

Article

Correlation between sleep quality and adverse reactions to chemotherapy, mental health status and quality of life in breast cancer patients undergoing chemotherapy

Fang Zhao^{1,†}, Yanjun Zhou^{2,†}, Huiyi Dong¹, Shanshan Zhu¹, Xinyun Li¹, Cheng Zeng¹, Enfeng Fu^{1,*}, Jiani Wang^{1,*}

¹ Department of Medical Oncology, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100021, China

² Department of Nursing, Beijing Children's Hospital, Capital Medical University, National Center for Children's Health, Beijing 100045, China

* **Corresponding authors:** Enfeng Fu, fef1024@163.com; Jiani Wang, wangjiani_edu@163.com

† These authors contributed equally to this work.

CITATION

Zhao F, Zhou Y, Dong H, et al.
Correlation between sleep quality and adverse reactions to chemotherapy, mental health status and quality of life in breast cancer patients undergoing chemotherapy. *Psycho-Oncologie*. 2025; 19(3): 4439.
<https://doi.org/10.18282/po4439>

ARTICLE INFO

Received: 24 April 2025

Revised: 20 May 2025

Accepted: 23 May 2025

Available online: 9 September 2025

COPYRIGHT



Copyright © 2025 by author(s).
Psycho-Oncologie is published by PiscoMed Publishing Pte. Ltd. This work is licensed under the Creative Commons Attribution (CC BY) license.
<https://creativecommons.org/licenses/by/4.0/>

Abstract: Objective: To analyze the correlation between sleep quality and adverse reactions to chemotherapy, mental health status, and quality of life in breast cancer patients undergoing chemotherapy. **Methods:** Two hundred and seventy-one eligible breast cancer patients undergoing chemotherapy in the Cancer Hospital of the Chinese Academy of Medical Sciences from January 2023 to December 2023 were selected as the study objects. Patients were assessed using the General Information Questionnaire, the Pittsburgh Sleep Quality Index (PSQI) scale, the Symptom Checklist 90 (SCL-90), the Symptom Measurement scale, and the Functional Assessment of Cancer Therapy-Breast (FACT-B) scale. Spearman correlation analysis was used to measure the correlation between sleep quality and adverse reactions to chemotherapy, mental health status, and quality of life in breast cancer patients undergoing chemotherapy. **Results:** The total incidence of grade I/II/III/IV adverse reactions in the sleep disorder group was higher compared to the normal sleep group (all $P < 0.05$). The sleep quality of patients with mild adverse reactions was better compared to patients with severe adverse reactions (all $P < 0.05$). The degree of adverse reactions was positively linked to the total PSQI score ($r = 0.531$, $P < 0.001$). The total PSQI score was positively correlated with the total SCL-90 score after chemotherapy, indicating that the worse the sleep quality was, the worse the mental health status of patients ($r = 0.513$, $P < 0.001$). The degree of adverse reactions to chemotherapy was positively correlated with the total SCL-90 score ($r = 0.542$, $P < 0.001$). After chemotherapy, the total FACT-B score and each status score in patients with sleep disorder were significantly lower compared to normal sleep patients (all $P < 0.05$). The total PSQI score was negatively correlated with the total FACT-B score after chemotherapy ($r = -0.679$, $P < 0.001$). The degree of adverse reactions to chemotherapy was negatively correlated with the total FACT-B score ($r = -0.762$, $P < 0.001$). The total SCL-90 score was negatively correlated with the total FACT-B score ($r = -0.567$, $P < 0.001$). **Conclusion:** Sleep disorders are common in breast cancer patients undergoing chemotherapy, which interacts with the degree of adverse reactions to chemotherapy, mental health, and quality of life.

Keywords: breast cancer; chemotherapy; sleep disorder; adverse reactions; mental health; quality of life

1. Introduction

Breast cancer (BC) is one of the most common malignant tumors in clinics [1]. In recent years, the incidence of BC has increased year by year and shows a trend of younger patients [2]. Chemotherapy is the cornerstone of BC treatment [3], which not

only improves the survival rate of BC patients but also has a certain impact on patients' physical and mental health [4]. In addition, patients lack a correct understanding of BC and are prone to negative emotions such as low mood, low self-esteem, and loss of confidence, which lead to poor medication compliance and strong adverse reactions, thereby reducing chemotherapy compliance and affecting treatment benefits [5]. Among them, sleep disorders are one of the symptoms that have plagued BC patients for a long time [6]. About 65% of BC patients have sleep disorders during the whole process of chemotherapy, and the level of sleep disorders changes dynamically over time, which makes patients feel uncomfortable, decreases physical strength and immunity, and affects the recovery of mental and physical state [7]. At present, there is no research report on the correlation between sleep quality and adverse reactions to chemotherapy, mental health status, and quality of life in BC patients undergoing chemotherapy. Moreover, because sleep disorders are easy to be ignored, coupled with the lack of knowledge of nurses themselves, imperfect nursing evaluation, inadequate health education, and unclear intervention measures, patients lack understanding and self-observation of sleep disorders, and nurses lack comprehensive whole-cycle management of such patients [8]. Therefore, this study aimed to assess the correlation between sleep quality and adverse reactions to chemotherapy in patients with BC chemotherapy, as well as the effects of adverse reactions to chemotherapy on sleep quality of patients after chemotherapy and sleep quality on patients' psychological state and quality of life, so as to provide clinical data reference for follow-up intervention of chemotherapy-related adverse reactions, improvement of sleep quality of BC patients, and maintenance of mental health status along with quality of life.

