Characteristics of sleep disturbance across two waves of the COVID-19 pandemic among nursing staffs

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ABSTRACT

Objectives: COVID-19 has impacted human lifestyles, including sleep quality. For nursing staff, sleep disorders not only impact their health and daily lives but also have implications for patient safety. The objective of this study is to explore the impact of the COVID-19 pandemic on the psychological and social aspects of nursing staff and the factors influencing their sleep quality through a two-wave survey.
Methods: Nursing staff from a psychiatric hospital in southern Taiwan were recruited in two waves during the COVID-19 epidemic. The level of sleep disturbance and related variables, such as Lo's Healthy and Happy Lifestyle Scale (LHHLS) and Societal Influences Survey Questionnaire (SISQ), were collected through self-report questionnaires. Factors related to the level of sleep disturbance were examined using univariate linear regression and multilevel linear regression.
Results: 508 nursing staff members were included in the study, with 254 members in each wave. A significant difference was found between the two waves in the positive thinking of LHHLS and all subscales of SISQ. During the second wave, sleep disturbances were mainly related to self-efficacy, positive thinking, social anxiety, and social desirability. At the fourth wave, sleep disturbances were mainly related to self-efficacy, positive thinking, and social anxiety. However, these effects change when the trend of the epidemic shifts, and other factors are taken into account.
Conclusions: This study analyzed the factors related to the sleep quality of nursing staff during the COVID-19 pandemic. We preliminarily explored the impact of the COVID-19 pandemic on the sleep quality of nursing staff. However, determining whether the end of the epidemic has reduced the impact on nursing staff requires further research.

1. Introduction

1.1. Background

COVID-19 has changed people's habits, such as work methods, learning modes, social behaviors, hygiene practices, shopping methods, and mental health [1–9]. Its impact on human lifestyles is not only evident during the pandemic but may also continue even after the pandemic ends [10–12]. Due to its wide-ranging and long-lasting impact, it is very important to deeply explore the effects of COVID-19 on human behavior.

The effects of sleep disorders encompass physiological,

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psychological, and social aspects [13–21]. As a fundamental physiological need for humans, the importance of maintaining sleep quality is reflected in all aspects of life. Especially for nursing staff, sleep disorders are a significant and common issue that not only affect their health and daily lives but also relate to patient safety [22–26].

Research indicates that the COVID-19 pandemic has generally increased public levels of stress, depression, and anxiety [9,27–29]. Such emotional stress can further affect daily life, including sleep quality [30–32].

1.2. Aim of the study

The purpose of this study is to explore the impact of the COVID-19 pandemic on the psychological and social aspects of nursing staff through a two-wave survey. Additionally, the survey aims to identify the factors affecting the sleep quality of nursing staff during the pandemic. Many studies have examined the sleep quality of nurses during the COVID-19 pandemic; however, most of them focus on the early stages of the outbreak [33–36]. It is difficult for us to understand how the pandemic has affected the sleep quality of nursing staff during different phases of the outbreak [37]. Understanding how the pandemic affects the sleep quality of nursing staff during different stages can help develop strategies to adapt to external changes and improve the quality of life for frontline healthcare workers. Additionally, we want to understand how different pandemic trends, beyond the personal characteristics and traits of nursing staff, influence their perception of external environmental changes and, in turn, affect their sleep quality. Research on the quality of life for nursing staff during the COVID-19 pandemic has primarily focused on psychological conditions such as PTSD, anxiety, and depression [38]. There has been less exploration of how their perceptions of social measures and environmental changes brought about by the pandemic affect their quality of life, including aspects like sleep quality. We aim to understand whether the personal psychological states of nursing staff and their perception of environmental impacts vary across different phases of the pandemic, and how these factors further influence sleep quality.*Positive emotion and sleep disturbance.*

Self-efficacy is a psychological state in which an individual believes they can complete tasks and achieve desired outcomes [39]. If the pandemic is viewed as a difficult stage that must be overcome, individuals with high self-efficacy should have a greater ability to cope with psychological stress and be able to quickly adapt to the inconveniences caused by the epidemic. Additionally, positive emotions, such as positive thinking, have been shown to reduce pain and lead to better health outcomes [40]. We might infer that promoting a positive mental state can help individuals better adapt to life during the epidemic, alleviate psychological and physiological burdens during the pandemic, and reduce sleep disturbances [41,42].

Besides, as the pandemic trends change, people's psychological states are likely to vary [43–45]. Thus, during the end of the pandemic, the level of positive emotions should be higher compared to the early stages of the pandemic.

1.3. Societal influences and sleep disturbance

During the COVID-19 pandemic, societal behaviors have impacted people's lives, leading to changes in psychological well-being, social habits, and lifestyle [46]. To slow down the spread of the virus, maintaining social distance is a common measure. However, maintaining social distancing means reducing contact with others, which can lead to feelings of isolation and loneliness, affecting interpersonal relationships [47]. Moreover, social distancing could impact people's mental health and lead to depression [47,48].

