



Observational Study

# Resilience provides mediating effect of resilience between fear of progression and sleep quality in patients with hematological malignancies

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**Specialty type:** Psychiatry

**Provenance and peer review:**

Unsolicited article; Externally peer reviewed.

**Peer-review model:** Single-blind

**Peer-review report's scientific quality classification**

Grade A (Excellent): 0  
Grade B (Very good): B  
Grade C (Good): 0  
Grade D (Fair): 0  
Grade E (Poor): 0

**P-Reviewer:** Giannoulis V, Greece

**Received:** January 19, 2024

**Peer-review started:** January 19, 2024

**First decision:** February 5, 2024

**Revised:** February 19, 2024

**Accepted:** March 28, 2024

**Article in press:** March 28, 2024

**Published online:** April 19, 2024



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## Abstract

### BACKGROUND

Hematological tumors are common malignant tumors, with high morbidity and mortality rates. Most patients with hematological malignancies develop sleep disorders that seriously affect their life and health because of acute onset of disease, rapid progression, high recurrence rates, complex treatment methods, and treatment costs.

### AIM

To explore the mediating effect of resilience on fear of disease progression and sleep quality in patients with hematological malignancies.

### METHODS

A cross-sectional analysis of 100 patients with hematological malignancies, treated in the First Affiliated Hospital of Jinzhou Medical University between August 2022 and August 2023, was conducted. Patients were assessed using a general data survey, a simplified scale for the fear of progression (FoP) of disease, a resilience scale, and the Pittsburgh Sleep Quality Index. Statistical analysis was conducted to determine the relationship between various patient characteristics and FoP, resilience, and sleep quality. Spearman's correlation analysis was used to examine the correlations between mental resilience, FoP, and sleep quality.

### RESULTS

The total FoP score mean value in patients with hematological malignancies was  $38.09 \pm 5.16$ ; the total resilience score mean value was  $40.73 \pm 7.04$ ; and the Pittsburgh Sleep Quality Index score mean value was  $10.72 \pm 1.90$ . FoP, resilience,

and sleep quality of the patients were associated with family per capita monthly income and patient education level ( $P < 0.05$ ). Spearman correlation analysis revealed that FoP was negatively correlated with resilience and sleep quality scores ( $r = -0.560, -0.537, P < 0.01$ ), respectively, and resilience was significantly associated with sleep quality scores ( $r = 0.688, P < 0.01$ ). Mediation analysis showed that the mediating effect of resilience between FoP and sleep quality in patients with hematological malignancies was  $-0.100$  and accounted for 50.51% of the total effect. This indicated that FoP directly and indirectly affected sleep quality through the mesomeric effect of resilience.

## CONCLUSION

Resilience is an intermediary variable between FoP and sleep quality in patients with hematological malignancies. Medical staff should evaluate and follow-up FoP and resilience to implement measures to improve sleep quality.

**Key Words:** Resilience; Blood tumor; Fear of progression; Sleep quality; Mediating effect

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**Core Tip:** Hematological tumors are common malignant tumors. Most patients with hematological malignancies develop sleep disorders that seriously affect their quality of life and health, owing to the acute onset, rapid progression, and high recurrence rate of these tumors. In this study, we conducted a cross-sectional analysis of 100 patients with hematological malignancies in the oncology department of our hospital. A general data survey, simplified fear of disease progression scale, resilience scale, and the Pittsburgh Sleep Quality Index were used to investigate the mediating effect of resilience between fear of disease progression and sleep quality in patients with hematological malignancies.

**Citation:** Tian Y, Wang YL. Resilience provides mediating effect of resilience between fear of progression and sleep quality in patients with hematological malignancies. *World J Psychiatry* 2024; 14(4): 541-552

**URL:** <https://www.wjgnet.com/2220-3206/full/v14/i4/541.htm>

**DOI:** <https://dx.doi.org/10.5498/wjp.v14.i4.541>

## INTRODUCTION

In recent years, the incidence and mortality of hematological tumors in China have increased[1]. Owing to the characteristics of hematological malignancies, such as acute onset, rapid progression, easy recurrence, complex treatment methods, and high treatment costs[2], concern about the progression or recurrence of the disease may seriously affect physical and mental health as well as sleep quality in patients. The term fear of progression (FoP) denotes a psychological condition marked by apprehension, fear, or worry regarding the potential advancement or recurrence of a medical condition[3]. Studies have shown that FoP is one of the most common pain symptoms in patients with carcinomas and other chronic diseases. An increase in these levels may lead to patient dysfunction and affect happiness, quality of life, and social function[4]. It is difficult to provide an effective relief of symptoms in cancer patients who have an obvious fear of disease progression. FoP is an urgent problem that must be addressed in patients with hematological tumors.

