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ORIGINAL ARTICLE

Sleep status of cervical cancer patients and predictors of poor sleep quality during adjuvant therapy

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Abstract
Purpose This study was designed to detect the prevalence of poor sleep quality in cervical cancer patients before and after adjuvant therapy, determine whether the prevalence of poor sleep quality in cervical cancer patients is higher than that in the general population, and analyze the factors associated with poor sleep quality.
Methods A total of 76 stages I and II cervical cancer patients and 116 female residents completed the Pittsburgh Sleep Quality Index (PSQI). Patient Neurotoxicity Questionnaire (PNQ), Distress Thermometer (DT), Multidimensional Fatigue Inventory, and Hospital Anxiety and Depression Scale were used to measure the patients' chemotherapy-induced peripheral neurotoxicity (CIPN), psychological distress, fatigue, anxiety, and depression. Data on social support and exercise were collected by the questionnaire. Logistic regression was used to identify the factors associated with poor sleep quality.
Results Prevalence rates of poor sleep quality were 27.59 % for female residents, 52.63 % for patients before adjuvant therapy, and 64.50 % for patients after adjuvant therapy. The distributions of the PSQI scores of the patients before ($Z=3.814$, $P<0.001$) and after ($Z=5.957$, $P<0.001$) adjuvant therapy were different from those of the residents. The difference in the PSQI scores before and after adjuvant therapy among cervical cancer patients was significant ($P=0.007$). The factors associated with poor sleep quality were high DT score ($P=0.045$), depression ($P=0.028$), anxiety ($P=0.027$), high PNQ grade ($P=0.016$), and chemotherapy+radiotherapy treatment ($P=0.017$). Exercise was a protective factor for poor sleep quality ($P=0.019$).
Conclusion The prevalence of poor sleep quality in stages I and II cervical cancer patients was approximately twice than that of women in the communities. Cancer treatment considerably affected sleep quality. Psychological distress, depression, anxiety, and high grade of CIPN during adjuvant therapy were factors associated with poor sleep quality. Exercise during adjuvant therapy could reduce the risk of poor sleep quality.

Keywords Sleep quality · Cervical cancer · Peripheral neurotoxicity · Depression · Anxiety · Exercise

Introduction

Cervical cancer is a common gynecologic malignancy in China. Approximately 130,000 cases of cervical cancer are discovered annually in this country [1], and its incidence rate ranks second among all gynecologic cancers [2]. Treatments for stages I and II cervical cancer patients include surgery combined with chemotherapy/radiotherapy [3]. Chemotherapy and radiotherapy can kill cancer cells, but can also produce side effects. Treatment-induced side effects, as well as worrying about the disease, lead to anxiety and depression [4], which affect patients' sleep quality [5, 6].

Sleep quality is an important factor that affects the quality of life (QOL) of both healthy and sick individuals [7]. Restless nights caused by sleep disorders can impair patients' immune systems, cognitive abilities, and abilities to perform daily functions [8]. Lack of sleep is associated with depression, anxiety, and decreased cognitive function [9].

Cancer and treatments pose great risk to patients to develop sleep disturbances [10]. Several studies have reported that

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cancer patients commonly experience sleep disturbances, such as difficulty in falling asleep and maintaining sleep, poor sleep efficiency, early awakening, and excessive daytime sleepiness [11, 12] and that 30 to 88 % of cancer patients are affected by sleep disturbances [13]. Treatment-induced side effects, such as pain, fatigue, anxiety, and depression, often affect patients' sleep quality [14] and may even cause patients to suffer from sleep disturbances [15].

Sleep problems are also important for cervical cancer patients [16]. Given that hysterectomy- and radiotherapy-induced urodynamic alterations (reduced storage, bladder emptying capacity, and urinary incontinence) [17], cervical cancer patients are more likely to have poor sleep quality [17, 18]. Cervical cancer patients often suffer high distress at the time of diagnosis and during treatment [20] because they are subject to a wide range of problems (loss of fertility, early menopause, sexual disharmony, and poor living conditions) [19]. During treatment, chemotherapy-induced peripheral neurotoxicity (CIPN) can make the patients in pain and sensory discomfort [21], and restricted activities during the day and reduced exposure to natural illumination can result in changes in the regularity of the human organism's rhythms [22]. Therefore, these phenomena potentially place cervical cancer patients at elevated risk for sleep disturbance. However, few studies have investigated the prevalence of and risk factors for poor sleep in cervical cancer patients during cancer treatments. Therefore, this study was designed to (1) detect the prevalence of self-reported poor sleep quality in cervical cancer patients prior to and after adjuvant therapy, (2) determine whether the prevalence of poor sleep quality in cervical cancer patients is higher than that in the general population, and (3) analyze what factors confer increased risk for poor sleep quality in cervical cancer patients after adjuvant therapy.