COVID-19 epidemic has brought uncertainty to economies around the world [49]. Schooling, employment, and tourism have all had a significant impact [50]. Work stoppages, school closures, and economic losses caused by the epidemic may lead to uneasiness and anxiety about

the future [46]. It could lead to depression, stress, and sleep disorders [48,51].

During an epidemic, people's confidence in the government will impact the response time to epidemic prevention measures [52]. At the same time, when people have a high level of awareness of the government's social support, the psychological impact of the epidemic will also be reduced [53]. Thus, when people have higher confidence in the government, it indicates greater social desirability [46], and the physical and mental impact of the epidemic on them would be effectively reduced.

People heavily relied on social media during the COVID-19 pandemic [54]. However, the frequency, duration, and variety of media exposure are positively associated with more depressive symptoms, non-specific anxiety, and COVID-19-specific anxiety [55]. Frequent use of media to obtain information may reflect people's inner panic and anxiety. Moreover, studies have indicated that individuals with low interest in COVID-19 news who are exposed to high levels of news may experience more stress and lower levels of satisfaction, gratitude, and happiness [56]. The convenience of the media may be one of the factors that exacerbates people's panic about the epidemic.

During COVID-19, people's willingness and behavior to travel have decreased [57,58]. This means reduced opportunities for business and entertainment. This situation involves a decrease in business and entertainment opportunities, which may result in economic losses, reduced leisure activities. Furthermore, travel restrictions could have an impact on students' education. This could cause anxiety, psychological stress, and depression. This could cause anxiety, psychological stress, and depression [46,49,51].

2. Methods

2.1. Participants and ethics

Data for this study were part of a series of studies exploring the psychological and social impacts of COVID-19 on the public. The sample we focused on in this study was nursing staff from a psychiatric hospital in southern Taiwan. Participants were recruited in two waves during the COVID-19 epidemic, namely the second wave from June 28, 2021, to July 22, 2021, and the fourth wave from October 18, 2022, to March 2023. The periods mentioned above were close to the two waves of the COVID-19 pandemic in Taiwan. The studies were cross-sectional surveys conducted using paper-and-pencil questionnaires.

The inclusion criteria for participants were as follows: first, nursing staff who worked at the hospital or affiliated institutes; and second, those who were aged more than 20 years. All participants signed informed consent forms before the survey. The study was approved by the Institutional Review Board of KSPH (KSPH-2020-03; KSPH-2021-08; KSPH-2023-04).

3. Measures

3.1. Sleep disturbance scales from the Pittsburgh Sleep quality index

The Pittsburgh Sleep Quality Index (PSQI) was developed to measure sleep quality with good validity and reliability [59]. We selected four items from the PSQI's subscale. The items were designed to measure the level of sleep disturbance, including difficulty falling asleep, waking during the night, subjective sleep quality, and daytime alertness over the past month. Each item was rated on a 4-point Likert scale, with scores ranging from 0 to 1. Higher total scores of the four items indicated a more severe sleep disturbance (Supplementary Table S1).

3.2. Lo's Healthy and Happy Lifestyle Scale

The Lo's Healthy and Happy Lifestyle Scale (LHHLS) was developed to assess the well-being linked to mental health and lifestyle. It has been

found to demonstrate good reliability and validity [39]. LHHLS included two sub-dimensions: self-efficacy, rated by eight items, and positive thinking, rated by six items. The LHHLS is graded on a 5-point Likert scale, with responses ranging from 1 (never) to 5 (always). Participants were asked to rate themselves on their feelings of happiness and the quality of their lifestyle over the past 2 weeks. A higher score on the LHHLS indicates a higher level of well-being in health and lifestyle (Supplementary Table S1).

3.3. Societal Influences Survey Questionnaire

The Societal Influences Survey Questionnaire (SISQ) was developed to evaluate social influences on individuals during the COVID-19 pandemic [46]. The fifteen-item SISQ contains five assessment categories: social distancing, social anxiety, social desirability, social information, and social adaptation [46,60]. Each item was rated on a 4-point Likert scale, with scores ranging from 1 (never) to 4 (often). Higher total scores for each of the five categories indicated better compliance with social distancing measures, increased anxiety related to COVID-19, a stronger inclination to seek COVID-19-related information, and heightened awareness of the global progression of the COVID-19 pandemic. The internal consistency of SISQ measures showed a Cronbach's α value of .64 for self-efficacy and .83 for positive thinking (Supplementary Table S1).

3.4. Demographic characteristics

The continuous variables included age (in years) and the frequency of life stress levels (such as experiencing financial, emotional, parenting, marital, or work stress in the past year, rated from 0 for never to 3 for always).

