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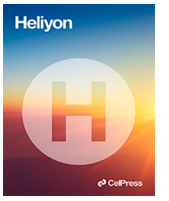

# Risk factors for post-traumatic stress disorder in nurses from the regional medical alliance during the COVID-19 epidemic: A prospective cross-sectional study

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ABSTRACT

Mental health issues among nursing professionals have been increasingly reported during the coronavirus disease (COVID-19) pandemic. However, there is a paucity of research on post-traumatic stress disorder (PTSD) among nurses working in Medical Alliances. In this study, we aimed to investigate the risk factors associated with PTSD in the Regional Medical Alliance (MA) in Shantou (China) during the COVID-19 pandemic. A total of 1286 nurses from four MA hospitals participated in the study from February to March 2020. Our findings revealed that the incidences of PTSD, depression, anxiety, and sleep disorders among nurses from MA were 15.6%, 35.5%, 18.3%, and 36.4%, respectively. Moreover, PTSD was positively correlated with depression, anxiety, and sleep disorders. In addition, the results of logistic regression analysis showed that working in a tertiary hospital, older age, more severe depression, more severe anxiety, and prevalent sleep disorders were independent risk factors for PTSD among nurses. Therefore, mental health interventions targeting high-risk nurses in MA with an incidence of PTSD are urgently needed.

## 1. Introduction

Post-traumatic stress disorder (PTSD) is a psychological condition that arises following exposure to or witnessing unusually catastrophic or threatening traumatic events or situations [1,2]. PTSD is characterized by difficulties in daily functioning due to recurring flashbacks or uncontrollable thoughts of past traumatic events, avoidance of trauma-related stimuli, and heightened vigilance [2,3]. The prolonged course of PTSD can detrimentally affect psychological wellbeing, social functioning, and quality of life [1].

The COVID-19 outbreak, a respiratory infectious disease caused by the novel coronavirus, has increased the global incidence of PTSD. This pandemic has affected people of all ages, races, and nationalities [4]. Since its discovery in Wuhan, China, in December 2019, the number of infected patients has rapidly increased [5], significantly affecting public health and daily life [6–8]. Since the beginning of the pandemic, national healthcare systems in China and other countries have faced mounting pressures and challenges [9,

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10]. Nurses, one of the primary healthcare professionals, have a heavy clinical workload and encounter unique problems such as a drastic shift in working patterns and an increased risk of infection [10,11]. In addition, the presence of physical symptoms was identified as an independent predictor of adverse psychological outcomes [12]. Therefore, evidence-based mental health services are preferable, and it is necessary to explore the mental health status of frontline nurses during the COVID-19 pandemic.

Studies conducted during the severe acute respiratory syndrome and Middle East Respiratory Syndrome pandemics have found that PTSD [1,3,8,9], depression, anxiety, and sleep disorders [7,10,11,13] are the most common mental health problems and long-term consequences of these outbreaks, while few studies have evaluated the four crucial psychological dimensions. To the best of our knowledge, no previous quantitative study has attempted to measure PTSD, depression, anxiety, and sleep disorders among clinical nurses in the Medical Alliance (MA) during the COVID-19 pandemic. A Regional Medical Treatment Alliance refers to a grade-A-class-3 hospital in China that is the core hospital in a region and integrates medical resources and implements educational and research programs to improve the efficiency of the medical service in this region [13,14]. The MA has several advantages, such as rational allocation of medical resources, continuity of services, and resource accessibility [13,15,16]. However, studies regarding the mental health of frontline nurses in regional MAs during the COVID-19 outbreak are lacking. Therefore, this study aimed to investigate PTSD and related factors caused by psychological stress among nurses in the MA during the early stages of the COVID-19 outbreak in China. The present findings can assist healthcare policymakers and practitioners in identifying the reasons for poor mental health and in designing policies and guidelines to promote mental well-being among nurses in the MA.

## 2. Methods

### 2.1. Study design and participants

This was a prospective cross-sectional study that recruited clinical nurses from four hospitals between February and March 2020. This study was conducted using the resources of the Regional MA in Shantou (China), with the First Affiliated Hospital of Shantou University Medical College being the core hospital.