Elevated FoP levels in patients with cancer and other chronic diseases may lead to health dysfunction, including sleep problems. Sleep is an important marker of related functions in the human body and is crucial for maintaining individual physical and mental health[5]. Saletin *et al*[6] proposed a simple definition of sleep: A reversible behavioral state that is detached and unresponsive to the environment. The typical characteristics of sleep include closed eyes, lying supine, behavioral immobility, and reduced reactivity[6]. However, abnormal conditions may also occur during sleep, such as individuals exhibiting certain behaviors (sleepwalking, somniloquy, grinding teeth) or sleep problems (insomnia, dreaminess, wakefulness)[6]. In view of this, researchers have proposed the concept of sleep quality to better probe the sleep status in individuals. Sleep quality refers to a person's subjective evaluation of sleep quality, including the evaluation of sleep duration, sleep continuity, and wake-up feelings[7]. However, there is currently no standardized definition of sleep quality. Subjective and objective indicators are used to measure sleep quality, and some instruments convert sleep-related physiological indicators into sleep quality indicators[8,9]. Several studies have shown that patients with cancer have difficulties in initiating or maintaining sleep, wake up earlier than expected, and are unable to fall back to sleep; furthermore, they experience excessive daytime sleepiness and other sleep disorders, which remain as well during the recovery period[10]. Studies have shown that the stronger the fear of recurrence in patients with cancer, the worse their sleep quality[11].

Research has confirmed that the occurrence of sleep disorders is associated with individual negative emotions and mental disorders[12]. Bad mood can lead to decreased sleep quality, and approximately 80% of patients with depression have sleep disorders such as insomnia, early waking, and excessive sleep[13]. Resilience has attracted the attention of many researchers in the field of positive psychology. Resilience refers to an individual's positive internal coping abilities and good adaptation processes in the face of adversity and trauma. It is a complex internal psychological potential that has a significant impact on the development and growth of an individual[14]. Studies have found that the degree of

mental resilience in patients after cancer surgery is inversely proportional to the degree of FoP[15]. Furthermore, resilience has been demonstrated to improve sleep quality[16]. Overall, hematologic malignancies, such as leukemia, lymphoma, and myeloma, usually involve long-term and complex treatment processes, posing significant psychological and emotional burdens on patients and their families. Therefore, psychological resilience plays a crucial role in the study of patients with hematologic malignancies, affecting not only their mental health but also significantly impacting their treatment outcomes and quality of life.

Based on previous studies, in this study, we aimed to investigate the relationship between FoP and quality of sleep in patients with hematological malignancies. To the best of our knowledge, this is the first attempt to explore the mediating effect of resilience on FoP and sleep quality in this group of patients, providing a theoretical basis and practical reference for promoting quality of sleep in these patients from the perspective of FoP.

## MATERIALS AND METHODS

### Research participants

A cross-sectional design was used in this study. The research process is illustrated in Figure 1. One hundred patients with hematologic malignancies treated at the First Affiliated Hospital of Jinzhou Medical University between August 2022 and August 2023 were included in this study. The inclusion criteria were as follows: (1) Patients with hematological malignancies; (2) Age  $\geq 18$  years old; (3) Primary school or above education level, able to correctly communicate and answer the questions included in the tests; and (4) Awareness of their illness and willingness to cooperate with the study. The following exclusion criteria were applied: (1) Impairment of cognitive function or other psychiatric diseases; (2) Serious damage to vital organs such as the heart, brain, and kidneys; (3) Malignant tumors at other sites; and (4) Other primary sleep disorders such as sleep apnea syndrome.

