Thyroid Nodules and Sleep Disorders

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Article

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Abstract

The aim of this study was to explore the association between thyroid nodules and sleep disorders among adult patients diagnosed with thyroid nodules. Demographic data were obtained, and baseline thyroid nodule characteristics were evaluated using thyroid ultrasonography. The Symptoms Scale and Pittsburgh Sleep Scale were used to measure the sleep status of the patients. Overall, 180 participants with a mean age of 50 ± 12.7 years were included in this study. The majority of patients had TI-RADS grade 3 (80.14%), TI-RADS grade 4 (18.82%), and multiple nodules (70%). Pittsburgh Sleep Quality Index score (PSQI) revealed that 88.89% of the participants had PSQI scores > 5, indicating sleep disorders, with a mean PSQI score of 10.7 ± 3.6. Analysis of PSQI scores based on nodule length and TI-RADS grades showed no significant differences. In conclusion, patients with thyroid nodules experienced sleep disorders greatly, with difficulty falling asleep, poor subjective sleep quality, daytime fatigue, and short sleep time having a more significant impact on thyroid nodules, especially high-risk and small thyroid nodules. Our findings emphasize the importance of addressing sleep disturbances in patients with thyroid nodules to improve their quality of life and potentially mitigate the impact of thyroid diseases.

Introduction

Thyroid nodules and sleep disorders are common prevalent chronic conditions worldwide, causing significant distress to patients and posing challenges for resolution. A national epidemiological survey of thyroid diseases in China shows that the prevalence of thyroid nodules in adults over 18 years old is 20.43% [1], and its incidence shows a significant upward trend. Previous studies have shown that imaging detection rates range from 20–76%, with many Chinese clinical studies suggesting a detection rate of thyroid nodules of approximately 50% using ultrasound [2, 3].

Sleep is a complex biological behavior. Sleep disorders severely impact the quality of life of patients and are risk factors for secondary diseases such as diabetes [4, 5], cardiovascular diseases [6, 7], depression [8], and thyroid diseases [9]. Additionally, sleep disorders can be caused by various diseases [10–12]. The incidence of insomnia in the United States is approximately 10–22% [13, 14]. The third edition of the International Classification of Sleep Disorders (ICSD-3) pragmatically groups sleep disorders into six main categories and five dimensions [15]. The six categories are insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, and sleep-related movement disorders. The five dimensions are sleep duration, efficiency, satisfaction, time, and daytime alertness. Sleep disorders are characterized by difficulty initiating sleep, difficulty maintaining sleep, early awakening, excessive daytime sleepiness, nighttime movements, awakening, decreased sleep efficiency, and decreased sleep duration, all of which cause anxiety, fatigue, fatigue, neurasthenia, migraine. Disorders of initiating and maintaining sleep are collectively referred to as insomnias [16]. In our previous clinical study, we found that patients with thyroid nodules and thyroid cancer commonly have sleep disorders and insomnia, and these conditions can coexist. Studies have shown that sleep disorders affect thyroid function and disease [9], leading to the hypothesis that sleep disorders could promote the development of thyroid nodules. The diversity of sleep disorders reflects the need for the involvement of diverse medical specialties. Moreover, with the high incidences of thyroid nodules and cancer, understanding and identifying potentially modifiable risk factors is imperative.

While previous studies have demonstrated an association between thyroid nodules and insomnia, reports on the different dimensions of sleep disorders in patients with thyroid nodules and whether sleep disorders are correlated with the specific characteristics of thyroid nodules are lacking. Considering the high prevalence rates of both, the aim of this study was to (1) describe the characteristics of sleep disorders in patients with thyroid nodules using the PSQI scale; (2) determine whether sleep disorders, including different indicators, are correlated with the size, nature, and malignant risk of thyroid nodules; and (3) investigate how sleep management and improvement in patients with thyroid nodules may contribute to the prevention of thyroid cancer and diseases.