The inclusion criteria were as follows: 1) a nurse qualification certificate and 2) regular work experience as a nurse starting no later than December 2019. The exclusion criteria were as follows: 1) nurses working in non-nursing positions or without direct everyday contact with patients (e.g., administration positions), 2) interns or nursing students, and 3) questionnaires with incomplete answers or suspected unreal answers. This study was approved by the Clinical Research Ethics Committee of the First Affiliated Hospital of Shantou University Medical College (No. 2020-008). All participants completed this study's online self-rated questionnaire based on WeChat and Wenjuanxing platforms anonymously, and self-rated questionnaires were disseminated through a QR code or a website link. All participants electronically provided informed consent before registration. The informed consent page presented two options (yes or no). Only participants who chose yes were taken to the questionnaire page, and they could quit the process at any time. Sit-up random rewards, including praise or small tokens such as snacks and gifts, were provided when the participants completed the survey and submitted the questionnaires to improve the survey response rate.

### 2.2. Measures

Demographic variables included age, sex, marital status, education level, professional qualifications, department, years of working experience, administrative position, type of employment, shift pattern, duty changes during the pandemic, and participation in the frontline medical team in Wuhan.

The presence of PTSD was evaluated using the PTSD self-rating scale (PTSD-SS) [17]. This scale comprises 24 items categorized into five dimensions, including subjective assessment of traumatic events, repeated experience, avoidance of symptoms, increased alertness, and impaired social function. Participants were asked to score each item using the 5-points Likert scale, and a threshold score of $\geq$50 points was used to define PTSD. The Cronbach's α of PTSD-SS was 0.921, indicating excellent reliability and validity [18].

The symptoms of depression were assessed using the self-rating depression scale (SDS) [19], which utilized a Likert-4 scale for scoring. Depression severity was graded as normal ($<$50 points), mild (50–59 points), or moderate to severe ($\geq$60 points). The Cronbach's α of SDS was 0.802, indicating good reliability and validity [20].

Anxiety was evaluated using the self-rating anxiety scale (SAS) [21], which uses a 4-points Likert scale, for scoring. Depression severity was graded as normal ($<$50 points), mild (50–59 points), or moderate-to-severe ($\geq$60 points). The Cronbach's α of SAS was 0.931, indicating excellent reliability and validity [22].

The Pittsburgh Sleep Quality Index (PSQI) [23] was used to evaluate sleep quality. It includes 24 items across seven dimensions: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. The items were scored using a Likert-5 scale, and a threshold score of $\geq$7 points was used to define sleep disorders. Cronbach's α was 0.842, suggesting good reliability and validity [24].

### 2.3. Statistical analysis

Statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Continuous data were checked for normality of distribution using the Kolmogorov-Smirnov test and are presented as mean ± standard deviation. Categorical data are expressed as frequencies and percentages, and analyses were performed using the chi-square test or Fisher's exact probability method. Pearson's correlation analysis was conducted to explore the association between the mental health scores. Logistic regression analysis

**Table 1**
Baseline characteristics of 1286 nurses who participated in the study, according to the absence or presence of post-traumatic stress disorder (PTSD), n (%).