2. Data and methods

2.1. Study design and sample size calculation

A cross-sectional, convenience sampling method was adopted to process this study. The convenience sampling process was that the investigator asked and selected among eligible BC chemotherapy patients admitted to the Cancer Hospital of the Chinese Academy of Medical Sciences from January 2023 to December 2023. The sample size was estimated to be $n = 271$ using the Cochran formula ($\alpha = 0.05$, $d = 0.06$, $Z = 1.96$) [9]. Considering dropout probability, 300 questionnaires were distributed, of which 29 questionnaires were excluded from the study due to a high rate of missing values. Therefore, the effective response rate was 90.33%.

2.2. General data

A total of 271 eligible BC chemotherapy patients were admitted to the Cancer Hospital of the Chinese Academy of Medical Sciences from January 2023 to December 2023. This study was approved by the Ethics Committee of Cancer Hospital, Chinese Academy of Medical Sciences (Approval No. 22/272-3474). Inclusion criteria: (1) patients with postoperative pathological diagnosis of BC; (2) female; (3) age between 23 and 76 years old; (4) patients requiring adjuvant chemotherapy after surgery according to the 2022 NCCN guidelines; (5) no other treatment was received at the same time as adjuvant chemotherapy; (6) Karnofsky

Performance Status (KPS) score ≥ 2 points; (7) patients knew about the study and signed informed consent; (8) the patient's family members have good communication, understanding, and writing skills; Exclusion criteria: (1) male; (2) history of mental illness or past anti-anxiety or depression treatment; (3) history of drug dependence; (4) unable to complete the questionnaire after explanation and help from family members. Withdrawal criteria: (1) The subjects were unwilling to continue to take part in the study; (2) patients had a disease change or accident and cannot continue the study.

2.3. Grouping methods

According to the Pittsburgh Sleep Quality Index (PSQI), patients' sleep quality before chemotherapy was divided into the sleep disorder group ($n = 132$) and the normal sleep group ($n = 139$). Patients in the normal sleep group were stratified and compared based on the degree of chemotherapy adverse reactions. The severity of adverse reactions of BC patients after chemotherapy was evaluated based on the Common Terminology Criteria for Adverse Events (National Cancer Institute (NCI)) version 5.0 (CTCAE V5.0) [10], including Grade 0: no symptoms; Grade I: mild symptoms, only clinical or diagnostic findings, and no treatment required; Grade II: moderate symptoms, need for smaller, local or non-invasive treatments, and age-appropriate limitations in instrumental activities of daily living; Grade III: severe or medically important symptoms but not immediately life-threatening, leading to or prolonging hospitalization, disabling, and personal activities of daily living are limited; Grade IV: life-threatening and need for urgent treatment. Patients with grade I and II adverse reactions were classified as the mild group, and patients with grade III and IV were classified as the severe group.

2.4. Survey tools

The general information questionnaire was developed by the researchers themselves, containing gender, age, marital status, occupation, education, economic level, body mass index, and whether there are underlying diseases.

PSQI is mainly used to evaluate patients' subjective sleep quality [11], which is composed of 19 self-rated items as well as 5 other rated items, among which the 19th self-rated item along with 5 other rated items are not involved in the scoring. Therefore, 18 self-rated items were used in this paper, which together composed 7 components, including subjective sleep quality, waiting time before falling asleep, sleep duration, habitual sleep efficiency, sleep disturbance, sleeping pills, and daytime dysfunction. The total score ranged from 0 to 21, and the higher the score, the worse the sleep quality of the patient. At present, people with $PSQI \geq 5$ points are evaluated as having sleep disorders [12]. People with $PSQI < 5$ were evaluated as having normal sleep. Cronbach's α coefficient of this scale was 0.814, which had good reliability.

The Symptom Checklist 90 (SCL-90) includes 10 symptom factors [13], containing somatization, obsessive-compulsive symptoms, interpersonal sensitivity, depression, anxiety, hostility, terror, paranoia, and psychosis, as well as diet and sleep, which are scored on five levels, among which none = 1, mild = 2, moderate = 3, fairly severe = 4, and severe = 5. The total score ranged from 90 to 450 points. (1)

Somatization reflects the subjective feeling of physical discomfort; (2) obsessive-compulsive symptoms indicate a compulsion symptom group; (3) interpersonal sensitivity mainly means some people's sense of discomfort and inferiority, especially when compared with others more prominent; (4) depression mainly means the concept linked to clinically depressed symptom groups; (5) anxiety refers to the psychiatric symptoms and experiences that are clinically clearly associated with anxiety symptom groups; (6) hostility majorly reflects the hostile performance of the subjects from three aspects: emotion, behavior, and thinking; (7) terror: Much the same as traditional terror!; (8) paranoia reflects suspicion and relationship delusion; (9) psychosis reflects the symptoms of schizophrenia; (10) diet and sleep mainly reflect the diet and sleep of the subjects. SCL-90 was scored using a 5-level scoring system, and the evaluation time was now or within 1 week: (1) None: subjects felt that they had no such problem and were rated 1; (2) very mild: the subject consciously has this symptom but has no actual effect, or the effect is mild, which is recorded as 2 points; (3) moderate: subjects consciously have this symptom and have a certain impact, recorded as 3 points; (4) heavy: subjects consciously have this symptom and have a considerable degree of influence, recorded as 4 points; (5) serious: the subjects feel that the intensity and frequency of this symptom are very serious, and the impact is serious, which is recorded as 5 points. Cronbach's α coefficient ranged from 0.7026 to 0.9221, I-CVI ranged from 0.847 to 0.932, and S-CVI was 0.959.