Results

Demographic and clinical characteristics of the participants (N = 180)

This study included 180 participants, with an average age of 50 ± 12.7 years. Age distribution was as follows: 18–30 years (7.22%), 31–45 years (31.11%), 46–60 years (37.22%), and > 60 years (24.44%). Following thyroid ultrasound examinations, 80.14% of cases were classified as having TI-RADS grade 3 and 18.81% as having TI-RADS grade 4. The mean PSQI score for patients with scores > 5 was 10.7 ± 3.6 (88.89%), and that for patients with scores > 10 was 13.9 ± 2.1 (46.11%). (Table 1)

Table 1
Demographic characteristics of the patients (n = 180)

	Category	Mean (SD)/*N* (%)
Sex	Male	15/8.33%
	Female	165/91.67%
Age		50 ± 12.7
	18–30	13 (7.22%)
	31–45	56 (31.11%)
	46–60	67 (37.22%)
	>60	44 (24.44%)
TI-RADS	3	230 (80.14%)
	4	54 (18.82%)
Characteristics	Multiple nodules	126 (70.0%)
	Single nodule	54 (30.0%)
Insomnia	PSQI scores>5	10.7 ± 3.688.89%)
	PSQI scores>10	13.9 ± 2.1 (46.11%)

Description of the Pittsburgh Sleep Quality Index

The PSQI was scored on a scale of 0–21, with scores below 5 indicating good sleep quality, 5–10 moderate sleep quality, 10–15 poor sleep quality, and > 15 indicating very poor sleep quality. In this study, the mean PSQI score for patients with scores > 10 was 13.92 ± 2.14 (45.90%, 95% confidence interval (CI) = 13.45–14.38, p < 0.01), while that for patients with scores < 10 was 7.11 ± 1.91 (54.1%, 95% CI = 6.73–7.50, p < 0.01). The proportion of patients with the worst sleep quality, scoring > 15 points, was 15.5% (16.54 ± 0.92, 95% CI = 16.18–16.89, p < 0.01). The differences between the groups were statistically significant (p < 0.01). (Table 2)

Table 2
Mean PSQI scores by score category

Scale scores	Mean (SD)/*N* (%)	95%CI	P value
> 10	13.92 ± 2.14	13.45–14.38	< 0.01
≤ 10	7.11 ± 1.91	6.73–7.50	
≤ 5	4.62 ± 1.86 (11.6%)	3.77–5.46	< 0.01
6–10	7.84 ± 1.36 (42.5%)	7.53–8.14	
11–15	12.61 ± 1.22 (30.4%)	12.29–12.93	
> 15	16.54 ± 0.92 (15.5%)	16.18–16.89	

Comparison of the Pittsburgh Sleep Quality Index scores by age

Table 3 shows the mean PSQI scores across different age groups. The mean PSQI score of patients aged > 46 years was > 10 (61.3%) (Table 3).

Table 3
Mean PSQI scores by age group

Age	18–30	31–45	46–60	> 60	P value
Scale scores	7.92 ± 2.84 (7.2%)	9.59 ± 3.54 (30.9%)	10.34 ± 4.13 (37.0%)	11.66 ± 4.08 (24.3%)	0.008

Nature of thyroid nodules and sleep quality

Nodule length was categorized as < 1.0 cm, 1.0–1.9 cm, and ≥ 2.0 cm. A relationship between nodule size and sleep quality was observed. The mean PSQI scores of patients in each nodule length category were 10.44 ± 3.97 (95% CI = 9.65–11.24), 10.13 ± 4.06 (95% CI = 9.32–10.95), and 9.66 ± 4.24 (95% CI = 8.32–11.0), respectively. The PSQI scores of patients with thyroid nodules classified as TI-RADS 3 and TI-RADS 4 were 10.22 ± 4.10 (95% CI = 9.56–10.88, p = 0.406), and 10.77 ± 3.59 (95% CI = 9.73–11.81, p = 0.406), respectively. Additionally, differences in PSQI scores between patients with solid and cystic solid nodules were analyzed. (Table 4)

Table 4
Comparison of mean PSQI scores by thyroid nodule length, echo, and TI-RADS classification

Nodule	Scale scores	95% CI	P value
Solid nodules (hypoechoic, isoechoic)	10.56 ± 4.09	9.87–11.25	0.389
Cystic and solid nodules (mixed echo)	10.08 ± 3.86	9.24–10.93	
< 1.0 cm	10.44 ± 3.97	9.65–11.24	0.502
≥ 1.0 cm, < 2.0 cm	10.13 ± 4.06	9.32–10.95	
≥ 2.0 cm	9.66 ± 4.24	8.32–11.0	
TI–RADS 3	10.22 ± 4.10	9.56–10.88	0.406
TI-RADS 4	10.77 ± 3.59	9.73–11.81	