Materials and methods

Participants

Two samples were included in this study. The first sample comprised cervical cancer patients (patient sample). To evaluate the effect of disease and treatments on sleep quality in cervical cancer patients, we randomly selected female residents from two communities in Fuzhou City, China. These female residents comprised the second sample (resident sample).

The present study was approved by relevant institutional review boards for human research of Fujian Medical University.

Resident sample

The sample consisted of randomly selected women in two communities in Fuzhou City, which were selected using a two-stage cluster sampling method. In the first stage, we used the random digits to select two districts (Taijiang District and Gulou District) from the four districts in Fuzhou city, and then, we randomly selected two communities from Taijiang District and Gulou District by using cluster sampling. In the second stage, we used the simple random sampling to select 152 eligible women in these two communities. The inclusion criteria were as follows: (1) 20 to 70 years of age, (2) literate, (3) without cancer, and (4) without mental or psychological disease. For 152 eligible women, the health care workers in the communities introduced the research content to them. After obtaining their written informed consent, health care workers asked them to complete a self-administered questionnaire. Data on their sleep qualities in the past week were obtained.

Patient sample

Study participants were stages I and II cervical cancer patients who were diagnosed and treated at four provincial hospitals in Fuzhou between January 2013 and December 2013. Eligible patients were (1) more than 20-day post-operative, (2) without mental or psychological disease history, (3) aged 20 to 70 years, and (4) literate. Only eligible patients receiving adjuvant chemotherapy or adjuvant chemotherapy+radiotherapy were included. Patients with a history of sleep disorders prior to cancer diagnosis were excluded.

There were 76 patients who met our inclusion criteria. All of them provided written informed consent and completed two times of measurement of sleep quality.

Data of each patient were collected before and after adjuvant therapy. On the day before the start of adjuvant therapy, the patient's sleep quality in the past week was measured by trained graduate students from Fujian Medical University. The second measurement of sleep quality was on the day of the end of adjuvant therapy cycle. Besides sleep quality, at the end of adjuvant therapy, the patient's chemotherapy-induced peripheral neurotoxicity (CIPN), psychological distress, fatigue, anxiety, and depression were also measured by trained graduate students. In addition, patient's social support and exercise status during treatment were investigated. The patient's treatment plans were provided by the attending doctor.

Measures

The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality of the participants [23]. It is a self-administered questionnaire, and it assesses sleep quality of an individual in the past week. The PSQI is a valid and reliable tool that measures sleep quality and quantity. It consists of 19 self-rated questions that include seven component scores or subscales: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Global scores ranging from 0 to 21 can be obtained from the sum of the seven components, and higher scores denote poorer sleep quality. The original authors of this index identified a cutoff of >5 in global scores to distinguish poor sleepers (>5) from good sleepers (≤5) [23]. In this study, the patient's sleep status was considered of poor quality when her PSQI score was >5.

The Patient Neurotoxicity Questionnaire (PNQ) was used to quantify the symptoms and severity of CIPN [24] at the end of adjuvant therapy. The PNQ is a self-administered questionnaire that comprises two items: (1) "Do you have numbness, pain, or tingling in your hands or feet?" and (2) "Do you have weakness in your arms or legs?" A 1 to 5 numerical rating scale was used as follows: 1, none; 2, mild; 3, moderate; 4, moderate to severe; and 5, severe. The CIPN of each patient was assessed by adding the scores of these two items, and the final score was called the PNQ total score. The PNQ total score ranged from 2 to 10, with a high total score indicating severe CIPN symptoms. The PNQ total scores were defined as follows: grade A, 2; grade B, 3 to 4; grade C, 5 to 6; grade D, 7 to 8; and grade E, 9 to 10 [25]. The validity of the PNQ has been confirmed in numerous studies [25, 26].