| Variables | Total ($n = 1286$) | Without PTSD ($n = 1086$) | With PTSD ($n = 200$) | $\chi^2$ | *P*-value |
|---|---|---|---|---|---|
| **Grade of hospital** | | | | 20.299 | 0.002* |
| Secondary hospitals | 256 (19.9) | 232 (90.6) | 24 (9.4) | | |
| Tertiary hospitals | 1030 (80.1) | 854 (82.9) | 176 (17.1) | | |
| **Age, year** | | | | 18.579 | 0.001* |
| ≤25 | 476 (37.0) | 422 (88.7) | 54 (11.3) | | |
| 26–30 | 385 (29.9) | 328 (85.2) | 57 (14.8) | | |
| 31–35 | 151 (11.7) | 125 (82.8) | 26 (17.2) | | |
| 36–40 | 87 (6.8) | 68 (78.2) | 19 (21.8) | | |
| >40 | 187 (14.5) | 143 (76.5) | 44 (23.5) | | |
| **Gender** | | | | 0.040 | 0.540 |
| Male | 44 (3.4) | 37 (84.1) | 7 (15.9) | | |
| Female | 1242 (96.6) | 1049 (84.5) | 193 (15.5) | | |
| **Education** | | | | 1.696 | 0.638 |
| Secondary specialized school | 494 (38.4) | 412 (83.4) | 82 (16.6) | | |
| Junior college | 328 (25.5) | 277 (84.5) | 51 (15.5) | | |
| Undergraduate | 448 (34.8) | 382 (85.3) | 66 (14.7) | | |
| Master | 16 (1.2) | 15 (93.8) | 1 (6.2) | | |
| **Professional Qualification** | | | | 2.241 | 0.692 |
| Trainee Nurse | 450 (35.0) | 382 (84.9) | 68 (15.1) | | |
| General Nurse | 528 (41.1) | 440 (83.3) | 88 (16.7) | | |
| Nurse in charge | 257 (20.0) | 223 (86.8) | 34 (13.2) | | |
| Deputy chief nurse | 45 (3.5) | 36 (80.0) | 9 (20.0) | | |
| Chief nurse | 6 (0.5) | 5 (83.3) | 1 (16.7) | | |
| **Administrative Position** | | | | 4.410 | 0.030* |
| None | 1201 (93.4) | 1021 (85.0) | 180 (15.0) | | |
| Head nurse | 85 (6.6) | 65 (76.5) | 20 (23.5) | | |
| **State of Marriage** | | | | 1.364 | 0.505 |
| Unmarried | 498 (38.7) | 417 (83.7) | 81 (16.3) | | |
| Married | 782 (60.8) | 663 (84.8) | 119 (15.2) | | |
| Divorced or widowed | 6 (0.5) | 6 (100) | 0 (0) | | |
| **Working Department** | | | | 18.974 | 0.002* |
| Infection & respiratory | 71 (5.5) | 64 (90.1) | 7 (9.9) | | |
| Other internal | 243 (18.9) | 220 (90.5) | 23 (9.5) | | |
| Surgery | 328 (25.5) | 295 (89.9) | 33 (10.1) | | |
| Emergency and critical department | 146 (11.4) | 112 (76.7) | 34 (23.3) | | |
| Gynecology Surgery and pediatrics | 215 (16.7) | 188 (87.4) | 27 (12.6) | | |
| Others department | 283 (22) | 250 (88.3) | 33 (11.7) | | |
| **Type of Employment** | | | | 0.451 | 0.996 |
| Authorities | 164 (12.8) | 144 (87.8) | 20 (12.2) | | |
| Agency | 239 (18.6) | 211 (88.3) | 28 (11.7) | | |
| Contract | 883 (68.7) | 774 (87.7) | 109 (12.3) | | |
| **Years of Working, year** | | | | 0.495 | 0.920 |
| 1–5 | 606 (47.1) | 512 (47.1) | 94 (47.0) | | |
| 5.1–10 | 367 (28.5) | 307 (28.3) | 60 (30.0) | | |
| 10.1–15 | 103 (8.0) | 89 (8.2) | 14 (7.0) | | |
| >15 | 210 (16.3) | 178 (16.4) | 32 (16.0) | | |
| **Shift Pattern** | | | | 16.943 | <0.001* |
| Day shift | 350 (27.2) | 318 (29.3) | 32 (16.0) | | |
| Night shift | 700 (54.4) | 581 (53.5) | 119 (59.5) | | |
| Irregular night shift | 236 (18.4) | 187 (17.2) | 49 (24.5) | | |
| **Duty Changes during the Pandemic** | | | | 4.479 | 0.022* |
| No | 922 (71.7) | 791 (72.8) | 131 (65.5) | | |
| Yes | 364 (28.3) | 295 (27.2) | 69 (34.5) | | |
| **Applied to the Medical Team** | | | | 3.614 | 0.033* |
| No | 1139 (88.6) | 954 (87.8) | 185 (92.5) | | |
| Yes | 147 (11.4) | 132 (12.1) | 15 (7.5) | | |
| **Frontline Member** | | | | 1.009 | 0.184 |
| No | 1085 (84.4) | 921 (84.8) | 164 (82.0) | | |
| Yes | 201 (15.6) | 165 (15.2) | 36 (18.0) | | |

PTSD, post-traumatic stress disorder self-rating scale; *denotes the statistically significant at $P < 0.05$.

was used to identify the factors linked to PTSD using the backward Wald method. Statistical significance was denoted by two-sided *p*-values <0.05.