The symptom assessment scale for adverse reactions in BC patients with chemotherapy adopted the Chinese version of the scale compiled by Wen Cuiju and Lu Qian et al., which has 26 items and adopts a 5-level scoring method, with 4 points as "very severe", 3 points as "severe", 2 points as "moderate", 1 point as "mild" and 0 points as "no". Cronbach's α coefficient of the scale was 0.818, retest reliability was 0.745, and the content validity index was 0.977.

Functional Assessment of Cancer Therapy-Breast (FACT-B) was developed by the Center for Outcome Research and Evaluation [14], which includes physical status dimension, social/family status dimension, emotional status dimension, functional status dimension, and additional attention dimension. The scale has a total score of 144, and the higher score represents a better quality of life. The total Cronbach α coefficient of the scale was 0.91.

2.5. Statistical method

SPSS 26.0 software was used to complete statistical processing. Counting data were exhibited as cases and percentages, and the Chi-square test was employed for comparison between groups. Measurement data were exhibited by mean $\pm$ standard deviation ($\bar{x} \pm s$), and a paired *T*-test was implemented for comparison between groups. Spearman correlation analysis was used to measure the correlation between sleep quality and adverse reactions to chemotherapy, mental health status, and quality of life in BC patients accepting chemotherapy. $P < 0.05$ was considered a significant difference, and $\alpha = 0.05$ was used as the test standard.

3. Results

3.1. General information of patients

As Table 1 displayed, no significant differences were seen in age, body mass index, menopausal condition, tumor site, whether to receive radiotherapy, whether to receive endocrinotherapy, pathological stage, and drug types between the 2 groups (all $P > 0.05$).

Table 1. General information of patients.

Items	Normal sleep group ($n = 139$)	Sleep disorder group ($n = 132$)	t/χ^2	P
Age ($\bar{x} \pm s$, years)	48.49 $\pm$ 10.43	50.48 $\pm$ 10.60	-1.527	0.128
BMI ($\bar{x} \pm s$, kg/m ²)	23.69 $\pm$ 3.18	23.78 $\pm$ 3.26	-0.213	0.832
Menopausal condition [Cases (%)]			5.928	0.052
Premenopause	7 (5.0)	8 (6.1)		
Yes	60 (43.2)	75 (56.8)		
No	72 (51.8)	49 (37.1)		
Tumor site [Cases (%)]			0.193	0.660
Left side	69 (49.6)	62 (48.5)		
Right side	70 (50.4)	70 (51.5)		
Radiotherapy [Cases (%)]			3.352	0.067
Yes	12 (8.6)	21 (15.9)		
No	127 (91.4)	111 (84.1)		
Endocrinotherapy [Cases (%)]			0.119	0.730
Yes	12 (8.6)	13 (9.8)		
No	127 (91.4)	119 (90.2)		
Pathological stage [Cases (%)]			0.400	0.940
Stage I	24 (17.3)	26 (19.7)		
Stage II	58 (41.7)	51 (38.6)		
Stage III	44 (31.7)	43 (32.6)		
Stage IV	13 (9.4)	12 (9.1)		
Drug type [Cases (%)]			3.814	0.282
Paclitaxel-containing drugs	124 (44.0)	114 (43.7)		
Anthracyclines-containing drugs	63 (22.3)	43 (16.5)		
Platinum-containing drugs	42 (14.9)	47 (18.0)		
Anti-HER2 targeted therapy-containing drugs	53 (18.8)	57 (21.8)		

3.2. Effects of sleep quality on adverse reactions to chemotherapy in patients before chemotherapy

According to PSQI ≥ 5 scores, 132 patients with low sleep quality before chemotherapy were taken as the sleep disorder group, and 139 patients with high sleep quality were taken as the normal sleep group. The total incidence of grade I/II/III/IV

Table 2. Effects of sleep quality on adverse reactions to chemotherapy in patients before chemotherapy.

Items	Normal sleep group (<i>n</i> = 139)						Sleep disorder group (<i>n</i> = 132)						χ^2	<i>P</i>
	Grade 0	Grade I	Grade II	Grade III	Grade IV	Total incidence rate	Grade 0	Grade I	Grade II	Grade III	Grade IV	Total incidence rate		
Nausea and vomiting	74	38	19	8	0	46.76%	53	32	34	13	0	59.85%	9.248	0.026
Fatigue	75	46	13	5	0	46.04%	56	45	12	13	6	57.58%	12.190	0.016
Numbness in hands/feet	82	37	18	2	0	41.01%	65	40	16	7	4	50.76%	9.576	0.048
Body pain	102	27	8	2	0	26.62%	69	38	18	7	0	47.73%	14.683	0.002
Oral mucositis	106	24	8	1	0	23.74%	84	26	17	5	0	36.36%	8.359	0.039
Bad mood	77	33	21	8	0	44.60%	50	33	36	12	1	62.12%	11.314	0.023
Alopecia	79	36	19	5	0	43.17%	60	31	28	13	0	54.55%	8.074	0.045
Diarrhea and constipation	104	23	10	2	0	25.18%	85	18	22	6	1	35.61%	9.846	0.043
Decreased sexual desire	116	16	5	2	0	16.55%	96	15	15	6	0	27.27%	8.744	0.033
Memory deterioration	98	26	12	3	0	29.50%	72	31	18	9	2	45.45%	10.441	0.034
Fever	118	15	4	2	0	15.11%	95	20	11	6	0	28.03%	8.289	0.040
Altered taste and decreased appetite	106	26	5	2	0	23.74%	89	22	13	8	0	32.58%	8.796	0.032
Difficulty concentrating	95	31	10	3	0	31.65%	73	29	21	8	1	44.70%	9.949	0.041

adverse reactions, including nausea and vomiting, fatigue, numbness in hands/feet, body pain, oral mucositis, bad mood, alopecia, diarrhea and constipation, decreased sexual desire, memory deterioration, fever, altered taste, decreased appetite, and difficulty concentrating in the sleep disorder group was higher compared to the normal sleep group (all $P < 0.05$, **Table 2**).