The Distress Thermometer (DT) recommended by the National Comprehensive Cancer Network [27] was used to measure the levels of psychological distress of participants at the end of adjuvant therapy. It is a visual analog scale through which participants rate their level of distress over the last 7 days from 0 (none) to 10 (extreme). A high DT score indicates severe distress. Some studies have determined that a cutoff score of ≥4 indicates distress [28, 29]. The validity of the Chinese version of the DT has been confirmed in a previous study [30].

The Hospital Anxiety and Depression Scale (HADS) [31] is a 14-item (seven each for the anxiety and depression subscales) questionnaire used to evaluate the anxiety and depression of patients at the end of adjuvant therapy. Scores for each item ranged from 0 to 3, and patients scored the items based on their current situation. Scores for both the anxiety and depression subscales ranged from 0 to 21, as follows: 0 to 7, asymptomatic status; 8 to 10, suspicious symptoms; and 11 to 21, certainly existing symptoms [31]. The Chinese version of the HADS has been confirmed to be suitable for Chinese patients [32]. In the current study, a patient with depression and anxiety subscale scores >11 was considered to be depressed and anxious, respectively.

The Multidimensional Fatigue Inventory (MFI-20) developed by a Dutch research group [33] measures fatigue of participants at the end of adjuvant therapy. MFI-20, a standardized measure to assess fatigue, comprises 20 items that include general fatigue, physical fatigue, mental fatigue, reduced activity, and reduced motivation. Each item was scored from 1 (true) to 4 (not true) by patients based on their current situation. The total score of MFI-20 ranged from 20 to 80. The MFI-20 score indicates the degree of fatigue of an individual. A high total score indicated serious fatigue. We confirmed in our previous study that the Chinese version of MFI-20 is a reliable and valid instrument for assessing fatigue and can effectively measure the physical and mental fatigue of cancer patients in China [34].

The Chinese Social Support Questionnaire (CSSQ) [35] measures the social support of participants during treatment. It is a 10-item questionnaire that assesses objective support, subjective support, and exploitation degree of social support. Each item was scored from 1 to 4 by patients based on their current situation. The total score of CSSQ ranged from 14 to 52. A high total score indicated good social support. CSSQ has been widely used to measure the level of social support in China [36–38]. The previous studies have confirmed that the CSSQ is a reliable and valid instrument for assessing social support and can effectively measure objective support, subjective support, and exploitation degree of social support in general population in China [39, 40]. The validity and reliability of the CSSQ were 0.835 and 0.896, respectively [40].

The exercise status of the patient during treatment was measured by two items: (a) "In the last week, how many times did you walk or performed other activities? (1 to 4 numerical rating scale: 1=none, 2=less than three times, 3=more than four times, and 4=every day)," and (b) "In the last week, how long did you walk or perform other activities? (1 to 5 numerical rating scale: 1=none, 2=less than 10 min, 3=10 min to 20 min, 4=30 min to 40 min, and 5=more than 40 min)." Patients were considered to have exercised if scores of >2 and >4 were given for items (a) and (b), respectively.

Statistical analysis

The levels of poor sleep quality among residents and cervical cancer patients were represented in percentages and 95 % confidence intervals (CIs). χ^2 test and Wilcoxon rank sum test were used to compare sleep quality between residents and cervical cancer patients. Paired sample *t* test and Wilcoxon signed-rank test were performed to determine the effect of adjuvant therapy on sleep quality of the patients. Logistic regression was applied to analyze the factors associated with poor sleep quality during adjuvant therapy. The significance level was 0.05.

Results

The initial sample was consisted of 152 eligible residents. Thirty-six residents (23.68 %) did not complete PSQI (all of them were under 35 years of age). Therefore, a total of 116 women with a mean age of 49.03 years (standard deviation (SD)=12.71) were included in the resident samples. The education levels of the participants were as follows: primary school, 40.52 %; middle school, 19.83 %; high school, 17.24 %; and college, 22.41 %.

A total of 76 participants with a mean age of 48.43 years (SD=16.72) were included in the patient samples. The mean time after surgery was 20.8 days (range, 20–23). The education levels of the participants were as follows: primary school, 40.75 %; middle school, 21.05 %; high school, 17.10 %; and college, 21.10 %. Among the cancer patients, 34 (44.74 %) and 42 (55.26 %) patients were in stages I and II, respectively. Moreover, 39 (51.32 %) patients received surgery combined with chemotherapy (3 weeks of chemotherapy after surgery) and 37 (48.68 %) patients received surgery combined with chemotherapy and radiotherapy (5 weeks of chemotherapy and radiotherapy after surgery).