### Research methods

**Patient data collection:** Data regarding sex, age, marital status, education level, average monthly family income, medical payment method, place of residence, occupation type, illness course, religious beliefs, and family history were collected.

**FoP Questionnaire-short Form:** This instrument was developed by Mehnert *et al*[17] and translated into Chinese by Cheng *et al*[18]. The questionnaire includes 12 items and two dimensions: Physical health (six items) and social family (six items) assessed on a 5-point Likert scale (1 = never and 5 = always). Cronbach's  $\alpha$  coefficient was 0.820. On a scale of 12-60 points, the score was correlated to the severity of fear.

**Connor-Davidson Resilience scale:** The scale was translated and revised into Chinese by Xie *et al*[19] and included three dimensions: Toughness respectively (13 items), optimism (4 items), and self-strengthening (8 items), with a total of 25 items assessed on a 5-point Likert scale (0 = "never" and 4 = "almost"). Cronbach's  $\alpha$  coefficient was 0.897 and Cronbach's  $\alpha$  coefficient for each table was 0.66-0.88. On a scale of 0-100 points, the higher the sum of the scores in each dimension, the stronger the mental resilience in patients.

**Pittsburgh Sleep Quality Index:** Buysse *et al*[8] evaluated sleep quality in hospitalized patients. Cronbach's  $\alpha$  coefficient for the table was 0.750. The scale comprises 18 items, categorized into seven dimensions including sleep efficiency, sleep disorders, sleep time, sleep quality, daytime dysfunction, and use of hypnotic drugs. Each table is scored on a 0-3 scale, with a total score of 0-21. Scores  $\geq 8$  indicate a sleep disorders. Cronbach's  $\alpha$  coefficient was 0.850.

### Statistical methods

IBM SPSS (version 26.0) was used to analyze the data. Measurement data are described as mean  $\pm$  SD, and counting data are described as component ratio (%). Spearman's rank correlation analysis was used to test the correlations between fear of disease progression, mental resilience, and sleep quality. The macro program Process in IBM SPSS 26.0 was applied to inspect the mediating effect between fear of disease progression, resilience, and sleep quality, and the bootstrap method was applied to verify the mediating effect between mental resilience and fear of disease progression and sleep quality. The test level was  $\alpha = 0.05$ , and a  $P$  value  $< 0.05$  was considered statistically significant.

## RESULTS

### Resilience, FoP, and sleep quality scores of patients

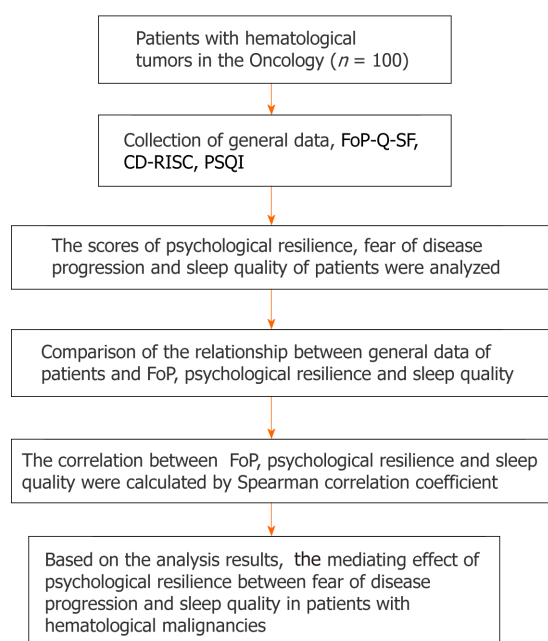
The total FoP score mean value in patients with hematologic malignancies was  $38.09 \pm 5.16$ . The total resilience score mean value was  $40.73 \pm 7.04$ . The total sleep quality score mean value was  $10.72 \pm 1.90$ . The scores for each scale are presented in Table 1.