Several categorical variables were included in the study: sex (male, female), educational level (college and lower, master's or doctorate), marital status (with or without a partner), history of psychological trauma (yes or no), smoking (yes or no), alcohol consumption (≥3 times per week or not), regular exercise (≥3 days per week or not), regular diet habits (three or four meals a day, ≥5 days per week or not), history of chronic medical disease (yes or no), work unit characteristics (chronic ward, acute ward, intensive care unit, and non-shift unit), and measures related to COVID-19 (under self-health management, under home isolation/quarantine, or infection).

3.5. Statistical analysis

We utilized descriptive analysis to present the characteristics of the participants. Categorical variables between the second and fourth waves were compared using Pearson's χ2 test. As for the continuous variables of participants in two waves, they were compared using an independent *t*-test.

Univariate linear regression and multiple linear regressions were used to measure the relationship between predictor variable and the degree of sleep disturbance. We examined the normality of dependent variables using Kolmogorov–Smirnov test and found the distribution were non-normality ($p < 0.001$). Thus, bootstrapping multiple linear regression with 5000 bootstrap samples was employed to validate the results of the multiple linear regression analysis. Through this method, we could confirm the stability of the regression coefficients, reduce the length of the confidence intervals, and obtain a sufficiently accurate 95th percentile [61,62]. The data were analyzed using IBM SPSS Statistics (Version 27).

4. Results

4.1. Demographic analysis

From the second and fourth waves, 508 nursing staff members were

included in the study, with 254 members from each wave. Experiences with measures related to COVID-19, such as self-health management, home isolation/quarantine, or confirmed infection, were significantly different between the two waves (15 vs. 164, $p < 0.001$). For the Healthy and Happy Life Measurement, which indicated whether individuals successfully managed the impact of COVID-19 on their lives, the results showed a significant difference between the two waves in the subscale of positive thinking (19.66 vs. 20.70, $p = 0.010$). For social influences on people during COVID-19, measured by the SISQ-15 scale, there were significant differences between the second and fourth waves in all subscales: social distance (12.63 vs. 10.35, $p < 0.001$), social anxiety (9.42 vs. 8.46, $p < 0.001$), social desirability (10.07 vs. 9.09, $p < 0.001$), social information (5.18 vs. 4.31, $p < 0.001$), and social adaptation (6.54 vs. 5.35, $p < 0.001$). (Table 1.).

4.2. Predictors for sleep disturbance

For nursing staff members in the second wave, the results of univariate regression indicated that more frequent life stress (β = 0.22, $p < 0.001$), high social anxiety (β = 0.26, $p < 0.001$), psychological trauma (β = 0.22, $p = 0.001$), smoking habit (β = 0.12, $p = 0.048$), drinking habit (β = 0.23, $p < 0.001$), and experiences related to COVID-19 measures (β = 0.14, $p = 0.031$) were positively related to more sleep disturbance. Additionally, compared to those who worked in non-shift units, members who worked in acute wards (β = 0.07, $p = 0.027$) and intensive care units (β = 0.41, $p < 0.001$) also suffered from more serious sleep disturbance. On the contrary, higher levels of self-efficacy (β = −0.47, $p < 0.001$), positive thinking (β = −0.48, $p < 0.001$), and social desirability (β = −0.18, $p = 0.004$) were associated with less sleep disturbance. Regular diets were also related to better sleep quality (β = −0.27, $p < 0.001$).

Results of multiple regression showed that higher frequency of life stress (β = 0.22, $p < 0.001$), higher levels of social anxiety (β = 0.16, $p = 0.013$), drinking habit (β = 0.12, $p = 0.018$), working in an intensive care unit (β = 0.22, $p = 0.001$), and having experiences related to COVID-19 measures (β = 0.13, $p = 0.009$) were positively related to more sleep disturbance. On the other hand, the behavior of maintaining regular diets (β = −0.13, $p = 0.012$) was beneficial for improving sleep quality (Table 2.).

As for nursing staff members in the fourth wave, univariate regression showed that more frequent life stress (β = 0.40, $p < 0.001$), high social anxiety (β = 0.19, $p = 0.003$), and working in an intensive care unit (β = 0.23, $p = 0.009$) were positively related to sleep disturbance. Higher levels of self-efficacy (β = −0.41, $p < 0.001$) and positive thinking (β = −0.39, $p < 0.001$) were helpful in avoiding sleep disturbance. Moreover, having a partner (β = −0.13, $p = 0.046$) and maintaining a regular diet (β = −0.15, $p = 0.014$) also led to less sleep disturbance.

Multiple regression indicated that more frequent life stress (β = 0.30, $p < 0.001$) led to more sleep disturbance. Members with partners (β = −0.14, $p = 0.036$) reported better sleep quality (Table 3.).