3.3. Influence of the degree of adverse reactions before chemotherapy on sleep quality

There were 139 patients with normal sleep quality before chemotherapy, and after chemotherapy, there were 88 patients with normal sleep quality and 51 patients had sleep disorders. According to the degree of chemotherapy adverse reactions, 0~1 degree was classified as the mild group, and 3~4 degrees was classified as the severe group. The results showed that the sleep quality of patients with mild adverse reactions was better than that of patients with severe adverse reactions (all $P < 0.05$, **Table 3**). Besides, the degree of adverse reactions was positively correlated with the total PSQI score ($r = 0.531$, $P < 0.001$, **Figure 1**).

Table 3. Influence of the degree of adverse reactions before chemotherapy on sleep quality.

Adverse reactions	Degree	Normal sleep	Sleep disorder	χ^2	P
Nausea and vomiting	Mild group ($n = 131$)	90 (68.70)	41 (31.30)	15.591	< 0.001
	Severe group ($n = 5$)	0 (0.00)	5 (100.00)		
Fatigue	Mild group ($n = 137$)	94 (68.61)	43 (31.39)	4.239	0.040
	Severe group ($n = 8$)	0 (0.00)	8 (100.00)		
Numbness in hands/feet	Mild group ($n = 134$)	82 (61.19)	52 (38.81)	7.461	0.006
	Severe group ($n = 2$)	0 (0.00)	2 (100.00)		
Body pain	Mild group ($n = 137$)	95 (69.34)	42 (30.66)	4.381	0.036
	Severe group ($n = 5$)	0 (0.00)	5 (100.00)		
Oral mucositis	Mild group ($n = 137$)	93 (67.88)	44 (32.12)	4.103	0.043
	Severe group ($n = 2$)	0 (0.00)	2 (100.00)		
Alopecia	Mild group ($n = 136$)	98 (72.06)	38 (27.94)	7.329	0.007
	Severe group ($n = 2$)	0 (0.00)	2 (100.00)		
Bad mood	Mild group ($n = 137$)	92 (67.15)	45 (32.85)	3.972	0.046
	Severe group ($n = 3$)	0 (0.00)	3 (100.00)		
Diarrhea and constipation	Mild group ($n = 137$)	99 (72.26)	38 (27.74)	5.022	0.025
	Severe group ($n = 2$)	0 (0.00)	2 (100.00)		
Decreased sexual desire	Mild group ($n = 138$)	112 (81.16)	26 (18.84)	4.178	0.041
	Severe group ($n = 2$)	0 (0.00)	3 (100.00)		
Memory deterioration	Mild group ($n = 137$)	97 (70.80)	40 (29.20)	4.686	0.030
	Severe group ($n = 1$)	0 (0.00)	1 (100.00)		
Fever	Mild group ($n = 131$)	75 (57.25)	56 (42.75)	9.948	0.002
	Severe group ($n = 2$)	0 (0.00)	2 (100.00)		
Altered taste and decreased appetite	Mild group ($n = 136$)	90 (66.18)	46 (33.82)	5.632	0.018
	Severe group ($n = 8$)	0 (0.00)	8 (100.00)		

Table 3. (Continued).

Adverse reactions	Degree	Normal sleep	Sleep disorder	χ^2	<i>P</i>
Difficulty concentrating	Mild group (<i>n</i> = 134)	85 (63.43)	49 (36.57)	8.164	0.004
	Severe group (<i>n</i> = 3)	0 (0.00)	3 (100.00)		

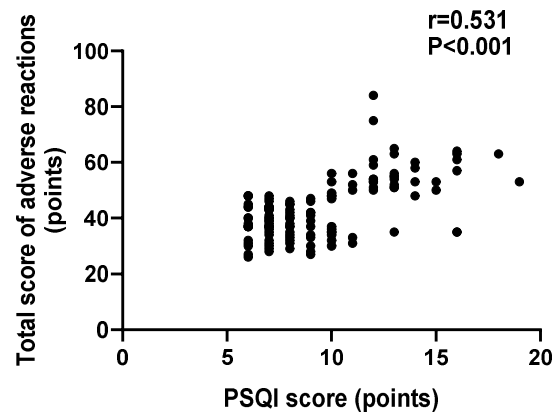


Figure 1. Spearman correlation analysis of the degree of adverse reactions and sleep quality.

3.4. Effect of sleep quality on mental health of patients after chemotherapy

The total PSQI score was positively correlated with the total SCL-90 score after chemotherapy ($r = 0.513$, $P < 0.001$, **Figure 2**).

