, can zero out weak correlations to control the number of false-positive edges; EBIC adjusts the model density through hyperparameters, with the hyperparameter set to 0.5. The centrality Plot function in the "qgraph" package was used to estimate and visualize the centrality indices and bridge centrality of symptoms. A higher strength centrality value indicates that the node is more important; the bridge centrality index reflects the role of a node in connecting different disease symptoms. The "bootnet" package (2000 bootstraps) was used to estimate the stability coefficients (correlation stability coefficient, CS) of edge weights and centrality indices to evaluate the robustness of the network model results, with CS being at least 0.25.[24]

Results

Multiple Linear Regression Analysis of General Information of Patients and Influencing Factors of Fear of Recurrence

General information of patients: a total of 248 patients with chemotherapy for ovarian cancer were included, with a score of (34.49±5.97) and an incidence rate of 54.3%. The sleep disturbance score was (9.29±3.56) and the incidence was 66.2%. Among them, 21 cases under 40 years old, 175 cases between 40 and 60 years old and 52 cases were > 60 years old; 168 cases with stage III and above; 97 cases of recurrence, 108 cases of employee medical insurance, and 140 cases of resident medical insurance/resident + self-funded; 41 cases with a family history of tumors; Education level 125 cases of junior high school and below, 52 cases of high school/technical secondary school, and 71 cases of junior college/ bachelor's degree or above.

Multiple linear regression analysis of influencing factors of recurrence fear in patients with ovarian cancer during chemotherapy: Although the fear of recurrence score does not obey the norm, the residual plot shows that it obeys the normal distribution. At the same time, Devin Watson tested yielded a value of 1.80 indicates good data independence; The maximum and minimum values of the standardized residuals are close to 0, and the mean value is 0, and the homogeneity of variance also meets the requirements. Therefore, multiple linear regression analysis was used, with the fear of recurrence as the dependent variable and the sleep disturbance score as the explanatory variable, and the patient's age (brought in from the original value), disease stage (brought in from the original value), education level (based on junior high school and below), whether or not to recur (based on no), payment method (based on resident medical insurance), and family tumor history (based on no) for multiple linear regression. The results showed that sleep disturbance and age were the main influencing factors of recurrence fear in patients with ovarian cancer chemotherapy, among which sleep disturbance was positively correlated with recurrence fear, and age was negatively correlated with recurrence fear (Table 1).

Table 1 The Main Influencing Factors of Recurrence Fear in Patients with Ovarian Cancer During Chemotherapy

Variable	*β*	*SE*	*β′*	t	*P*	*CI*
Constants	34.414	3.335		10.318	**<0.001**	27.844, 40.984
Age	−0.189	0.044	−0.277	−4.259	**<0.001**	−0.277, −0.102
FIGO	−0.144	0.524	−0.017	−0.274	0.784	−1.177, 0.889
Education level	0.459	0.582	0.058	0.788	0.431	−0.689, 1.604
Recurrence	0.912	0.886	0.066	1.029	0.305	−0.834, 2.658

(*Continued*)

Table 1 (Continued).

Variable	*β*	*SE*	*β′*	*t*	*P*	*CI*
Medical expense disbursement	−0.620	0.959	−0.045	−0.647	0.518	−2.508, 1.268
Family history of tumors	0.046	1.095	0.002	0.042	0.967	−2.111, 2.203
Sleep quality	0.577	0.118	0.304	4.890	**<0.001**	0.345, 0.810

Notes: R^2=0.160, Adjust R^2=0.135, F=6.512, P<0.001; Bold indicates $p < 0.05$.

Correlation Analysis Between Fear of Cancer Recurrence and Sleep Disturbances

Correlation analysis showed that the fear of cancer recurrence in patients with ovarian cancer during chemotherapy was positively correlated with sleep disturbances (r=0.226; P<0.05).

Results of Symptom Network Analysis and Stability Tests

Network structure and central index of ovarian cancer recurrence fear symptom during chemotherapy: The recurrence fear symptom network in the chemotherapy period of ovarian cancer has a stability coefficient CS = 0.51, indicating that the network has good stability. In the entire network, a total of 12 symptoms in two dimensions are included. The node colors yellow and blue represent the symptoms of the physical health dimension and the social - family dimension respectively (Figure 1). Among the node centrality indicators, the top three symptoms in terms of strength coefficient are "F10 Worried that the drug will damage the body (rs = 1.068), F9 Worried about some major treatments (rs = 0.912), F11 Worried about what will happen to the family if something happens to me (rs = 0.905)", indicating that they are the core