## 3. Results

### 3.1. Analysis of baseline characteristics of 1286 nurses

A total of 1334 questionnaires were received initially. During the data collection process, 40 surveys were eliminated, and 1286 complete surveys were obtained, with a response rate of 96.4%. The age of the nurses ranged from 19 to 55 years, with a mean age of 30.0 ± 8.3 years, and the vast majority (96.6%) were female. The overall prevalence of PTSD was 15.6% (200/1286). There were significant differences in the prevalence of PTSD with respect to hospital grade, age, administrative position, departments, shift pattern, and duty changes during the pandemic among the medical team and frontline members (all $p < 0.05$). However, no significant differences were observed in the prevalence of PTSD regarding sex, education, professional qualification, state of marriage, type of employment, years of working, or frontline nursing status (all $p > 0.05$) (Table 1).

### 3.2. Analysis of PTSD-SS, SDS, SAS, and PSQI scores among nurses

The scores of PTSD-SS were 37.55 ± 14.15, mostly on account of repeated experience (11.34 ± 4.41) and avoidance of symptoms (10.29 ± 4.22) sub-scale changes. The scores of SDS and SAS were 47.91 ± 11.91 and 40.93 ± 10.06, respectively. The total PSQI scale score was 6.52 ± 3.69, primarily because of sleep latency (1.50 ± 0.99) sub-scale changes (Table 2).

Correlation analyses showed that PTSD-SS scores positively correlated with SDS ($r = 0.49$, $p < 0.001$), SAS ($r = 0.64$, $p < 0.001$), and PSQI scores ($r = 0.49$, $p < 0.001$) (Supplementary Table 1). Furthermore, there were significant differences in the prevalence of PTSD-SS among the different grades of depression, anxiety, and sleep disorders (all $p < 0.001$), and the prevalence of PTSD-SS increased with the grade of anxiety ($p < 0.001$) and depression ($p < 0.001$) (Table 3).

### 3.3. Analysis of risk factors affecting the occurrence of PTSD in nurses

Older age was one of the most notable risk factors: Odds ratio (*OR*) = 2.15 for the 36–40 years group (95% confidence interval (*CI*): 1.02–4.49, $p = 0.043$) and *OR* = 2.36 for the >40 years group (95% *CI*: 1.32–4.21, $p = 0.004$). In addition, tertiary hospital (*OR* = 1.92, 95% *CI*: 1.12–3.31, $p = 0.018$), level of depression (moderate-to-severe, *OR* = 2.35, 95% *CI*: 1.18–4.69, $p = 0.004$), anxiety (*OR* = 18.46, 95% *CI*: 7.75–43.97, $p < 0.001$), and sleep disorders (*OR* = 4.15, 95% *CI*: 2.78–6.20, $p < 0.001$) were independently associated with PTSD in nurses (Table 4).

## 4. Discussions

The COVID-19 pandemic has highlighted inadequacies in healthcare systems, leading many hospitals worldwide to make difficult decisions regarding patient triage and admission denials. In retrospect, COVID-19 presents an opportunity to identify and address the gaps and shortcomings in healthcare systems in preparation for future pandemics [25]. Therefore, it is crucial to identify the factors associated with PTSD in nurses on the frontlines of patient care during events like a pandemic to improve their psychological