### Relationship between general data and FoP, resilience, and sleep quality

Statistical analysis showed that the FoP, resilience, and sleep quality in patients with hematological malignancies were associated with per capita monthly household income and education level ( $P < 0.05$ ). The per capita monthly income of households and education level were inversely proportional to the FoP score and directly proportional to the resilience

**Table 1 Patient fear of progression, resilience, and sleep quality scores**

Project	Number of items	Rating range	Score
Fear of disease progression	12	12-60	38.09 ± 5.16
Physical health	6	6-30	19.56 ± 3.01
Social family	6	6-30	18.53 ± 4.06
Resilience	25	0-100	40.73 ± 7.04
Toughness	13	0-52	19.69 ± 5.45
Optimistic	4	0-16	6.33 ± 2.92
Self-strengthening	8	0-32	14.70 ± 3.60
Sleep quality	18	0-21	10.72 ± 1.90
Sleep efficiency	1	0-3	1.30 ± 0.90
Sleep disorders	9	0-3	2.36 ± 0.62
Sleeping time	2	0-3	2.52 ± 0.64
Sleep time	1	0-3	0.56 ± 0.37
Sleep quality	1	0-3	2.04 ± 0.77
Daytime dysfunction	3	0-3	1.26 ± 0.83
Use of hypnotic drugs	1	0-3	0.67 ± 0.56

**Figure 1 Flowchart of the research study process.** CD-RISC: Connor-Davidson Resilience scale; FoP: Fear of progression; FoP-Q-SF: Fear of Progression Questionnaire-short Form; PSQI: Pittsburgh Sleep Quality Index.

and sleep quality scores (Tables 2-4).

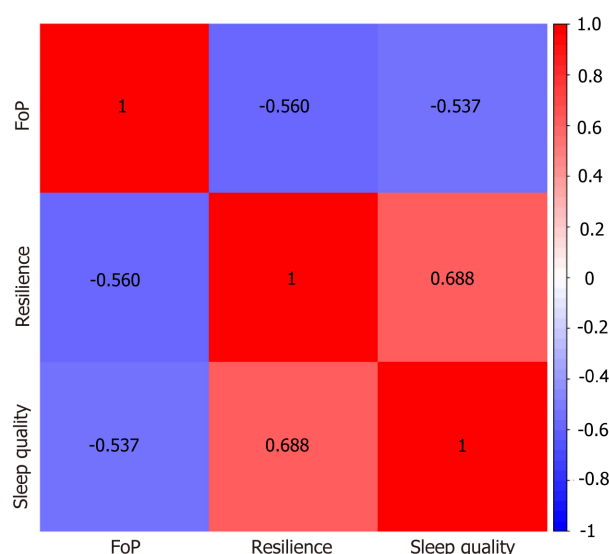
### Correlation analysis of patient FoP, resilience, and sleep quality

Spearman's correlation analysis was performed on the FoP, resilience, and sleep quality in patients with hematological malignancies, and the results revealed that FoP was negatively correlated with resilience and sleep quality scores ( $r = -0.560, -0.537, P < 0.01$ ). Resilience was significantly associated with sleep quality scores ( $r = 0.688, P < 0.01$ ) (Table 5 and Figure 2).

**Table 2 Relationship between general patient data and fear of progression**

Projects	Number, <i>n</i> (%)	Score	<i>t/F</i>	<i>P</i> value
Sex				
Male	49 (49)	36.46 ± 4.30	3.232	0.002
Female	51 (51)	39.65 ± 5.47		
Age (yr)				
≤ 35	34 (34)	38.69 ± 5.37	0.426	0.654
35-60	36 (36)	37.55 ± 3.83		
≥ 60	30 (30)	38.04 ± 6.30		
Marital status				
Married	27 (27)	37.09 ± 4.55	0.190	0.827
Unmarried	48 (48)	39.19 ± 5.55		
Divorce/widowhood	25 (25)	37.04 ± 4.74		
Family per capita monthly income (RMB)				
< 3000	32 (32)	41.71 ± 4.65	32.112	0.000
3000-5000	38 (38)	38.62 ± 3.27		
> 5000	30 (30)	33.54 ± 4.23		
Medical expenses payment method				
Medical insurance	46 (46)	37.54 ± 5.09	0.896	0.412
Agricultural insurance	51 (51)	38.39 ± 5.14		
Other	3 (3)	41.21 ± 7.24		
Educational level				
Junior high school and below	40 (40)	38.65 ± 4.75	3.189	0.046
High school/technical secondary school	41 (41)	38.76 ± 4.88		
College degree or above	19 (19)	35.45 ± 5.98		
Type of occupation				
Employment	46 (46)	37.10 ± 4.39	1.782	0.078
Unemployment	54 (54)	38.93 ± 5.65		
Type of residence				
Rural	34 (34)	39.08 ± 4.09	1.396	0.166
Town	66 (66)	37.57 ± 5.60		
Disease course				
Less than 2 yr	50 (50)	37.64 ± 5.08	-0.859	0.393
2 yr and above	50 (50)	38.53 ± 5.26		
Religious beliefs				
Yes	5 (5)	37.99 ± 5.60	-0.806	0.422
No	95 (95)	39.90 ± 5.15		
Family history				
Yes	16 (16)	38.79 ± 4.41	-0.594	0.554
No	84 (84)	37.95 ± 5.30		
Tumor type				
Leukemia	29 (29)	39.15 ± 6.07	1.068	0.366
Lymphoma	30 (30)	37.95 ± 3.79		