The age and education level distribution of the resident sample was similar to that of the cancer patient sample ($P=0.117$ for age distribution and $P=0.995$ for education level).

Sleep quality

In the resident sample, the distribution of the PSQI score was skewed (skewness=0.833 and kurtosis=0.805), and the median (inter-quartile range (IQR)) of the PSQI score was 4.2 (4.2). The prevalence of poor sleep quality was 27.59 % (32/116).

In the patient sample, the distributions of the PSQI score were also skewed (skewness=0.983 and kurtosis=0.817 before adjuvant therapy and skewness=0.859 and kurtosis=−0.066 after adjuvant therapy). Before adjuvant therapy, the median (IQR) of the PSQI score was 5.6 (2.8), and the prevalence of poor sleep quality was 52.63 % (40/76). After adjuvant therapy, the median (IQR) of the PSQI score was 7.0 (7.0), and the prevalence of poor sleep quality was 64.50 % (49/76).

Comparison of sleep qualities between residents and patients

Table 1 shows the distributions of the PSQI score for the two samples. The Wilcoxon rank sum tests showed that the distribution of the PSQI score of the patients before ($Z=3.814$, $P<0.001$) and after ($Z=5.957$, $P<0.001$) adjuvant therapy was different from that of the residents. Table 2 shows the prevalence rates and their 95 % CIs of poor sleep quality. The discrepancy in the prevalence rates of poor sleep quality between patients before adjuvant therapy and residents was statistically significant ($\chi^2=12.289$, $P<0.001$), and the discrepancy in the prevalence rates of poor sleep quality between patients after adjuvant therapy and residents was statistically significant ($\chi^2=25.617$, $P<0.001$). These results suggest that whether before or after adjuvant therapy, the sleep quality of the cervical cancer patients was worse than that of the general population.

Table 1 Comparison of PSQI score distributions between residents and cervical cancer patients

PSQI score	Residents		Patients			
			Before treatment		After treatment	
	n	%	*n*	%	*n*	%
0–4	84	72.41	36	47.37	27	35.53
5–9	32	27.59	33	43.42	27	35.53
10–14	0	0.00	7	9.21	10	13.16
15–19	0	0.00	0	0.00	9	11.84
20–21	0	0.00	0	0.00	3	3.95
Total	116	100.00	76	100.00	76	100.00
			$P=0.000^a$		$P=0.000^b$	

[a] *P* value for the comparison of PSQI score distributions between residents and patients before treatment

[b] *P* value for the comparison of PSQI score distributions between residents and patients after treatment

Comparison of sleep qualities during and after treatment

For each patient, the PSQI score difference before and after adjuvant therapy was obtained by the PSQI score after adjuvant therapy minus the PSQI score before adjuvant therapy. A total of 47 (61.84 %) patients had a positive difference in the PSQI scores, 27 (35.53 %) patients had a negative difference in the PSQI scores, and two (2.63 %) patients had no difference in the PSQI scores. Patients with a positive difference of the PSQI score experienced worse sleep quality at the end of adjuvant therapy than before adjuvant therapy. A total of 22 patients who underwent surgery combined with chemotherapy and 25 patients who underwent surgery combined with chemotherapy and radiotherapy showed a positive difference in the PSQI scores. All patients with a negative difference in the PSQI scores underwent surgery combined with chemotherapy.

The mean (SD) and median (IQR) of the PSQI score difference before and after adjuvant therapy were 2.13 (5.88) and 2.80 (7.45), respectively (Table 3). Table 3 shows that paired sample *t* test resulted in $P=0.002$ and Wilcoxon signed-rank test resulted in $P=0.007$, which suggests that adjuvant therapy significantly affects the sleep quality of cervical cancer patients.