Thyroid nodule size and sleep score

In total, 287 nodules from 180 participants were examined. Among them, 110 patients had hypoechoic thyroid nodules (138 nodules), and 28 patients had isoechoic nodules (33 nodules). Both types were solid nodules (171 nodules), accounting for 59.58% of all nodules examined. Nodule size was not closely related to sleep quality in patients with PSQI scores ≤ 10, > 10, > 5. (Table 5)

Table 5
PSQI scores and thyroid nodule lengths

Scale scores	< 1.0 cm	1.0–2.0 cm	2.1–5.0 cm	P value
≤ 10	7.02 ± 2.07	7.16 ± 1.85	6.68 ± 1.52	0.085
> 10	13.80 ± 2.04	14.22 ± 2.31	14.31 ± 2.52	
> 5	11.38 ± 3.36	10.79 ± 3.75	10.39 ± 4.00	

Effects of different characteristics of sleep disorders on thyroid nodules

Patients with high-risk nodules experienced greater difficulty falling asleep, had worse sleep efficiency and lesser sleep time, and had more significant daytime dysfunction (90.74%). Sleep disorders were categorized based on severity index, with scores ranging from 0–3 and 3 indicating “most severe.” Sleep disorder-related characteristics, labeled A–G, were assessed on a severity scale of 1–3. Table 6 shows the proportion of patients with different degree indices in this study. Scores of 2–3 indicate poor to very poor. More than 50% of participants with nodules scored 2–3 in subjective sleep quality (A), sleep latency (B), sleep duration (C), and daytime dysfunction (G) (Table 6). The number of nodules in each index group and their total proportion were evaluated. The effects of sleep disorders with different nodule characteristics are shown in Table 7.

Table 6
Sleep quality-related factors and actual scores (number, N%).

Scale scores	A	B	C	D	E	F	G
3	40(22.22%)	66(36.67%)	37(20.55%)	40(22.22%)	0(0%)	3(1.67%)	67(37.22%)
2	83(46.11%)	58(32.22%)	64(35.55%)	30(16.67%)	25(13.89%)	4(2.22%)	89(49.44%)
1	54(30.0%)	35(19.44%)	63(35.0%)	58(32.22%)	147(81.67%)	6(3.33%)	20(11.11%)

Table 7
Nodule size distribution across sleep disorder severity indices: impact of sleep characteristics

Scale scores		Solid nodules (171)	Cystic and solid nodules (116)	Risk Nodules (54)	< 1.0 cm (128)	1.0–2.0 cm (115)	2.1–5.0 cm (44)
subjective sleep quality	3	39(22.81%)	24(20.69%)	11(20.37%)	27(21.09%)	28(24.35%)	9(20.45%)
	2	83(48.54%)	48(41.38%)	28(51.85%)	64(50.0%)	52(45.22%)	15(34.09%)
	0–1	48(28.1%)	43(37.07%)	15(27.78%)	39(30.47%)	34(29.56%)	19(43.18%)
sleep latency	3	62(36.26%)	39(33.62%)	21(38.89%)	50(39.06%)	40(34.78%)	12(27.27%)
	2	50(29.24%)	42(36.21%)	23(42.59%)	43(33.59%)	31(26.96%)	19(43.18%)
	0–1	58(33.92%)	34(29.31%)	10(18.52%)	37(28.91%)	43(37.39%)	12(27.27%)
sleep duration	3	41(23.98%)	20(17.24%)	11(20.37%)	24(18.75%)	30(26.09%)	7(15.91%)
	2	60(35.09%)	34(29.31%)	24(44.44%)	52(40.62%)	31(26.96%)	12(27.27%)
	0–1	69(40.35%)	61(52.59%)	19(35.18%)	54(42.19%)	53(46.09%)	24(54.54%)
Sleep efficiency	3	43(25.15%)	22(18.96%)	16(29.63%)	27(21.09%)	29(25.22%)	10(22.73%)
	2	25(14.62%)	16(13.79%)	8(14.81%)	23(17.97%)	14(12.17%)	4(9.09%)
	0–1	102(59.65%)	77(66.38%)	30(55.55%)	80(62.5%)	71(61.74%)	29(65.91%)
daytime dysfunction	3	67(39.18%)	38(32.76%)	24(44.44%)	50(39.06%)	43(37.39%)	13(29.54%)
	2	73(42.69%)	64(55.17%)	25(46.30%)	68(53.12%)	49(42.61%)	21(47.73%)
	0–1	30(17.54%)	13(11.21%)	5(9.26%)	12(9.37%)	22(19.13%)	9(20.45%n)