5. Discussion

5.1. Key results of the present study

In this study, we aimed to identify factors affecting the sleep quality of nursing staff by analyzing data from the second and fourth waves of surveys conducted during the COVID-19 pandemic. We first compared the characteristics of the participants between the two waves during the pandemic and further analyzed the predictive factors that might impact sleep quality. The study results also showed that during the fourth wave of the survey, COVID-19-related measures were significantly more prevalent than in the second wave. Additionally, the mindset of the nursing staff changed, with a significantly higher tendency for positive thinking in the fourth wave compared to the second wave. In contrast,

Table 1
Characteristics of demographic and quantitative variables for nursing staff at second and fourth wave.

Group	Total (n = 508)		2nd wave (n = 254)		4th wave (n = 254)		Statistics	
Variable	Counts	%	Counts	%	Counts	%	χ^2	p
Sex							0.144	0.704
Female	435	85.60	219	86.20	216	85.00		
Male	73	14.40	35	13.80	38	15.00		
Educational level							0.065	0.799
College (including lower levels)	469	92.30	236	92.90	233	91.70		
Master's or doctorate	39	7.70	18	7.10	21	8.30		
Marital status							0.408	0.523
Without a partner	313	61.60	160	63.00	153	60.20		
With a partner	195	38.40	94	37.00	101	39.80		
Work unit characteristics							7.026	0.071
Acute ward	354	69.82	186	73.20	168	66.40		
Chronic ward	42	8.28	22	8.70	20	7.90		
Intensive care unit (ICU)	54	10.65	18	7.10	36	14.20		
Others (non-shift units)	57	11.24	28	11.00	29	11.50		
History of trauma [a]							3.664	0.056
No	394	77.56	206	81.10	188	74.02		
Yes	114	22.44	48	18.90	66	25.80		
Smoking							0.202	0.653
No	503	99.02	251	98.82	252	99.21		
Yes	5	0.98	3	1.18	2	0.79		
Drinking [b]							1.210	0.271
No	448	88.19	228	89.76	220	86.61		
Yes	60	11.81	26	10.24	34	13.39		
Regular exercise [c]							0.032	0.858
No	282	55.51	142	55.91	140	55.12		
Yes	226	44.49	112	44.09	114	44.88		
Regular diets [d]							2.548	0.110
No	17	33.66	77	30.31	94	37.01		
Yes	337	66.34	177	69.69	160	62.99		
Chronic disease							0.321	0.571
No	452	89.00	224	88.20	228	89.80		
Yes	56	11.00	30	11.80	26	10.20		
Measures related to COVID-19 [e]							191.51	**<0.001**
No	329	64.80	239	94.10	90	35.40		
Yes	179	35.20	15	5.90	164	64.60		
Variable	Mean	SD	Mean	SD	Mean	SD	t	P
Age [f]	34.16	8.85	34.26	8.84	34.05	8.87	0.28	0.783
Sleep disturbance [g]	2.74	2.68	2.81	2.81	2.67	2.55	0.61	0.541
Frequency of life stress [h]	0.70	0.82	0.76	0.87	0.65	0.76	1.57	0.116
Self-efficacy [i]	27.28	6.02	26.89	5.80	27.67	6.22	−1.47	0.143
Positive Thinking [i]	20.18	4.56	19.66	4.37	20.70	4.70	−2.58	**0.010**
Social distance [j]	11.49	3.15	12.63	2.57	10.35	3.26	8.78	**<0.001**
Social anxiety [j]	8.94	3.01	9.42	2.93	8.46	3.01	3.65	**<0.001**
Social desirability [j]	9.59	2.16	10.07	1.88	9.09	2.31	5.23	**<0.001**
Social information [j]	4.74	1.50	5.18	1.52	4.31	1.35	6.80	**<0.001**
Social adaptation [j]	5.95	1.97	6.54	1.73	5.35	2.02	7.15	**<0.001**

[a] Psychological trauma.
[b] : three times per week.
[c] Five days per week.
[d] Three or four meals a day, ≥5 days per week.
[e] Under self-health management, under home isolation/quarantine or infection.
[f] Measured by years.
[g] Measured by four selected items of Pittsburgh Sleep Quality Index.
[h] From economic, emotional, parenting, and marriage aspects, ranging from 0 = None to 1 = Always.
[i] Measured by Lo's Healthy and Happy Lifestyle Scale.
[j] Measured by Societal Influences Survey Questionnaires; COVID-19: coronavirus disease 2019; SD: standard deviation; **Bolds**: statistical significance.

reactions and preventive measures related to the pandemic significantly decreased.

In the second wave of the survey, factors such as frequency of life stress, self-efficacy, positive thinking, social distance, social anxiety, social desirability, psychological trauma, smoking habits, drinking habits, regular diets, workplace location, and measures related to COVID-19 were significantly related to sleep disturbance. Further analysis using multiple regression revealed that frequency of life stress, social anxiety, drinking habits, regular diets, working in an intensive care unit, and measures related to COVID-19 were significantly associated with sleep quality.