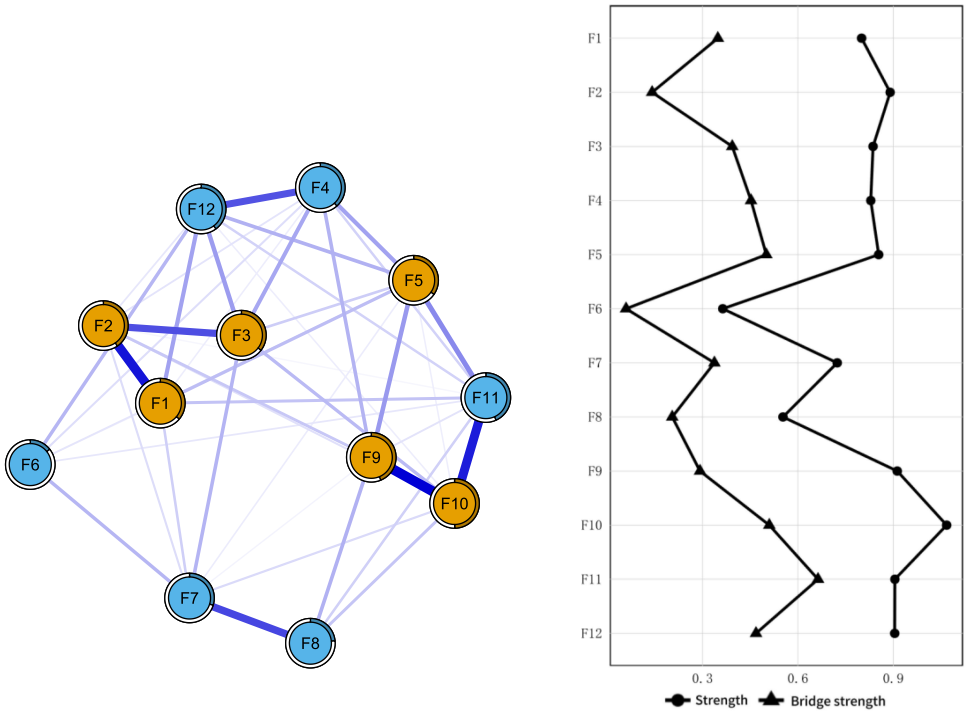

Figure 1 Network structure and central indicators of ovarian cancer recurrence fear symptoms during chemotherapy.
Notes:F1 "I become anxious when I think about the progression of the disease", "F2 I feel nervous before doctor appointments or regular check - ups", "F3 I'm afraid of the pain caused by this disease", "F4 The idea that the disease reduces my work efficiency bothers me", "F5 I have some physical discomforts such as rapid heartbeat, stomachache, and nervousness when I'm anxious", "F6 I worry that the disease will be passed on to my children", "F7 I'm anxious that I may have to rely on strangers in my daily life", "F8 I worry that I may not be able to continue my hobbies at some point due to the disease", "F9 I worry that there will be some major treatments during the course of the disease", "F10 I worry that the drugs will damage my body", "F11 I worry about what will happen to my family if something happens to me", "F12 The idea that I may not be able to work due to the disease bothers me".

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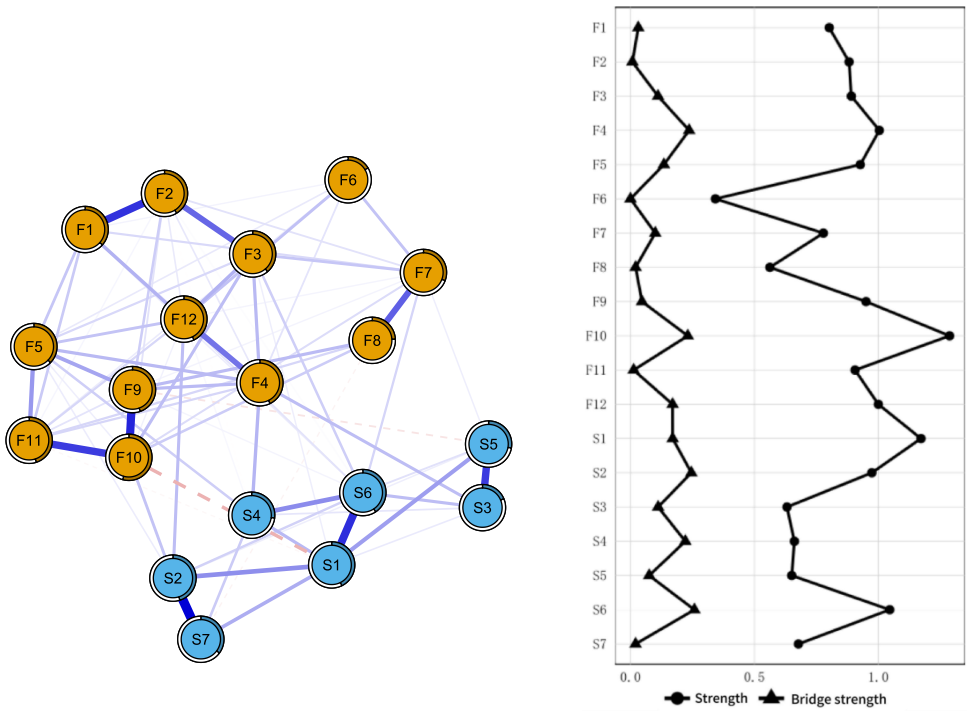