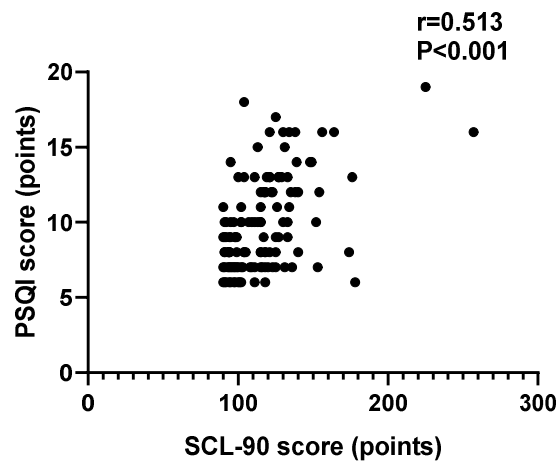


Figure 2. Spearman correlation analysis of sleep quality and mental health.

3.5. Effects of adverse reactions after chemotherapy on mental health of patients

The degree of adverse reactions to chemotherapy was positively correlated with the total SCL-90 score ($r = 0.542$, $P < 0.001$, **Figure 3**).

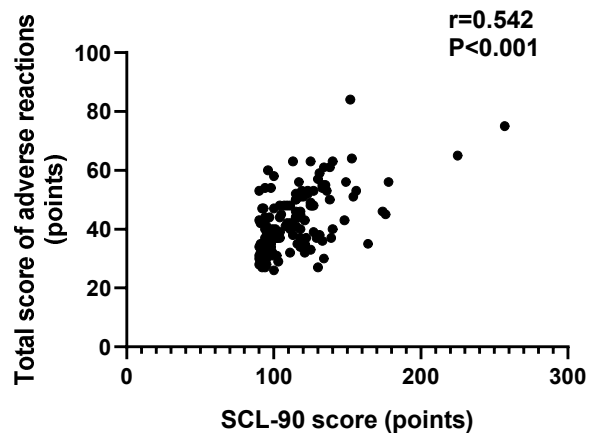


Figure 3. Spearman correlation analysis of the degree of adverse reactions and mental health.

3.6. Effect of sleep quality on patients' quality of life after chemotherapy

After chemotherapy, the total FACT-B score and each status score in patients with sleep disorder were significantly lower compared to normal sleep patients (all $P < 0.05$, **Table 4** and **Figure 4**). The total PSQI score was negatively correlated with the total FACT-B score after chemotherapy ($r = -0.679$, $P < 0.001$, **Figure 5**).

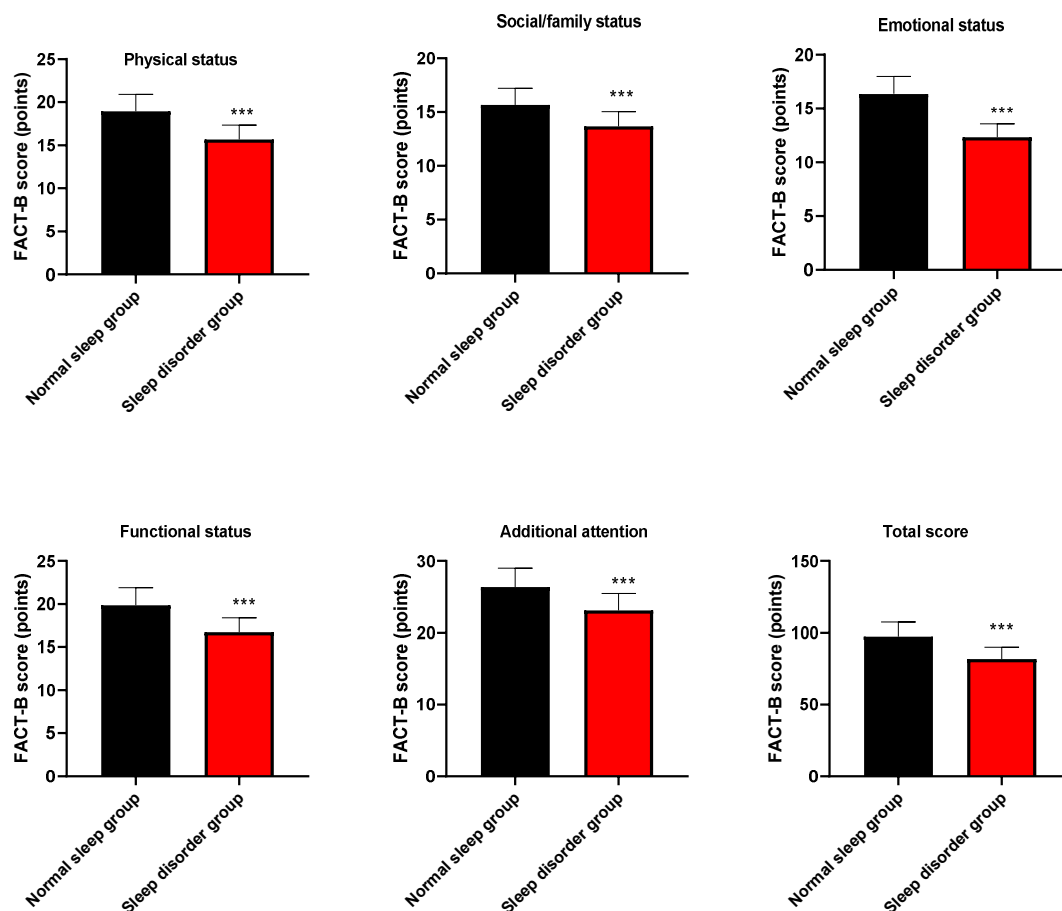


Figure 4. Total score of FACT-B and scores of status in patients with normal sleep and sleep disorder.