Multiple myeloma	21 (21)	36.54 ± 5.21
Myelodysplastic syndrome	20 (20)	38.38 ± 5.43



**Figure 2** Spearman correlation heat map. Darker colors indicate stronger correlations between the two indicators. FoP: Fear of progression.

### The mediating effect of resilience on FoP and sleep quality in patients with hematologic malignancies

Using the FoP in patients with hematological malignancies as an independent variable (X), resilience as a mediating variable (M), and sleep quality (Y) as a dependent variable, SPSS 26.0, Macro Process Model 4 was applied to analyze the mediating effect of resilience. Regression analysis indicated that the total effect value “c” of FoP on sleep quality was -0.539 ( $P < 0.05$ ). The regression coefficient “a” of FoP on resilience was -0.566 ( $P < 0.05$ ). The regression coefficient “b” of resilience on sleep quality was 0.481 ( $P < 0.05$ ). When resilience was added, the direct effect value “c’” of FoP on resilience was -0.267, which was still significant ( $P < 0.05$ ). These results suggest that resilience mediates the relationship between FoP and sleep quality in patients with hematological malignancies. The bootstrap method was used to further examine the mediating effects of resilience. The results showed that the mediating effect value was -0.100 (95% confidence interval: -0.139 to -0.068), indicating that the mediating effect of resilience was established and accounted for 50.51% of the total effect (Tables 6 and 7, Figure 3).

## DISCUSSION

Hematological malignancies are common; owing to characteristics such as acute onset, long treatment cycle, and high risk of recurrence, these tumors have a considerable physical and mental impact on patients. Optimizing the sleep quality in patients has recently attracted significant research attention. In this study, a cross-sectional analysis of 100 patients with hematologic malignancies in our hospital showed that FoP could affect patient sleep quality directly as well as indirectly through the mediating effect of resilience.

The purpose of this study was to improve our understanding of the mediating effect of resilience between FoP and sleep quality in patients with hematologic malignancies. This study utilized a cross-sectional design to ascertain the prevalence of blood cancers in certain populations, along with associated risk or protective factors. Cross-sectional designs are advantageous owing to their cost-efficiency and ease of implementation, enabling concurrent investigation into the progression of blood cancers, psychological resilience, and sleep quality. Nevertheless, the simultaneous data collection precludes direct demonstration of causality between variables or the observation of how these variables change over time. Consequently, in this study, we have advanced to using mediation effect analysis to assess the causal links among variables. Additionally, future studies should incorporate longitudinal research to better understand the dynamic interrelations among the variables.