**Table 2**
Evaluation of the Post-Traumatic Stress Disorder (PTSD) severity, depression, anxiety, and sleeping quality.

| Variables | Score (mean ± SD) |
|---|---|
| **PTSD-SS** | 37.55 ± 14.15 |
| Subjective assessment of traumatic events | 2.12 ± 0.96 |
| Experience repeated | 11.34 ± 4.41 |
| Avoidance of symptoms | 10.29 ± 4.22 |
| Increased alertness | 9.21 ± 3.75 |
| Impaired social function | 3.27 ± 1.45 |
| **SDS** | 47.91 ± 11.91 |
| **SAS** | 40.93 ± 10.06 |
| **PSQI** | 6.52 ± 3.69 |
| Sleep quality | 1.07 ± 0.75 |
| Sleep latency | 1.50 ± 0.99 |
| Sleep duration | 0.98 ± 0.81 |
| Habitual sleep efficiency | 0.97 ± 0.95 |
| Sleep disturbance | 1.06 ± 0.62 |
| Use of sleeping medication | 0.08 ± 0.39 |
| Daytime dysfunction | 0.86 ± 0.83 |

PTSD-SS, post-traumatic stress disorder self-rating scale; SDS, self-rating depression scale; SAS, self-rating anxiety scale; PSQI, Pittsburg sleep quality index scale.

**Table 3**
Comparison of the Post-Traumatic Stress Disorder (PTSD) incidence among participants with different grades of depression, anxiety, and sleep disorder, n (%).

| Variable | Total ($n$ = 1286) | Without PTSD ($n$ = 1086) | With PTSD ($n$ = 200) | $\chi^2$ | $P$-value |
|---|---|---|---|---|---|
| **Anxiety Lever** | | | | 336.163 | <0.001* |
| Normal | 1051 (81.7) | 973 (92.6) | 78 (7.4) | | |
| Mild | 181 (14.1) | 103 (56.9) | 78 (43.1) | | |
| Moderate-to-Severe | 54 (4.2) | 10 (18.5) | 44 (81.5) | | |
| **Depression Lever** | | | | 165.548 | <0.001* |
| Normal | 830 (64.5) | 768 (92.5) | 62 (7.5) | | |
| Mild | 363 (28.2) | 275 (75.8) | 88 (24.2) | | |
| Moderate- Severe | 93 (8.3) | 43 (4.0) | 50 (25.0) | | |
| **Sleep Disorder** | | | | 172.893 | <0.001* |
| No | 818 (63.6) | 773 (94.5) | 45 (5.5) | | |
| Yes | 468 (36.4) | 313 (66.9) | 155 (33.1) | | |

*denotes the statistically significant at P < 0.05.

**Table 4**
Multivariate analysis of risk factors related to the incidence of Post-Traumatic Stress Disorder (PTSD) in nurses.

| Variables | OR | 95% CI | $P$-value |
|---|---|---|---|
| Grade of Hospital | | | |
| Secondary hospitals | 1 | | |
| Tertiary hospitals | 1.92 | 1.12–3.31 | 0.018* |
| **Age, year** | | | |
| ≤25 | 1 | | |
| 26–30 | 1.55 | 0.94–2.56 | 0.087 |
| 31–35 | 1.64 | 0.88–3.04 | 0.118 |
| 36–40 | 2.15 | 1.02–4.50 | 0.043* |
| >40 | 2.36 | 1.32–4.21 | 0.004* |
| **Administrative Position** | | | |
| No | 1 | | |
| Yes | 1.88 | 0.99–3.60 | 0.055 |
| **Working Department** | | | |
| Infection & respiratory | 1 | | |
| Other internal | 0.97 | 0.55–1.70 | 0.918 |
| Surgery | 1.50 | 0.81–2.76 | 0.194 |
| Emergency and critical department | 1.65 | 0.88–3.09 | 0.122 |
| Gynecology surgery and pediatrics | 0.66 | 0.35–1.23 | 0.187 |
| Others department | 1.12 | 0.44–2.82 | 0.816 |
| **Anxiety Level** | | | |
| Normal | 1 | | |
| Mild | 4.21 | 2.65–6.70 | <0.001* |
| Moderate-to-severe | 18.46 | 7.75–43.97 | <0.001* |
| **Depression Level** | | | |
| Normal | 1 | | |
| Mild | 1.74 | 1.11–2.74 | 0.016* |
| Moderate-to-severe | 2.35 | 1.18–4.69 | 0.016* |
| **Sleep Disorder** | | | |
| No | 1 | | |
| Yes | 4.15 | 2.78–6.20 | <0.001* |