Figure 2 Network diagram of fear of cancer recurrence symptoms and sleep disorder symptoms.
Notes:F1 "I become anxious when I think about the progression of the disease", "F2 I feel nervous before doctor appointments or regular check - ups", "F3 I'm afraid of the pain caused by this disease", "F4 The idea that the disease reduces my work efficiency bothers me", "F5 I have some physical discomforts such as rapid heartbeat, stomachache, and nervousness when I'm anxious", "F6 I worry that the disease will be passed on to my children", "F7 I'm anxious that I may have to rely on strangers in my daily life", "F8 I worry that I may not be able to continue my hobbies at some point due to the disease", "F9 I worry that there will be some major treatments during the course of the disease", "F10 I worry that the drugs will damage my body", "F11 I worry about what will happen to my family if something happens to me", "F12 The idea that I may not be able to work due to the disease bothers me"; "S1 Sleep latency", "S2 Sleep duration", "S3 Sleep quality", "S4 Hypnotic drugs", "S5 Daytime dysfunction", "S6 Sleep problems", "S7 Sleep efficiency".

symptoms of the FCR network; among the bridge centrality indicators, "F11 I'm worried about what will happen to the family if something happens to me (r = 0.40)" has the strongest edge connection (Figure 1).

Network visual view of fear of cancer recurrence symptoms and sleep disorders in ovarian cancer patients during chemotherapy: in patients with ovarian cancer chemotherapy A total of 19 symptoms of recurrence fear and sleep disturbances were included in the entire network, of which yellow represented symptoms related to recurrence fear and blue represented symptoms related to sleep disturbances (Figure 2).

From the perspective of the network structure, the nodes of relapse fear and sleep disorders are clustered respectively, forming two clusters. The bridge centrality index shows that the symptom of "S6: Sleep problem" has the highest bridging strength (rbs = 0.26), indicating that the above symptoms are important bridging nodes connecting the relational network between relapse fear and sleep disorders (Figure 2).

Discussion

The results of this study show that the top three central symptoms are "F10, F9, and F11", among which the fear that drugs will damage the body is the strongest. This result indicates that this symptom may be a key node affecting the overall mental health level of the symptom network and has the broadest and closest associations with other symptoms. In other words, its activation can spread the activation effect to the entire network model by connecting other symptom pathways, thereby exerting a significant impact on other symptoms.[25] This is inconsistent with the results of Richter et al.[26] The reason for the analysis may be due to the study subjects, the study was conducted on patients with different cancers aged 15 to 39 years, and the study subjects included in this study were all women, and all ovarian cancer patients were on chemotherapy. The adverse effects of chemotherapy, including pain, fatigue, and bone marrow suppression, may activate the patient's attention system and form a negative cognitive schema,[27] which in turn leads the patient to interpret

these negative messages as signs of disease progression or recurrence. This suggests that in the prevention and intervention of fear of recurrence, focus should be placed on and priority given to intervening in the core symptom of "worrying that medications will harm the body". For instance, VR technology can be used to create immersive relaxation scenarios for patients, assisting them in learning and practicing relaxation techniques. Meanwhile, combining breathing exercises and mindfulness meditation can help patients shift their excessive focus away from real-life stressors, thereby alleviating their fear and anxiety related to recurrence.[28]

The network visually shows that the three symptoms of worrying about The network visually shows that the three symptoms of "worrying about major treatment, worrying about drugs damaging the body, and worrying about what will happen to my family if something happens to me" are closely connected and positively correlated. Patients' concerns about the side effects of medication and the possibility of major treatment during the course of the disease can significantly exacerbate their psychological stress. This dual anxiety stems from a high degree of uncertainty about treatment effects and prognosis, and often triggers secondary psychological reactions, manifested as deep concerns about the impact on the family, including increased economic burden, lack of family roles, and difficulties in raising children. These continuous psychological pressures will consume a large amount of patients' psychological resources, increase their psychological burden of coping with the disease, and then affect treatment compliance and rehabilitation effects.