In the fourth wave of the survey, frequency of life stress, self-efficacy, and positive thinking were still related to sleep disturbance. Among the psychological aspects related to COVID-19, only social anxiety showed a significant relationship with sleep disturbance. Additionally, marital status, regular diet, and working in the ICU were also related to sleep quality. Further analysis using multiple regression revealed that frequency of life stress and marital status had an impact on sleep quality.

5.2. Changes in different COVID-19 waves

There were significant differences in experiences related to COVID-

Table 2

Predictors for level of sleep disturbance examined by univariate and multiple regression among nursing staff in the second wave.

Predictors	Univariate regression				Multiple regression			
Continuous variables	β	t	95 % CI	p	β	t	95 % CI	p
Age (years) [a]	0.01	0.18	−0.04, 0.04	0.859	0.04	0.69	−0.03, 0.05	0.491
Frequency of life stress [b]	0.51	9.48	1.31, 2.00	**<0.001**	0.22	3.86	0.35, 1.09	**<0.001**
Self-efficacy [c]	−0.47	−8.50	−0.28, −0.18	**<0.001**	−0.09	−0.80	−0.14, 0.06	0.425
Positive Thinking [c]	−0.48	−8.73	−0.38, −0.24	**<0.001**	−0.20	−1.92	−0.26, 0.00	0.056
Social distance [d]	−0.06	−0.94	−0.20, 0.07	0.347	−0.06	−0.97	−0.20, 0.07	0.335
Social anxiety [d]	0.26	4.31	0.14, 0.37	**<0.001**	0.16	2.50	0.03, 0.28	**0.013**
Social desirability [d]	−0.18	−2.88	−0.45, −0.09	**0.004**	−0.07	−1.03	−0.29, 0.09	0.305
Social information [d]	0.10	1.63	−0.04, 0.42	0.104	−0.03	−0.39	−0.29, 0.19	0.697
Social adaptation [d]	0.05	0.81	−0.12, 0.28	0.419	0.03	0.57	−0.13, 0.24	0.570
Categorical variables	β	t	95 % CI	p	β	t	95 % CI	p
Sex								
Male	−0.02	−0.29	−1.16, 0.86	0.770	0.001	−0.04	−0.84, 0.80	0.967
Female	Ref	–	–	–	Ref	–	–	–
Marital status								
Without a partner	Ref	–	–	–	Ref	–	–	–
With a partner	−0.06	−1.00	−1.08, 0.35	0.320	−0.10	−1.75	−1.23, 0.07	0.082
Educational level								
College (including lower levels)	Ref	–	–	–	Ref	–	–	–
Master's or doctorate	−0.02	−0.32	−1.58, 1.14	0.750	−0.002	−0.04	−1.12, 1.08	0.971
Psychological trauma [e]								
No	Ref				Ref	–	–	–
Yes	0.22	3.50	0.67, 2.41	**0.001**	0.02	0.41	−0.60, 0.91	0.684
Smoking								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.12	1.99	0.03, 6.42	**0.048**	−0.03	−0.54	−3.40, 1.94	0.590
Drinking (≥3 times per week)								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.23	3.77	1.02, 3.25	**<0.001**	0.12	2.38	0.20, 2.08	**0.018**
Exercise (≥3 days per week)								
No	Ref	–	–	–	Ref	–	–	–
Yes	−0.04	−0.69	−0.94, 0.46	0.493	0.01	0.28	−0.49, 0.65	0.783
Regular diets (≥5 days per week)								
No	Ref	–	–	–	Ref	–	–	–
Yes	−0.27	−4.45	−2.37, −0.92	**<0.001**	−0.13	−2.52	−1.41, −0.17	**0.012**
Chronic disease (medical)								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.11	1.78	−0.11, 2.04	0.077	0.02	0.47	−0.66, 1.08	0.638
Work unit characteristics								
Chronic ward	0.17	0.82	−0.61, 1.47	0.413	0.07	1.11	−0.53, 1.92	0.267
Acute ward	0.07	2.22	0.19, 3.10	**0.027**	−0.02	−0.29	−1.09, 0.82	0.775
Intensive care unit (ICU)	0.41	5.76	2.97, 6.07	**<0.001**	0.22	3.30	0.95, 3.76	**0.001**
Others (non-shift units)	Ref	–	–	–	Ref	–	–	–
Measures related to COVID-19 [f]								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.14	2.17	0.15, 3.08	**0.031**	0.13	2.62	0.39, 2.72	**0.009**
			n = 254				R^2 = 0.49, n = 254	

[a] Measured by years.

[b] From economic, emotional, parenting, and marriage aspects, ranging from 0 = None to 1 = Always.

[c] Measured by Lo's Healthy and Happy Lifestyle Scale.

[d] Measured by Societal Influences Survey Questionnaires.

[e] Experiencing or witnessing events such as natural disasters, accidents, or abuse, and so on.

[f] Under self-health management, under home isolation/quarantine or infection; COVID-19: coronavirus disease 2019; β: standardized coefficients; t score; CI: Confidence interval; **Bolds:** p < 0.05.