Subjective sleep quality

In total, 71.35% of participants with solid nodules (hypoechoic and isoechoic) reported poor subjective sleep quality (scores of 2 – 3), significantly higher than the proportion of those with scores of 0–1 (28.1%). Subjective

sleep scores of 2–3 were observed in 62.07% of patients with cystic and solid nodules, which was lower than the proportion of patients with solid nodules alone. Scores of 2–3, which indicated poor subjective sleep quality, were observed in 72.22% of patients with high-risk nodules (TI-RADS grade 4) and in 71.09%, 69.57%, and 54.54% of those with nodules lengths < 1.0 cm, 1.0–2.0 cm, and 2.1–5.0 cm, respectively.

Sleep latency

Scores of 2–3 in sleep latency indicated difficulty in falling asleep, which accounted for 65.50% and 69.83% of patients with solid and cystic-solid nodules, respectively; 81.48% of those with high-risk nodules; and 72.65%, 61.74%, and 70.45% of those with nodule lengths < 1.0 cm, 1.0–2.0 cm, and 2.1–5.0 cm, respectively.

Sleep duration

Regarding sleep duration, scores of 2–3 were observed in 59.07% and 46.55% of patients with solid and cystic-solid nodules, respectively; in 64.8% of those with high-risk nodules; and in 59.37%, 53.05%, and 43.18% of those with nodule lengths < 1.0 cm, 1.0–2.0 cm, and 2.1–5.0 cm, respectively.

Sleep efficiency

Regarding sleep efficiency, scores of 2–3 were observed in 39.77% and 32.75% of patients with solid and cystic-solid nodules, respectively; in 44.44% of those with high-risk nodules; and in 39.06%, 37.39%, and 31.82% of those with nodule lengths < 1.0 cm, 1.0 – 2.0 cm, and 2.1–5.0 cm, respectively.

Daytime dysfunction

Scores of 2–3 in daytime dysfunction indicated mainly fatigue and lack of energy. The scores were observed in 81.87% and 87.93% of patients with solid and cystic-solid nodules, respectively; 90.74% of those with high-risk nodules; and in 92.18%, 80.0%, and 77.27% of those with nodule lengths < 1.0 cm, 1.0–2.0 cm, and 2.1–5.0 cm, respectively (Table 7)

Discussion

Thyroid nodules are a common condition of the endocrine system, with a significantly increasing incidence over the past decade. A national epidemiological survey of thyroid diseases in China revealed a prevalence of 36.9% [17]. Our study included 180 patients with clear thyroid nodules, and baseline nodule characteristics were determined through thyroid ultrasound. A cross-sectional study conducted between March and September 22 among 1,851 patients presenting to our department for their first thyroid ultrasound examination, including out-patients and in-patients, revealed a thyroid nodule prevalence of 50.57%. A randomized controlled study was then conducted to observe the high-risk characteristics of thyroid nodules and treatment in 180 patients. In addition, the PSQI was used to analyze the relationship between thyroid nodule characteristics and sleep.

The findings of this study showed that 88.89% of participants with thyroid nodules had sleep disorders, and 46.11% had poor sleep quality, including difficulty falling asleep, waking up early, short sleep duration, low sleep efficiency, fatigue, and sleepiness after waking up, and poor daytime energy. Previous studies on the correlation between thyroid nodules and sleep disorders are limited. However, the present study provides valuable data for clinical practice, aiding the exploration of the relationship between thyroid nodules and sleep disorders and

potentially improving the quality of life of patients. A correlation exists between demographic characteristics and sleep quality, with older adults being more prone to sleep disorders than the younger ones. Our findings showed that sleep quality was worse in patients with thyroid nodules aged over 46 years old.

In the present study, TI-RAD grade 3 nodules accounted for 80.1% of all cases, and TI-RAD grade 4 nodules, associated with a higher risk of malignancy, accounted for 18.8%. Upon analyzing the relationship between the size and nature of thyroid nodules and sleep quality, the data revealed that the mean PSQI scores for nodule diameter < 1.0 cm and 1.0–2.0 cm, TI-RADS 3 and 4 nodule, solid and cystic-solid nodule groups were all greater than 10. No significant difference was observed between the groups, indicating that sleep disorders were related to thyroid nodules. However, there was no clear relationship between the size and nature of the nodules.