Statistical results show that the more severe the psychological dysfunction of the patient's fear of relapse, the more likely they are to develop sleep disorders, which is consistent with the results of domestic and international studies.[29,30] First of all, the ovarian cancer patient is in the chemotherapy period, pain and fatigue caused by disease treatment are analyzed as internal triggers that stimulate the level of FCR and affect the patient's sleep duration and sleep quality to varying degrees.[31] Secondly, when patients face multiple practical difficulties such as declining physical function, family economic pressure, and declining professional competitiveness, the resulting worries will further induce negative emotions such as anxiety and depression. Studies have shown that anxiety and depression are a common comorbid symptom of FCR, and FCR can positively predict patients' anxiety/depression levels.[32] During the circadian rhythm, the peak of negative emotions and the trough of positive emotions often occur at the same time,[33] which affects their cognitive evaluation and emotional regulation ability, leading to difficulty falling asleep and increasing the incidence of sleep disorders. Long-term sleep deprivation or poor sleep quality can lead to fatigue, cognitive decline, and exacerbate negative emotions such as anxiety/depression,[34] further affecting the FCR, and the cycle repeats to form a vicious circle.

Network analysis revealed a potential association between fear of recurrence and patients' sleep quality. Among all symptoms, "sleep problems" exhibited the highest bridge strength centrality, suggesting it may serve as an internal bridging symptom connecting fear of recurrence and sleep disturbances. Bridge symptom act as a key information transmission medium within the overall symptom network, facilitating interactions between symptom networks across different dimensions. Therefore, it will become one of the key targets for symptom intervention in the fear of recurrence-sleep disorder network system. In terms of specific manifestations, this symptom is mainly reflected in "easy awakening at night or early awakening", "needing to use the toilet at night", and "feeling hot", with their incidence rates reaching 74.3%, 69.6%, and 40.5% respectively. Previous studies have shown that patients with sleep problems have a lower proportion of N3 stage and poorer mental status.[35] Stage N3 is in the non-REM phase, also known as slow-wave sleep or deep sleep, which is an important sleep stage that affects sleep quality. This stage plays a key role in body recovery, memory consolidation, and emotional regulation.[36] Based on this, clinical interventions such as cranial magnetic stimulation and auditory stimulation can be used to enhance the depth of slow-wave sleep to achieve dual improvement of patients' sleep quality and psychological state.

In addition, in the relationship between FCR and sleep disorders, the key bridging nodes also have high intensity centrality in each local network. This result suggests that effective interventions for FCR can not only weaken the association between relapse and its own network nodes, but also prevent or block the link between FCR and sleep disorders. Therefore, it is of great significance to prevent and control negative emotions such as FCR and promote the improvement of mental health for ovarian cancer chemotherapy patients to form a healthy and regular sleep pattern.

Limitation

This study has the following limitations: First, it only adopted a cross-sectional survey design, and the network analysis was undirected. Therefore, it cannot clarify the causal relationship between "fear of cancer recurrence" and "sleep disorders". Second, to ensure the stability of the network model, this study did not conduct a stratified discussion of the subjects by age, failing to conduct an in-depth exploration of the characteristic differences among different age groups.

Future studies can be optimized in three aspects: adopting longitudinal data tracking to explore causality accurately, expanding the sample size to improve the reliability and generalizability of results, and conducting age-stratified analysis when the sample size is sufficient to explore the core symptoms of fear of cancer recurrence in patients of different age groups, thereby providing targeted basis for clinical intervention.

Additionally, This study only examined the network relationship between fear of recurrence (FCR) and sleep disorders. Future studies could start from emotional regulation mechanisms or cognitive processing modes to explore in depth whether these two act as mediating variables in the network regulation of the association between FCR and sleep quality, and to uncover more potential network influence mechanisms of FCR, thereby enhancing the accuracy and generalizability of the research results.

Conclusion

This study provides important insights into the interaction mechanisms among the internal symptoms of FCR in ovarian cancer patients. Through network analysis, the study accurately identified the core symptoms of FCR and the bridging symptoms between this symptom cluster and sleep disturbances, thereby providing a basis for the targeted design of combined prevention programs and intervention strategies for FCR and sleep disturbances in ovarian cancer patients.

Abbreviations

PSQI, Pittsburgh Sleep Quality Indexand; FCR-Q-SF, Fear of Cancer Recurrence-Short Form.

Data Sharing Statement

The datasets generated and analyzed during the current study are available from the corresponding author (TC) upon reasonable request.

Ethical Approval

This study protocol has been reviewed and unanimously approved by the Medical Ethics Committee of the Affiliated Cancer Hospital of Xinjiang Medical University (approval number: K - 2024214). The review process adhered strictly to the standards set forth in the Helsinki Declaration. Prior to their participation, all study participants provided informed consent.

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.

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Disclosure

The authors declare no conflicts of interest in this work.

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