Notes: *** $P < 0.001$.

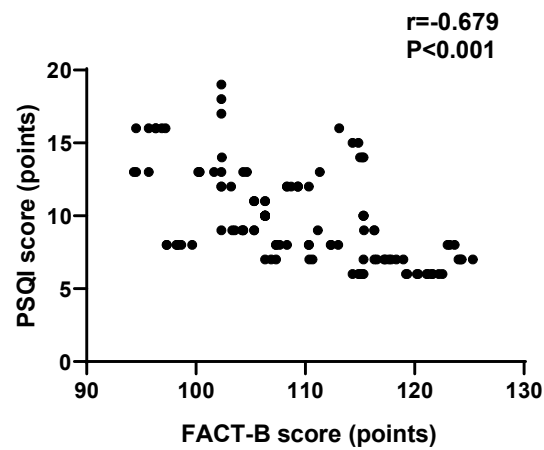


Figure 5. Spearman correlation analysis of sleep quality and quality of life.

Table 4. Effect of sleep quality on mental health of patients after chemotherapy.

Items	Normal sleep group (<i>n</i> = 88)	Sleep disorder group (<i>n</i> = 51)	<i>t</i>	<i>P</i>
Physical status	18.94 ± 1.96	15.67 ± 1.68	9.824	< 0.001
Social/family status	15.65 ± 1.57	13.67 ± 1.38	7.304	< 0.001
Emotional status	16.35 ± 1.64	12.32 ± 1.26	15.50	< 0.001
Functional status	19.85 ± 2.03	16.73 ± 1.68	9.258	< 0.001
Additional attention	26.35 ± 2.65	23.12 ± 2.35	7.018	< 0.001
Total score	97.14 ± 10.36	81.52 ± 8.32	9.255	< 0.001

3.7. Effects of adverse reactions after chemotherapy on patients' quality of life

Besides, the degree of adverse reactions to chemotherapy was negatively correlated with the total FACT-B score ($r = -0.762$, $P < 0.001$, **Figure 6**).

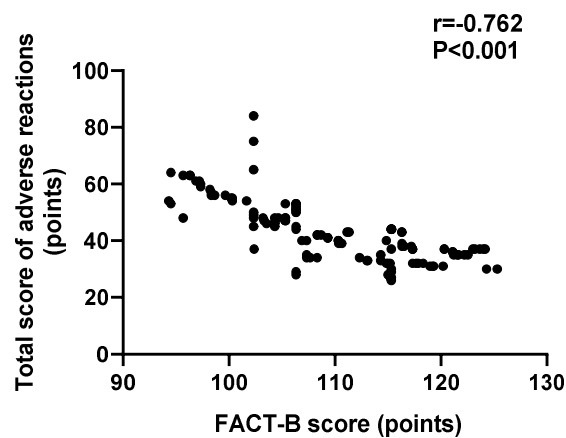


Figure 6. Spearman correlation analysis of the degree of adverse reactions and quality of life.

3.8. Correlation between mental health and quality of life

As **Figure 7** displayed, the total SCL-90 score was negatively correlated with the total FACT-B score ($r = -0.567$, $P < 0.001$).

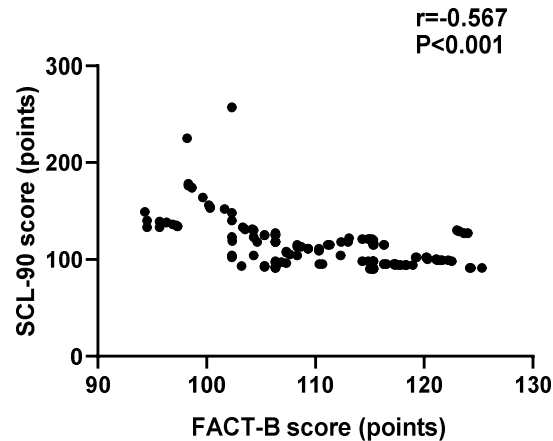


Figure 7. Spearman correlation analysis of mental health and quality of life.

4. Discussion

Chemotherapy is one of the important methods for the treatment of BC. However, due to the poor selectivity of chemotherapy drugs, while killing or inhibiting tumor cells, they will also damage normal cells of the body, causing various toxic side effects, such as nausea, vomiting, and alopecia [15]. Long-term accumulation of adverse reactions will lead to poor sleep quality of patients [16]. Moreover, chemotherapy patients are often accompanied by pain, negative emotions, economic burden, and other problems, which can lead to the occurrence and development of sleep disorders [17]. Poor sleep quality will aggravate the occurrence of adverse reactions to chemotherapy, and the two form a vicious cycle [18]. Reports have manifested that persistent sleep disorders are linked to increased complications and early mortality in BC patients [19]. Studies have shown that BC patients with sleep disorders prior to chemotherapy are more likely to have adverse reactions to chemotherapy [20].

In this paper, it was found that the incidence of grade I/II/III/IV adverse reactions after chemotherapy in patients with sleep disorders before chemotherapy was higher compared with patients with normal sleep. Besides, the sleep quality of patients with mild adverse reactions was better than that of patients with severe adverse reactions, and the degree of adverse reactions was positively correlated to the total PSQI score. The reason for this is thought to be the decrease of sleep disturbance before chemotherapy due to the patient's concern about the disease itself and the treatment method, which leads to physical discomfort, fatigue, decreased immunity, and reduced tolerance to toxic side effects after chemotherapy [21].