19 measures between the two waves during the pandemic. During the fourth wave of the pandemic, participants experienced significantly more COVID-19 related measures compared to the second wave. This is consistent with the trend of the pandemic in Taiwan from 2021 to 2023. The second wave of the study was conducted from June to July 2021, while the fourth wave was conducted from October 2022 to March 2023. During this period, the number of confirmed cases in Taiwan increased from just over 10,000 to more than 10,150,000, with a sharp increase of over 10 million confirmed cases within eight months starting from May 2022 [63].

During this period, in the survey on participants' health and well-being, we found an increase in the tendency for positive thinking, while the overall social impact of the pandemic on participants decreased. This might also be related to the trend of the pandemic.

During the second wave of the survey, the number of confirmed cases in Taiwan was effectively suppressed by strict preventive measures [63]. Although the number of confirmed cases was low at that time, the uncertainty about the development of the pandemic likely caused higher levels of fear, vigilance, and attention among the public [64]. In contrast, during the fourth wave of the survey, although the number of confirmed cases increased, the trend of the pandemic was gradually declining [65]. Additionally, due to effective preventive measures, such as vaccination, the public's positive mindset might be higher, and their attention and vigilance towards the pandemic gradually decreased.

We did not find any differences in sleep disturbances among nursing staff between the two waves of the survey. This may be because, despite the overall trend of the pandemic easing, the burden on nursing staff has not decreased. In 2022, the vacancy rate for nursing staff in Taiwan was

Table 3

Predictors for level of sleep disturbance examined by univariate and multiple regression among nursing staff in the fourth wave.

Predictors	Univariate regression				Multiple regression			
Continuous variables	β	t	95 % CI	P	β	t	95 % CI	p
Age (years) [a]	0.10	0.16	-.03, .04	.877	0.00	0.00	−0.04, 0.04	0.999
Frequency of life stress [b]	0.40	6.88	.95, 1.72	**<0.001**	0.30	4.47	0.56, 1.44	**<0.001**
Self-efficacy [c]	−0.41	−7.11	−0.21, −0.12	**<0.001**	−0.16	−1.24	−1.39, 0.32	0.218
Positive Thinking [c]	−0.39	−6.72	−0.27, −0.15	**<0.001**	−0.13	−1.01	−1.27, 0.41	0.314
Social distance [d]	−0.02	−0.35	−0.11, 0.08	0.73	−0.04	−0.51	−0.16, 0.09	0.612
Social anxiety [d]	0.19	3.02	0.06, 0.26	**0.003**	0.04	0.55	−0.10, 0.17	0.582
Social desirability [d]	−0.06	−0.92	−0.20, 0.07	0.36	−0.09	−1.31	−0.25, 0.05	0.192
Social information [d]	0.09	1.36	−0.07, 0.40	0.18	0.10	1.27	−0.10, 0.47	0.205
Social adaptation [d]	0.03	0.54	−0.11, 0.20	0.59	−0.04	−0.56	−0.25, 0.14	0.573
Categorical variables	β	t	95 % CI	P	β	t	95 % CI	p
Sex								
Male	−0.08	−1.27	−1.45, 0.31	0.21	−0.10	−1.62	−1.60, 0.16	0.107
Female	Ref	–	–	–	Ref	–	–	–
Marital status								
Without a partner	Ref	–	–	–	Ref	–	–	–
With a partner	−0.13	−2.00	−1.29, −0.01	**0.046**	−0.14	−2.11	−1.41, −0.05	**0.036**
Educational level								
College (including lower levels)	Ref	–	–	–	Ref	–	–	–
Master's or doctorate	0.01	0.17	−1.05, 1.25	0.86	0.04	0.66	−0.76, 1.52	0.510
Psychological trauma [e]								
No	Ref				Ref	–	–	–
Yes	0.08	1.34	−0.23, 1.21	0.18	−0.02	−0.30	−0.77, 0.57	0.684
Smoking								
No	Ref	–	–	–	Ref	–	–	–
Yes	−0.02	−0.37	−4.25, 2.90	0.71	−0.04	−0.71	−4.51, 2.13	0.480
Drinking (≥3 times per week)								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.12	1.91	−0.03, 1.81	0.058	0.08	1.28	−0.30, 1.42	0.201
Exercise (≥3 days per week)								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.02	0.33	−0.53, 0.74	0.741	0.09	1.47	−0.15, 1.06	0.143
Regular diets (≥5 days per week)								
No	Ref	–	–	–	Ref	–	–	–
Yes	−0.15	−2.47	−1.46, −0.17	**0.014**	−0.07	−1.19	−1.01, 0.25	0.234
Chronic disease (medical)								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.003	0.05	−1.02, 1.07	0.96	−0.01	−0.24	−1.13, 0.88	0.809
Work unit characteristics								
Chronic ward	0.14	1.05	−0.09, 2.80	0.067	0.05	0.63	−0.92, 1.79	0.527
Acute ward	0.12	−1.07	−0.34, 1.66	0.197	0.09	0.95	−0.50, 1.41	0.345
Intensive care unit (ICU)	0.23	2.25	0.42, 2.90	**0.009**	0.14	1.71	−0.15, 2.19	0.088
Others (non-shift units)	Ref	–	–	–	Ref	–	–	–
Measures related to COVID-19 [f]								
No	Ref	–	–	–	Ref	–	–	–
Yes	0.01	0.22	−0.59, 0.73	0.830	0.06	0.97	−0.31, 0.91	0.334
			n = 254				R² = 0.32, n = 254	

[a] Measured by years.