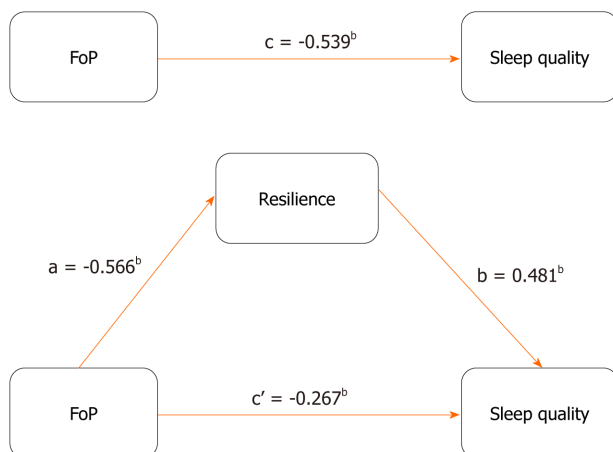
First, using general data and FoP Questionnaire-short Form, Connor-Davidson Resilience scale and Pittsburgh Sleep Quality Index surveys, we found that the total FoP score mean value in patients with hematological malignancies was  $38.09 \pm 5.16$ , which was slightly higher than that described by Zhang *et al*[20]. The total resilience score of  $40.73 \pm 7.04$  was consistent with the results reported by Greup *et al*[21] in a study on young patients with cancer. The total sleep quality score of  $10.72 \pm 1.90$  was similar to that reported by Fox *et al*[10] in a study on sleep quality in patients with cancer during chemotherapy[22]. Furthermore, the FoP, resilience, and sleep quality in patients were associated with per capita monthly family income and educational level, which was consistent with results of both domestic and international research[23-25]. Family per capita monthly income and education level are among the problems faced by patients with hematologic

**Table 3 Relationship between general patient data and patient resilience**

Projects	Number, <i>n</i> (%)	Score	<i>t/F</i>	<i>P</i> value
Sex				
Male	49 (49)	41.87 ± 7.08	-1.615	0.110
Female	51 (51)	39.62 ± 6.88		
Age (yr)				
≤ 35	34 (34)	41.94 ± 5.81	1.386	0.255
35-60	36 (36)	40.98 ± 6.73		
≥ 60	30 (30)	39.05 ± 8.44		
Marital status				
Married	27 (27)	40.82 ± 6.23	0.877	0.419
Unmarried	48 (48)	41.48 ± 7.28		
Divorce/widowhood	25 (25)	39.18 ± 7.40		
Family per capita monthly income (RMB)				
< 3000	32 (32)	33.56 ± 4.29	121.749	0.000
3000-5000	38 (38)	40.54 ± 2.96		
> 5000	30 (30)	48.60 ± 4.16		
Medical expenses payment method				
Medical insurance	46 (46)	43.30 ± 6.68	2.231	0.113
Agricultural insurance	51 (51)	39.45 ± 7.21		
Other	3 (3)	38.23 ± 5.98		
Educational level				
Junior high school and below	40 (40)	38.32 ± 7.23	7.744	0.001
High school/technical secondary school	41 (41)	40.84 ± 5.96		
College degree or above	19 (19)	45.55 ± 6.52		
Type of occupation				
Employment	46 (46)	41.68 ± 6.96	-1.25	0.214
Unemployment	54 (54)	39.92 ± 7.07		
Type of residence				
Rural	34 (34)	40.58 ± 7.31	-0.147	0.883
Towns	66 (66)	40.80 ± 6.95		
Disease course				
Less than 2 yr	50 (50)	40.92 ± 7.11	0.277	0.782
2 yr and above	50 (50)	40.53 ± 7.03		
Religious beliefs				
Yes	5 (5)	40.50 ± 3.59	0.073	0.942
No	95 (95)	40.74 ± 7.18		
Family history				
Yes	16 (16)	40.79 ± 7.21	0.192	0.848
No	84 (84)	40.42 ± 6.23		
Tumor type				
Leukemia	29 (29)	39.67 ± 6.71	0.841	0.475
Lymphoma	30 (30)	39.92 ± 7.50		



Multiple myeloma	21 (21)	41.90 ± 7.82
Myelodysplastic syndrome	20 (20)	42.23 ± 5.90



**Figure 3** Mediating effect of resilience between fear of progression and sleep quality. <sup>b</sup> $P < 0.01$ . FoP: Fear of progression.

tumors. Enhancing sleep quality necessitates a heightened focus on individual patient factors during the disease management process, encompassing aspects such as family income, educational attainment, and occupational stress levels.