The results of this study revealed that after chemotherapy, the total PSQI score was positively correlated with the total SCL-90 score after chemotherapy, which was similar to the findings reported by Lu et al. [22]. The possible reason is that patients themselves are affected by the disease will produce considerable psychological

pressure, coupled with the accumulation of various adverse reactions during chemotherapy, resulting in the body's immune system, nervous system, endocrine system, and other functional disorders, thereby aggravating patients' fatigue, anxiety, depression, and other symptoms. These symptoms will in turn affect the quality of sleep; the two affect each other, forming a vicious circle [23].

The results of this study manifested that the degree of adverse reactions was positively correlated with the SCL-90 score. The reason for consideration is that mental health status will affect the treatment effect, quality of life, and immune system function of patients (including cellular immunity and humoral immunity), increase the risk of BC recurrence and metastasis, and even shorten the survival time and increase the cancer mortality [24].

The outcomes of this study pointed out that after chemotherapy, the total FACT-B score and each status score in patients with sleep disorder were lower compared to normal sleep patients, and the total PSQI score was negatively correlated with the total FACT-B score after chemotherapy. Sleep problems also plague cancer patients to varying degrees, affecting their quality of life. Sleep disorders may lead to chemotherapy patients feeling, thinking, and action disordered way, resulting in feelings of helplessness and inability to cope with cancer [25]. Gooneratne et al. investigated the sleep quality and quality of life of long-term lung cancer survivors, and the results displayed that for every 1 point increase in sleep disorder score, the quality of life of patients decreased by 0.11 points [26]. Dreidi and his colleague also showed that sleep disorders were negatively correlated with quality of life in cancer patients [27].

The results of this study presented that after chemotherapy, the degree of adverse reactions to chemotherapy was negatively correlated with the total FACT-B score. Previous studies have shown that it is very common for chemotherapy of cancer to cause psychological disorders or disorders in patients, and adverse psychological reactions can affect the physiological functions of patients through the neuro-immune regulatory mechanism and ultimately lead to the reduction of patients' quality of life [28]. Additionally, our study exhibited that the total SCL-90 score was negatively correlated with the total FACT-B score. Consistently, Zare et al. suggested that there was a negative correlation between quality of life and negative emotions [29].

Our study has limitations. First, our study is dependent on convenience sampling. Convenience sampling may introduce selection bias, as the sample may not be representative of the broader population of BC chemotherapy patients. Participants who are more accessible and more willing to participate may differ in important ways that affect the external validity of the study. In addition, the findings may not be generalizable to all patients, as the sample may not accurately reflect the diversity of the broader breast cancer chemotherapy patient population in terms of demographic and clinical characteristics. Finally, we should be cautious in extrapolating these findings to the larger population of BC chemotherapy patients, although the results provide valuable insights. A second limitation is the single-center design of this study. These limitations may affect the relevance of the results to the broader population. Third, the short duration of follow-up also limits the assessment of long-term efficacy. In addition, most of our findings were derived from self-reported questionnaires and lacked objectivity.

5. Conclusion

Sleep disorders are common in patients with BC chemotherapy, which interacts with the degree of adverse reactions to chemotherapy, mental health, and quality of life. In clinical nursing work, we should focus on the sleep quality of patients, actively analyze the reasons, take targeted sleep intervention measures, and improve the sleep quality of patients with BC chemotherapy so as to improve patients' quality of life.

Author contributions: Conceptualization, FZ and YZ; methodology, HD; software, SZ; validation, XL, CZ and EF; formal analysis, JW; investigation, FZ; resources, YZ; data curation, HD; writing—original draft preparation, SZ; writing—review and editing, XL; visualization, CZ; supervision, EF; project administration, JW; funding acquisition, FZ. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Nursing Cultivation project of Medical Oncology Key Foundation of Cancer Hospital Chinese Academy of Medical Sciences No. CICAMS-MONP2022001.

Ethical approval: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College on January 2023, and the approval number was BJ2023_0042L.

Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Conflict of interest: The authors declare no conflict of interest.

References

1. Barzaman K, Karami J, Zarei Z et al. Breast cancer: Biology, biomarkers, and treatments. *International Immunopharmacology*. 2020; 84: 106535.
2. Pedersen RN, Esen EÖ, Mellemkjar L, et al. The Incidence of Breast Cancer Recurrence 10–32 Years After Primary Diagnosis. *Journal of The National Cancer Institute*. 2022; 114(3): 391–399.
3. Shen SJ, Liu CM. Chemotherapy for early-stage breast cancer: the more the better? *Lancet*. 2023; 401(10384): 1243–1245.
4. Zhu SY, Yu KD. Breast Cancer Vaccines: Disappointing or Promising? *Frontiers in Immunology*. 2022; 13: 828386.
5. Cescon DW, Schmid P, Rugo HS, et al. Health-related quality of life with pembrolizumab plus chemotherapy vs placebo plus chemotherapy for advanced triple-negative breast cancer: KEYNOTE-355. *Journal of The National Cancer Institute*. 2024; 116(5): 717–727.
6. He X, Nam NGMS, Choi KC, et al. Effects of a 16-week dance intervention on the symptom cluster of fatigue-sleep disturbance-depression and quality of life among patients with breast cancer undergoing adjuvant chemotherapy: A randomized controlled trial. *International Journal of Nursing Studies*. 2022; 133: 104317.
7. Zhang J, Qin Z, So TM, et al. Acupuncture for chemotherapy-associated insomnia in breast cancer patients: an assessor-participant blinded, randomized, sham-controlled trial. *Breast Cancer Research*. 2023; 25(1): 49.
8. Fox RS, Ancoli-Israel S, Roesch S, et al. Sleep disturbance and cancer-related fatigue symptom cluster in breast cancer patients undergoing chemotherapy. *Supportive Care in Cancer*. 2020; 28(2): 845-855.
9. Dehghan M, Namjoo Z, Jafari M, et al. Iranian nurses' knowledge and attitude toward complementary and alternative medicines: Is there any relation with quality of nursing care? *Frontiers in Public Health*. 2022; 10: 942354.