[b] From economic, emotional, parenting, and marriage aspects, ranging from 0 = None to 1 = Always.

[c] Measured by Lo's Healthy and Happy Lifestyle Scale.

[d] Measured by Societal Influences Survey Questionnaires.

[e] Experiencing or witnessing events such as natural disasters, accidents, or abuse, and so on.

[f] Under self-health management, under home isolation/quarantine or infection; COVID-19: coronavirus disease 2019; β: standardized coefficients; t: T score; CI: Confidence interval; **Bolds:** p < 0.05.

6.53 % and the turnover rate was 11.73 %, both higher than in 2019 before the outbreak of the pandemic and during the second wave survey in 2021 [66,67]. The continuous accumulation of confirmed patients and the inability to recruit enough personnel to compensate for the loss may be the reasons why we were unable to observe any improvement in the sleep quality of nursing staff. High vacancy rates and high turnover rates may also explain the lack of significant differences in self-efficacy among nursing staff between the two surveys. Self-efficacy is defined as the belief in one's ability to successfully perform tasks and achieve desired outcomes [39], and high self-efficacy is one of the factors that decrease turnover intention [68–70].

5.3. Factors related to sleep disturbance

For nursing staffs, life stress is the most important factor affecting sleep quality, which is consistent with most studies [71–74]. This is also consistent with studies during the COVID-19 pandemic [74,75]. We found in both waves of surveys that life stress affects sleep quality, indicating that the perception of life stress is an important predictor of sleep quality for nurses during the COVID-19 pandemic.

Social anxiety predicted sleep disturbances as well. For SISQ-15, social anxiety indicated the level of anxiety associated with COVID-19 [46]. Our finding was consistent with previous research [34,76]. However, when we used a multiple regression model to analyze the factors affecting sleep quality in the fourth wave of the survey, the impact of social anxiety on sleep disturbances was no longer significant. This may

be because, as the pandemic gradually subsided, the anxiety related to COVID-19 decreased, making its impact less important compared to other factors in the model. This is also consistent with our finding that the scores measured by SISQ-15 decreased across the two waves of surveys.

As the pandemic trend declined, the public, including nursing staff, paid less attention to the pandemic, which may also explain why we found that measures against COVID-19 were associated with reduced sleep quality in the second wave of the survey, but no significant impact was observed in the fourth wave. Previous study have indicated that although lockdowns due to the pandemic increased sleep duration, the stress caused by the interruption of work and studies might decrease sleep quality [35]. This indicates that regardless of whether the environment objectively allows or restricts sleep time, the key factor affecting sleep quality remains the psychological state of the individual. This might be similar to our findings: Although more measures were taken towards the end of the pandemic, people's attention to the pandemic decreased, suggesting that the uncertainty the pandemic brought to life and work had diminished. Therefore, its impact on sleep quality also changed.

Nursing staff's work units are also related to sleep quality. We found that nursing staff working in acute care units and intensive care units have poorer sleep quality. This is consistent with previous research, where nurses working in units requiring shift work have poorer sleep quality [33,77,78]. Additionally, consistent with previous research, we also found that nurses who have a spouse have better sleep quality [79]. However, although having a partner helps reduce sleep disorders, this result was only observed during the fourth wave of the pandemic. Liu and Hsieh indicated that although married individuals consistently reported higher levels of happiness than unmarried individuals during the COVID-19 pandemic, the increase in unhappiness from before the pandemic to during the pandemic was greater among married respondents, thereby narrowing the happiness gap [80]. This might explain why we only found better sleep quality among those with partners during the fourth wave of the survey.

Self-efficacy and positive thinking were also found to be associated with reduced sleep disturbances [41,42] which is consistent with our findings. However, when we used multiple regression analysis, this effect was no longer significant. Due to the fact that univariate analysis assesses marginal distribution, while multivariate analysis assesses conditional distribution, this difference highlights the importance of considering both individual and collective variable effects [81]. This means that in multivariate analysis, the effect of a single variable may be influenced by the effects of other variables, making it difficult for the single variable to reach significance simultaneously. Nevertheless, we can still gain a preliminary understanding of the impact of self-efficacy and positive thinking on sleep disturbances. This might be similar to our finding that a regular diet helps improve sleep quality [82,83], but only in univariate regression analysis. However, in both the second and fourth waves of the survey, a regular diet contributed to reducing sleep disorders.