The factor associated with poor sleep quality

Multivariate logistic regression was used to analyze the factors associated with poor sleep quality after adjuvant therapy. The factors analyzed in the logistic model were age, education level, PNQ grade (1, 2, 3, 4, or 5), social support, fatigue, DT score (0<4, 1≥4), exercise (0, no; 1, yes), depression (0, no; 1, yes), anxiety (0, no; 1, yes), and treatment (0, surgery+

Table 2 Prevalence rates of poor sleep quality between residents and cervical cancer patients

	Number	PSQI score ≤5	PSQI score >5	Prevalence (%)	95 % CI[a]	*P* value[b]
Resident	116	84	32	27.59	19.46–35.72	
Patient						
Before treatment	76	36	40	52.63	41.40–63.85	0.000
After treatment	76	27	49	64.47	53.71–75.23	0.000

[a] 95% confidence interval for prevalence of poor sleep quality

[b] *P* value for χ^2 test used to examine the discrepancy of prevalence rates of poor sleep quality between patients and residents

chemotherapy; 1, surgery+radiotherapy+chemotherapy). We used the stepwise method to detect the factors associated with poor sleep quality. The results are shown in Table 4. At $\alpha=0.05$ significance level, the factors associated with poor sleep quality after adjuvant therapy were high DT score ($P=0.045$), depression ($P=0.028$), anxiety ($P=0.027$), high PNQ grade ($P=0.016$), and chemotherapy+radiotherapy treatment ($P=0.017$). Exercise was a protective factor for poor sleep quality ($P=0.019$), and odds ratio (*OR*) of poor sleep quality was 0.155 (95 % CI 0.032–0.737).

Discussion

Our findings suggested that sleep qualities of stages I and II cervical cancer patients were worse than those of women in communities. Cancer treatments significant affect the patients' sleep quality. The treatment (chemotherapy-induced CIPN and chemotherapy combined with radiotherapy) and psychological factors (distress, anxiety, and depression) were the main factors associated with poor sleep quality, whereas performing exercise during adjuvant therapy helped reduce the risk of poor sleep quality in patients.

Sleep disturbance is common among cancer patients [6, 22]. The incidence of sleep disturbance in cancer patients ranges from 30 to 75 % [22, 41]. The rates of sleep disturbance in cancer patients have been suggested to be higher than those of the general population [41–43]. Our results also confirmed these points. The prevalence of poor sleep quality before and after treatment was 52.63 % and 64.47 %, respectively, whereas that of female residents with ages similar to the cancer patients was 27.59 %. Prevalence of poor sleep quality in stages I and II cervical cancer patients was approximately twice than that of the women in the communities. The high prevalence of sleep disorder in cancer patients is due to the symptoms associated with the disease or cancer treatment [44], psychological distress caused by the diseases [45, 46], and hospitalization and as well as other changes in the sleep place [22].

Our results suggested that sleep qualities of cervical cancer patients before and after adjuvant therapy were different, which was consistent with some reports [5, 46–49]. Chemotherapy and radiotherapy are associated with significantly poorer sleep quality [5, 44, 47]. Tumor and antitumor treatments both increase the production of pro-inflammatory cytokines, which in turn act on the central nervous system and alter rest–activity rhythms and negatively affect sleep [47, 48]. Cervical cancer patients are more likely to have poor sleep quality because of radiotherapy-induced urodynamic alterations and cystitis [17, 18]. In addition, restricted activities during the day and reduced exposure to natural illumination can result in changes in the regularity of the human organism's rhythms, which can negatively affect nocturnal sleep quality [9, 49]. The effect of cancer treatments on sleep quality should not be ignored. During treatment, patients' sleep quality should be promptly assessed to obtain symptomatic interventions and nursing.

In this study, we detected the effect of CIPN on poor sleep quality. CIPN is a complication of the use of chemotherapeutic drugs that results in nerve damage [50]. It is associated with pain, sensory discomfort, disrupted sleep, and fatigue [51]. Previous studies have reported that higher degrees of sleep disturbance are associated with more severe CIPN [51, 52].

Table 3 Descriptive statistics for the PSQI score difference before and after treatment by treatment plan

PSQI score difference	Chemotherapy (*n*=39)	Chemotherapy+radiotherapy (*n* =37)	Total (*n*=76)	*P* value
Mean±SD	0.68±4.96	3.66±6.44	2.13±5.88	0.002[a]
Median±IQR	1.4±5.6	2.8±8.4	2.80±7.45	0.007[b]

[a] *P* value obtained by the paired sample *t* test (null hypothesis: mean=0)

[b] *P* value obtained by the Wilcoxon signed-rank test (null hypothesis: median=0)

Table 4 Results of multivariate logistic regression

Factor	B	S.E.	*P* value	OR
DT	1.379	0.702	0.045	3.971
PNQ	0.891	0.372	0.016	2.438
Exercise	−1.865	0.796	0.019	0.155
Depression	2.534	1.131	0.028	12.604
Anxiety	1.589	0.719	0.027	4.899
Treatment	2.669	1.095	0.017	14.426

Data used in logistic regression analysis was obtained at the end of adjuvant therapy

However, literature on the association between neuropathy and psychological distress and sleep quality is scarce.