10. Guo Q, Zhang H, Li X, et al. Risk Factors for Chemotherapy-Induced Peripheral Neuropathy Caused by Nanoparticle Albumin-Bound Paclitaxel in Advanced Breast Cancer. *BioMed Research International*. 2022; 2022: 9430952.
11. Zitser J, Allen IE, Falgàs N, et al. Pittsburgh Sleep Quality Index (PSQI) responses are modulated by total sleep time and wake after sleep onset in healthy older adults. *PLoS One*. 2022; 17(6): e0270095.
12. Rasche RV, Schuster F, Meurer N, et al. Influence of Parathyroidectomy on Sleep Quality in Primary Hyperparathyroidism. *Advances in Experimental Medicine and Biology*. 2021; 1335: 121–127.
13. Timman R, Arrindell WA. A very short Symptom Checklist-90-R version for routine outcome monitoring in psychotherapy; The SCL-3/7. *Acta Psychiatrica Scandinavica*. 2022; 145(4): 397–411.
14. Md Yusof K, Mahmud R, Abdullah M, et al. Cross-Cultural Adaptation of the Functional Assessment of Cancer Therapy-Breast (FACT-B) in Malaysian Breast Cancer Survivors. *Asian Pacific Journal of Cancer Prevention*. 2021; 22(4): 1055–1061.
15. Kerr AJ, Dodwell D, McGale P, et al. Adjuvant and neoadjuvant breast cancer treatments: A systematic review of their effects on mortality. *Cancer Treatment Reviews*. 2022; 105: 102375.
16. Elia C, de Girolamo L, Clarisse B, et al. Effects of sleep disturbances and circadian rhythms modifications on cognition in breast cancer women before and after adjuvant chemotherapy: the ICANSLEEP-1 protocol. *BMC Cancer*. 2023; 23(1): 1178.
17. Rémi J, Pollmächer T, Spiegelhalter K, et al. Sleep-Related Disorders in Neurology and Psychiatry. *Deutsches Arzteblatt International*. 2019; 116(41): 681–688.
18. van Hulst AM, Peersmann SHM, van den Akker ELT, et al. Risk factors for steroid-induced adverse psychological reactions and sleep problems in pediatric acute lymphoblastic leukemia: A systematic review. *Psychooncology*. 2021; 30(7): 1009–1028.
19. Mogavero MP, DelRosso LM, Fanfulla F, et al. Sleep disorders and cancer: State of the art and future perspectives. *Sleep Medicine Reviews*. 2021; 56: 101409.
20. Beck SL, Berger AM, Barsevick AM, et al. Sleep quality after initial chemotherapy for breast cancer. *Support Care Cancer*. 2010; 18(6): 679–689.
21. Liu Q, Wang C, Wang Y, et al. Mindfulness-based stress reduction with acupressure for sleep quality in breast cancer patients with insomnia undergoing chemotherapy: A randomized controlled trial. *European Journal of Oncology Nursing*. 2022; 61: 102219.
22. Lu IC, Jen MCY, Lei SM, et al. BSRS-5 (5-item Brief Symptom Rating Scale) scores affect every aspect of quality of life measured by WHOQOL-BREF in healthy workers. *Quality of Life Research*. 2011; 20(9): 1469–1475.
23. Alonzo R, Hussain J, Stranges S, et al. Interplay between social media use, sleep quality, and mental health in youth: A systematic review. *Sleep Medicine Reviews*. 2021; 56: 101414.
24. Richardson R, Dale S, Robertson L, et al. Mental Health First Aid as a tool for improving mental health and well-being. *Cochrane Database of Systematic Reviews*. 2023; 8(8): Cd013127.
25. Erickson JM, Beck SL, Christian BR, et al. Fatigue, sleep-wake disturbances, and quality of life in adolescents receiving chemotherapy. *Journal of Pediatric Hematology/Oncology*. 2011; 33(1): e17–25.
26. Gooneratne NS, Dean GE, Rogers AE, et al. Sleep and quality of life in long-term lung cancer survivors. *Lung Cancer*. 2007; 58(3): 403–410.
27. Dreidi MM, Hamdan-Mansour AM. Pain, Sleep Disturbance, and Quality of Life Among Palestinian Patients Diagnosed with Cancer. *Journal of Cancer Education*. 2016; 31(4): 796–803.
28. Prieto-Callejero B, Rivera F, Rivera JF, et al. Relationship between chemotherapy-induced adverse reactions and health-related quality of life in patients with breast cancer. *Medicine (Baltimore)*. 2020; 99(33): e21695.
29. Zare A, Jahromi BN, Eidy F, et al. The relationship between spiritual well-being, mental health, and quality of life in cancer patients receiving chemotherapy. *Journal of Family Medicine and Primary Care*. 2019; 8(5): 1701–1705.