Second, Spearman's correlation analysis demonstrated that the progression of fear of disease was negatively correlated with resilience and sleep quality scores ( $r = -0.560, -0.537, P < 0.01$ ), and resilience was significantly associated with sleep quality scores ( $r = 0.688, P < 0.01$ ). The reasons for these results may be as follows: The factors of FoP in patients with hematological malignancies mainly include persistent pain, fatigue, anxiety, and depression related to the disease itself and its treatment[26], which also affect sleep quality to varying degrees[27]. However, external factors played an important role in the degree of pressure affecting the patients in this study. These included concerns over practical problems caused by the disease, such as poor mental state and decreased physical function, family economic difficulties, lower career competitiveness after returning to work, and the possibility of cancer recurrence or metastasis. Decreased ability to regulate negative emotions[28,29]. Patients with poor mental resilience often immerse themselves in their own thoughts, which aggravates the production of negative emotions and affects their sleep quality. Therefore, fear of recurrence, resilience, and sleep quality in patients with cancer are correlated.

Finally, in the results of mediation analysis, we found that resilience played a mediating role between the FoP of disease and sleep quality. That is, FoP ( $c = -0.539, P < 0.05$ ) and resilience ( $b = 0.481, P < 0.05$ ) had predictive effects on quality of sleep in patients with hematological malignancies. In addition, the FoP of disease could indirectly predict sleep quality in patients with hematologic malignancies through resilience ( $c' = -0.267, P < 0.05$ ), with a mediating effect size of 50.51%. There are several explanations for these results. First, FoP has an important impact on sleep quality. Cancer is a major stressor and negative event in individuals. Patients are prone to negative emotions such as loneliness, meaninglessness, worthlessness, and guilt due to decreased physical function, changes in social roles, increased leisure time, and high treatment costs, leading to sleep disorders[30-32]. Moderate fear can be the driving force of self-health management among patients; however, excessive fear can further aggravate negative emotions and sleep disorders. Second, poor mental resilience aggravates sleep disorders. Patients with fear of the disease experience significant psychological pressure and are more prone to anxiety and depression. It is necessary to show positive emotions such as optimism, tenacity, and self-improvement, and take actions such as actively seeking external support to promote physical and mental health and alleviate negative emotions[33]. In contrast, patients with hematological malignancies with low psychological resilience are prone to social withdrawal, avoidance of social activities, and other escape behaviors when facing stressful events. Thus, these patients receive less social support and are more likely to breed negative emotions, such as pessimism and despair, which further aggravates the FoP and affects their sleep quality[34]. Among them, cognitive-behavioral therapy, meditation, stress management training, relaxation techniques, and adjustments in daily routines are effective to enhance patients' psychological resilience. Notably, family and social support for blood cancer patients are of utmost importance. A supportive social environment and peaceful, joyful family life often significantly boost patients' psychological resilience, which in turn improves their sleep quality and prognosis. Therefore, it is important that medical intervention targeting sleep disorders in patients with hematological malignancies strengthens their resilience. In clinical practice, clinicians should pay attention to the psychological status in patients, help them establish a strong, optimistic, and self-strengthening mentality, and reduce negative psychological problems. Furthermore, personalized intervention plans tailored to the specific needs of patients can more effectively enhance psychological resilience.



**Table 4 Relationship between general patient data and sleep quality**

Projects	Number, <i>n</i> (%)	Score	<i>t/F</i>	<i>P</i> value
Sex				
Male	49 (49)	10.87 ± 1.90	-0.762	0.448
Female	51 (51)	10.58 ± 1.99		
Age (yr)				
≤ 35	34 (34)	10.80 ± 1.68	0.248	0.781
35-60	36 (36)	10.82 ± 1.70		
≥ 60	30 (30)	1.52 ± 2.35		
Marital status				
Married	27 (27)	10.62 ± 1.74	0.599	0.551
Unmarried	48 (48)	10.93 ± 2.10		
Divorce/widowhood	25 (25)	10.44 ± 1.65		
Family per capita monthly income (RMB)				
< 3000	32 (32)	8.98 ± 1.23	58.580	0.000
3000-5000	38 (38)	10.76 ± 1.21		
> 5000	30 (30)	12.53 ± 1.44		
Medical expenses payment method				
Medical insurance	46 (46)	10.93 ± 1.83	0.558	0.574
Agricultural insurance	51 (51)	10.56 ± 1.91		
Other	3 (3)	10.24 ± 3.11		
Educational level				
Junior high school and below	40 (40)	10.13 ± 1.75	8.12	0.001
High school/technical secondary school	41 (41)	10.67 ± 1.70		
College degree or above	19 (19)	12.11 ± 1.98		
Type of occupation				
Employment	46 (46)	10.82 ± 1.64	-0.48	0.632
Unemployment	54 (54)	10.64 ± 2.10		
Type of residence				
Rural	34 (34)	10.36 ± 1.55	-1.388	0.168
Towns	66 (66)	10.91 ± 2.04		
Disease course				
Less than 2 yr	50 (50)	10.78 ± 1.79	0.292	0.771
2 yr and above	50 (50)	10.67 ± 2.01		
Religious beliefs				
Yes	5 (5)	11.21 ± 2.13	-0.586	0.559
No	95 (95)	10.70 ± 1.89		
Family history				
Yes	16 (16)	10.76 ± 1.91	0.509	0.612
No	84 (84)	10.50 ± 1.84		
Tumor type				
Leukemia	29 (29)	10.38 ± 1.98	0.890	0.449
Lymphoma	30 (30)	10.75 ± 1.80		