Sleep quality encompasses multiple dimensions, with different factors representing efficiency problems related to sleep, including A) subjective sleep quality: some patients report poor sleep quality despite sleep time not being short, but they feel extremely tired and sleepy upon waking up, with no relief from fatigue; B) sleep latency, indicating the time taken to fall asleep, and reflects difficulty initiating sleep; C) sleep duration: some patients wake up multiple times in between sleep despite longer sleep durations; D) sleep efficiency: the ratio of actual sleep to bedtime, reflects sleep efficiency; E) sleep disturbances, such as early awakenings, were prevalent among the patients in this study, causing distress despite the low occupancy score; F) use of hypnotics; and G) daytime dysfunction: fatigue and reduced energy for daily activities.

Furthermore, we performed an analysis comparing the severity of the different sleep disorder and nodule characteristics. The findings showed that 68.3% of the participants had poor subjective sleep quality. The proportion of patients with solid nodules was higher than that of those with cystic-solid nodules, and the proportion of patients with grade 4 nodules (72.22%) was significantly higher than that of those with nodules below grade 4 (43.78%). Patients with thyroid nodules < 2.0 cm had worse sleep quality than those with thyroid nodules > 2.0 cm. An important index to measure sleep quality is sleep latency. Difficulty falling asleep despite adequate sleep duration is commonly observed in thyroid nodule clinics.

In this study, 68.89% of the patients reported falling asleep for half an hour to 4 hours, ≥ 2 times a week, which indicated no association with the presence of solid or cystic-solid nodules. Patients with grade 4 nodules experienced more difficulty falling asleep than those with < grade 4 nodules, with no significant correlation observed with nodule size.

Among patients with thyroid nodules, 56.1% reported < 6 hours of sleep time, which was not associated with the nature of the nodule. However, the proportion of less sleep time was higher in participants with nodules smaller than 1.0 cm. Daytime dysfunction, characterized by fatigue and lack of energy, was observed in 86.66% of patients, with a higher prevalence among those with grade 4 nodules. This aspect significantly impacts the quality of life of patients. The proportion of patients with short sleep duration was higher among those with nodules < 1.0 cm. The results of this study indicate that most patients with thyroid nodules have sleep disorders, with difficulty falling asleep, less sleep time, low efficiency, and daytime fatigue having a greater impact in patients with high-risk nodules and multiple small thyroid nodules.

The incidences of sleep disorders in Europe, the United States, and China are 10% [18], 10–22% [13, 14], and 15% [19], respectively. According to the ICSD-3, insomnia is characterized by difficulty initiating sleep, maintaining sleep continuity, or poor sleep quality. Insomnia is associated with mood disorders [20, 21], and depression and

anxiety are related to thyroid nodules [22]. Over 70% of patients with insomnia still meet the diagnostic criteria after 1 year. Women are 1.5 times more likely to be affected than men, often becoming chronic patients [16]. Studies have shown that insomnia also increases the risk of certain cancers. A meta-analysis showed that insomnia patients have an overall increased risk of malignant tumors by 24% [23], including thyroid cancer [24, 25]. Many studies have shown that mood disorders are associated with cancer [26]. Sleep disorders or insomnia are the risk factors for these diseases. Circadian rhythm disruption is considered to interfere with cell cycle progression, and abnormal expression of circadian clock genes is observed in differentiated thyroid cancer [27]. It is essential to prioritize sleep quality for individuals with thyroid nodules and thyroid cancers, as well as implement timely interventions for insomnia to improve overall quality of life.

Our findings showed a significant correlation between thyroid nodules and sleep disorders, suggesting that managing and enhancing sleep in patients with thyroid nodules is also beneficial for preventing thyroid cancer and thyroid diseases. Additionally, studies have shown that the effects of sleep disorders on thyroid nodules and thyroid cancer may be related to inflammation [28, 29], an aspect we intend to explore further in future studies.

One strength of this study is its enrollment of participants without consideration of their sleep status, thus providing more objective results regarding the coexistence of patients with thyroid nodules and insomnia. Data regarding patient symptoms, sleep status, and nodule characteristics were recorded to assess their correlation.

There are several limitations to this study, including the lack of anxiety and depression related assessment scales and stress tests. Through these tests, we can better understand the correlation between thyroid nodules, sleep disorders, and emotional disturbance. Although thyroid nodules and sleep disorders are more common in women than in men, data are lacking due to the small number of male participants in this study. The sample size of this study is also small, and it is expected that a multi-center study will be carried out.