Additionally, the study results show that, consistent with previous research, psychological trauma [84,85], smoking habits [76], and drinking habits [86]. are also factors that affect sleep quality. Although the influence of these variables only appeared in the univariate regression analysis framework, it still provides a preliminary understanding of their impact on sleep quality.

A psychological trauma refers to personally experiencing or witnessing events such as natural disasters, accidents, or abuse, and so on. In our second wave of surveys, we found that psychological trauma affected sleep quality; however, this was not observed in the fourth wave of surveys. In our study, we found that during the later stages of the pandemic, specifically in the fourth wave of surveys, nursing staffs had higher positive thinking scores. Previous studies have indicated that positive thinking can reduce traumatic stress [87]. However, whether this is the cause of the difference in the impact of psychological trauma

on sleep quality observed in the two surveys requires further research to verify. Regarding smoking and drinking habits, research indicates that during the COVID-19 pandemic, the consumption of cigarettes and alcohol significantly increased compared to pre-pandemic levels [88]. Therefore, as the impact of the pandemic on nursing staff diminished, it may have also led to a weakening effect of smoking and drinking habits on sleep quality.

5.4. The clinical implications

This study has several findings that can serve as references for clinical applications. Firstly, for clinical staff, enhancing self-efficacy and positive thinking can help reduce sleep disturbances. And these two abilities can be enhanced through training and environmental support. Research indicates that continuous reflection and peer support are key to the development of self-efficacy [89,90]. Additionally, by promoted by providing information and strategies related to mindset, humor, and strong spiritual support, the positive thinking abilities of healthcare workers can be enhanced [91]. Hospitals can adopt effective strategies to enhance the positive thinking and self-efficacy of nursing staff, thereby increasing their resilience to better manage nursing tasks while maintaining their quality of life [91]. Moreover, these strategies can also be applied in clinical treatment. Research indicates that enhancing self-efficacy can improve the functional status and quality of life of patients [92,93]. Positive thinking can enhance patients' well-being and mental health, thereby improving sleep quality [94,95]. Through psychological counseling and effective guidance and training, individuals whose life and sleep quality have been affected by the COVID-19 pandemic can be helped.

5.5. Limitations

This study had several limitations. First, to protect the privacy of the participants, we did not group participants or conduct paired surveys, so our results should not have been considered a comparison of paired samples. Second, we conducted the survey in a single institution, with the sample limited to nursing staff. Therefore, the external validity of this study was limited, and the findings should have been interpreted cautiously. Third, due to the cross-sectional design of this study and the long interval between the two surveys, our results could only describe the relationships between variables and were not suitable for causal interpretation. Finally, due to the composition characteristics of the nursing profession, our sample might have had a gender bias, which required further research to corroborate our findings.

6. Conclusions

This study analyzed the factors related to the sleep quality of nursing staff during the COVID-19 pandemic. The results showed that in different waves of the pandemic, the public's adaptation to the pandemic and its social impact varied. As the pandemic gradually came to an end, the public's adaptability to the pandemic increased, and its social impact on participants began to decline. At the same time, the extent to which these factors affected sleep quality also began to change. This result might be because, in the later stages of the pandemic, with sufficient medical resources and relaxed epidemic prevention policies, along with the public's understanding and adaptation to the pandemic, the impact of the pandemic on the public decreased. As people returned to normal life, the factors related to the pandemic had a reduced impact on sleep disturbances. Therefore, during the pandemic, reducing public anxiety, improving populations' adaptation to life during the pandemic, and minimizing the impact of the pandemic on daily life were important.

Secondly, for nursing staff, self-efficacy was one of the possible factors affecting sleep quality. However, the self-efficacy of nurses did not change with the easing of the pandemic. This might be due to the occupational burnout and exhaustion caused by the medical burden

during the pandemic. This requires further research for verification.

Overall, this study preliminarily explored the impact of the COVID-19 pandemic on the sleep quality of nursing staff. As the pandemic progressed, its effects varied. However, due to the occupational characteristics of healthcare workers, especially nurses, it is worth further investigating whether they were affected differently by the pandemic compared to the general public or other healthcare workers.

Data availability

Anonymized data, as described in this manuscript, will be shared upon request from any qualified investigator by the corresponding author (Dr. Frank Huang-Chih Chou, email: f50911.tw@yahoo.com.tw).

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CRediT authorship contribution statement

Pei-Jhen Wu: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Wen Chun Wang:** Writing – original draft, Formal analysis, Data curation. **Chin-Lien Liu:** Investigation. **Guei-Ging Lin:** Investigation. **Ying-Ying Lo:** Writing – review & editing, Formal analysis, Conceptualization. **Frank Huang-Chih Chou:** Writing – review & editing, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleepx.2024.100120.

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