Multiple myeloma	21 (21)	11.26 ± 2.12
Myelodysplastic syndrome	20 (20)	10.63 ± 1.66

Table 5 Correlation analysis of fear of progression, resilience and sleep quality

Variables	FoP	Resilience	Sleep quality
Fear of progression	1		
Resilience	-0.560 <sup>a</sup>	1	
Sleep quality	-0.537 <sup>a</sup>	0.688 <sup>a</sup>	1

<sup>a</sup>*P* < 0.01.

Table 6 Regression analysis of the relationship between variables in the mediation model

Regression equation		Overall fitting index		Significance of regression coefficient	
Outcome variable	Predictor variable	<i>R</i> <sup>2</sup>	<i>F</i>	<i>b</i>	<i>t</i>
Sleep quality	FoP	0.284	40.208	-0.539	-6.341 <sup>a</sup>
Resilience	FoP	0.314	46.226	-0.566	-6.799 <sup>a</sup>
Sleep quality	FoP	0.437	39.361	-0.267	-2.920 <sup>a</sup>
	Resilience			0.481	5.254 <sup>a</sup>

<sup>a</sup>*P* < 0.01.

FoP: Fear of progression.

Table 7 Mediating effect of resilience between fear of progression and sleep quality

Effect relationship	Effect value	Standard error	95%CI		Proportion of effect (%)
			Lower limit	Upper limit	
Total effect	-0.198	0.031	-0.260	-0.136	100.00
Direct effect	-0.098	0.034	-0.165	-0.031	49.49
Indirect effect	-0.100	0.018	-0.139	-0.068	50.51

CI: Confidence interval.

This study has some limitations. First, owing to the limitations of manpower and material resources, this study only selected patients with hematological malignancies from one hospital; therefore, the sampling was not sufficiently comprehensive. Second, a questionnaire survey was used to measure the studied variables, and patient attitudes when completing these questionnaires may have affected the validity of the research results. Therefore, in future research, qualitative interviews should be conducted.

CONCLUSION

This cross-sectional investigation explored the mediating role of resilience on FoP and sleep quality in patients with hematological malignancies. Our results showed that sleep quality in patients was suboptimal. Further, FoP can directly affect sleep quality and play an indirect role through resilience, which may furnish treatment decisions for the intervention in patients with blood tumors who have FoP. Medical staff should focus on the progression of fear of disease and the level of resilience in patients with hematological malignancies, to implement effective measures to reduce excessive fear in patients, improve the effectiveness of disease management, and promote sleep quality.

## FOOTNOTES

**Author contributions:** Tian Y designed the questionnaire, conducted the statistical analysis of the data, and drafted the initial manuscript; Wang YL supervised and guided the study and revised the manuscript.

**Institutional review board statement:** This study was reviewed and approved by the First Affiliated Hospital of Jinzhou Medical University.

**Informed consent statement:** All study participants or their legal guardians provided written informed consent prior to study enrollment.

**Conflict-of-interest statement:** All the authors report no relevant conflicts of interest for this article.

**Data sharing statement:** Data used in this study were obtained from the corresponding author.

**STROBE statement:** The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

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**S-Editor:** Wang JJ

**L-Editor:** A

**P-Editor:** Zhang YL

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