It is worth noting that many patients experience poor sleep quality, short sleep duration, and difficulty falling asleep or waking up early but are reluctant to use hypnotic drugs. Instead, some patients choose to use non-drug therapies or over-the-counter drug interventions, Highlighting the need for increased clinical education to promote better sleep quality on the premise of medication safety.

In conclusion, patients with thyroid nodules experienced a high prevalence of sleep disorders. Difficulty falling asleep, poor subjective sleep quality, daytime fatigue, and short sleep time have a greater impact on nodules, particularly high-risk and small thyroid nodules. Our findings underscore the critical importance of prioritizing sleep quality in patients with thyroid nodules, potentially aiding in the prevention of thyroid cancer and related conditions.

Methods

Study design

In a previous clinical observation, we conducted a cross-sectional survey of patients visiting the Endocrinology Department of Guang'anmen Hospital of China Academy of Chinese Medical Sciences between March 2022 and September 2022 for their first thyroid ultrasound examination. The prevalence of thyroid nodules, the proportion of high-risk nodules, and the proportion of patients with insomnia were observed. Patients with thyroid nodules were shown to have higher levels of insomnia. Based on this, 180 patients with thyroid nodules were

prospectively observed between September 2022 and November 2023. During this period, the participants completed the Pittsburgh Sleep Index, and we recorded data on thyroid nodule characteristics, clinical symptoms, and thyroid function. Before the study began, the objectives were thoroughly explained to the patients, and approval was obtained from the Ethics Committee of Guang'anmen Hospital.

Patients

Between September 2022 and December 2023, 180 patients diagnosed with thyroid nodules and admitted to Guang'anmen Hospital in Beijing, China, were prospectively enrolled in this study. The inclusion criteria were 1) thyroid nodules with a diameter greater than 0.5 cm evaluated using thyroid ultrasound; 2) age 18–75 years. The exclusion criteria were 1) medical conditions such as mental disorders or severe primary diseases; 2) poor control of hyperthyroidism or hypothyroidism indicators; 3) presence of thyroid cancer or malignant tumors; 4) severe liver and kidney dysfunction; and 5) pregnancy and lactation. All participants provided written informed consent. The study procedure was approved by the Ethics Committee of Guang'anmen Hospital (Approval number: ITMCTR2024000005; date: 2022-09-30). This study was conducted in accordance with relevant guidelines and regulations, including the Declaration of Helsinki, the quality control standard for clinical trials (GCP), and the human body biomedical research international moral guide. Clinicians conducted all consultations, examinations, and scales.

Data collection

Thyroid nodules and thyroid function

The thyroid glands of the patients were examined using color Doppler ultrasonography, revealing thyroid nodules with a maximum diameter of at least 0.5 cm. Echogenicity may include hypoechoic, mixed echoic, and anechoic, with or without goiter, with TI-RADS (a standardized system used to classify thyroid nodules based on their ultrasound appearance and other characteristics) grades 2–4. Serum thyroid-stimulating hormone (TSH), free thyroxine 3 (FT3), and free thyroxine 4 (FT4) levels were detected using chemiluminescence.

Insomnia

Insomnia is a sleep disorder that affects sleep quality. All participants were assessed using the Pittsburgh Sleep Quality Scale (PSQI), a commonly used clinical assessment scale for assessing sleep quality, with scores ranging from 0 (none) to 3 (very severe). Sleep is a complex process, and sleep disorders have different focuses, which were assessed under the following parameters. A: Sleep quality, B: time to fall asleep (difficulty in falling asleep), C: sleep duration, D: sleep efficiency, E: sleep disturbance, F: use of sleep aid, G: daytime dysfunction. The normal range is 0–5, with higher scores indicating poor sleep quality.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) software (version 24.0) was employed for data analyses. Standard descriptive statistics were used to summarize the clinical characteristics of the population. Continuous variables were presented as mean ± standard deviation. Relationships among variables were examined using Spearman’s rank correlation coefficients. Differences in sleep quality scores among groups associated with thyroid nodules were analyzed using one-way dependent variable analysis of variance, and multiple comparisons were performed. P values < 0.05 were considered statistically significant.

Data availability statement

The datasets generated during and/or analysed during the current study are not publicly available due to research and follow-up are continuing but are available from the corresponding author on reasonable request.

Declarations

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Author Contributions

Writing of the original draft: YRZ; Writing, review, and editing: QN. Writing and supervision: JL.

Additional Information

Competing Interests Statement

The authors declare no competing interests.

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