Many studies have shown that anxiety and depression are highly correlated with sleep disturbance [11, 53–55]. In a prospective longitudinal study, by examining contributions of depression and anxiety in sleep disturbance during the first year after diagnosis among ovarian cancer patients, studies have suggested that higher incidence in depression and anxiety are associated with increased disturbances in sleep quality over time [54]. In another study that assessed the risk factors for insomnia in stage I breast cancer patients, only women with clinically significant depression have an increased risk for developing insomnia symptoms [55]. In a case–control study, researchers have found that breast cancer patients possess higher levels of depression, anxiety, and sleep difficulties than healthy controls [56]. Depression and anxiety also correlate with insomnia among heterogeneous cancer populations and general population, with low mood predisposing an individual to develop insomnia [11]. Bardwell [58] and Palesh [57] showed that depression is a significant predictor of insomnia and sleep disturbances. Consistent with investigations, depression and anxiety were independent risk factors for poor sleep quality in stages I and II cervical cancer patients. Careful screening for depression and anxiety in cervical cancer patients during adjuvant therapy is necessary given that effective counseling and medication therapies are available.

Exercise can improve sleep problems in the general population [58]. Physical exercise, such as walking, can provide benefits for cancer patients and survivors, including improvements in sleep [59–63]. In a study for breast cancer survivors, the participants' sleep quality improved after a 12-week moderate walking intervention [60]. In a non-randomized study [61], researchers have assessed the effects of walking exercise intervention on sleep and cancer-related fatigue in breast cancer patients who were undergoing radiation treatments. The findings suggested that exercise intervention result in improved sleep outcomes, such as reduced difficulty in sleeping, as well as improved physical function, fatigue, and anxiety. Wang [62] showed that a low-to-moderate intensity walking program (3 to 5 days a week, 30 to 50 min a day for 6 weeks) improves sleep disturbance in women with stage I or II breast cancer. Tang [63] also showed that brisk walking (3 days/week, 30 min/day for 8 weeks) resulted in improvement in sleep quality and QOL in cancer patients. Our results also confirmed the function of exercise in improving sleep quality. The patients who walked 4 days/week and 40 min/day during treatment had a lower risk of poor sleep quality than those who did not exercise. Walking is safe and provides many benefits for cancer patients [64], so clinical staff should guide patients to exercise during treatment, regardless of the presence or absence of sleep disorders.

The limitations of our study must be mentioned. The assessments of sleep quality in our study were carried out by a different set of interviewers (graduate students for the patients and health care workers in the communities for the residents). The difference in investigation skill may exist between graduate students and the health care workers, which may increase the differences in sleep quality between patients and residents. However, PSQI is a self- administered scale, and the participants fill out PSQI by themselves. In addition, in order to reduce the confounding from the investigators, we have trained both the graduate students and the health care workers before the start of the investigation. Therefore, the differences in investigators may have a small impact on sleep measurement. Another limitation in our study was the cross-sectional nature of the multivariate analyses. Because anxiety and depression only described the psychological status of the cervical cancer patients at one time point, causal relationship between anxiety/depression and poor sleep quality cannot be determined. That is, the high levels of anxiety and depression may be the results of poor sleep quality rather than the cause. A more methodologically sound approach would be to use a longitudinal design in which the same individual will be assessed repeatedly at different time points. The patterns of changes in anxiety, depression, and sleep quality with time can best be evaluated by longitudinal studies.

In summary, the prevalence of poor sleep quality of stages I and II cervical cancer patients was approximately twice than that of the women in the communities. Cancer treatment had an important effect on sleep quality. Psychological distress, depression, anxiety, high grade of CIPN, and chemotherapy combined with radiotherapy during treatment were the factors associated with poor sleep quality. Performing exercise during treatment was a protective factor for poor sleep quality. Our results suggested that during treatment, the patients should be promptly given exercise guidance and mental care to improve sleep quality. In addition, our results emphasized the importance of assessing CIPN during chemotherapy and adjusting treatment plans based on assessment results.

Conflict of interest No conflicts of interest to declare. This study has no financial relationship with any organization that sponsored the

research and authorship. The corresponding author has full control of all primary data and will allow the journal to review our data if requested.

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