*P-values are significant at 95% confidence interval (P < 0.05). OR, odds ratio; CI, confidence interval.

well-being and the overall efficiency of healthcare systems. This study revealed that higher grades of hospitals in MA, older age, and more serious symptoms of depression, anxiety, and sleep disorders were all independently associated with PTSD among nurses during the COVID-19 pandemic. However, changes in duties during the pandemic and frontline nursing experience were not directly associated with the development of PTSD in this study. These findings may serve as a reference for future clinical studies and psychological interventions aimed at addressing public health emergencies such as pandemics.

### *4.1. Risk factors associated with PTSD in nurses*

Several studies have examined the occurrence of PTSD among nurses during the COVID-19 pandemic and reported numerous factors associated with PTSD. Jiang et al. [26] found that the occurrence of PTSD is related to factors such as average monthly income, length of service, number of children, scores on the Post-Traumatic Growth Inventory, and Nurses' Perceived Professional Benefits Scale. Marcomini et al. [27] reported that working in the emergency department during the pandemic, having irregular work shifts, and coming from a mental health ward increased the risk of receiving a provisional diagnosis of PTSD. Chen et al. [28] found that being

a woman, working in a critical care unit, a COVID-19-designated hospital, and COVID-19-related departments were associated with traumatic responses and emotional exhaustion. Bassi et al. [29] reported that among healthcare workers, women, nurses, frontline workers, and languishing workers were more likely to be diagnosed with PTSD. In a Korean study, PTSD was associated with working in designated COVID-19 hospitals, staffing issues, and COVID-19 symptoms [30]. In Uganda, social support, fear of contracting COVID-19, and increased workload were associated with PTSD in nurses [31]. Lazar et al. [32] reported that the mere fact of working with COVID-19 patients was a risk factor for PTSD, highlighting the traumatic potential of the pandemic. The wide range of reported risk factors for PTSD in nurses during the pandemic may be due to differences in healthcare management cultures across countries as well as variations in the specific factors collected or analyzed. Nevertheless, factors consistently observed across studies may be strong predictors of PTSD.

### 4.2. Hospitals in a medical alliance

Differences in the grades of specialized care can be attributed to factors such as patient volume, severity of the medical conditions being treated, and turnover rate. Higher hospital grades may result in heavier workloads and psychological pressure for clinical nurses [33]. In addition, in the context of the present study, tertiary hospitals bear the onus of admitting critical cases and patients with COVID-19 from their fellow units. The multiple linear regression analysis conducted in this study indicated that the incidence of PTSD among nurses in tertiary hospitals was 1.92 times higher than that among nurses in secondary hospitals. These findings suggest that nurses working in tertiary hospitals endure more pronounced physical and psychological pressures than those working in secondary hospitals and should be duly considered when planning future interventions.

### 4.3. Characteristics of nurses

A multicenter study in the Asia-Pacific region showed that regardless of the number of cases or deaths, healthcare workers from all countries were vulnerable to psychological distress due to the COVID-19 outbreak [34]. In particular, emergency departments were at the forefront of suspected cases, and intensive care units were the primary centers for confirmed cases. Consequently, nurses are at a higher risk of developing PTSD owing to prolonged exposure to these patients [27,35,36]. In this study, the incidence of PTSD among nurses who worked in emergency and critical departments appeared to be higher than those in the internal and surgery departments, although the difference was not statistically significant, aligning with previous research findings [28,37,38]. Conversely, the higher incidence of PTSD among nurses in emergency and critical departments may be due to more experienced nurses or head nurses being assigned to these units, which typically encounter more complicated situations such as nursing disputes, heavy workloads, and staff shortages. This is supported by the finding in this study that older nurses are more likely to develop PTSD.

### 4.4. Relationship of anxiety, depression, sleep disorders, and PTSD

It has been postulated that anxiety, depression, sleep quality, and PTSD exhibit reciprocal causality. Byllesby et al. [39] established that nurses with PTSD evinced heightened propensities for comorbid anxiety, depression, and burnout, and that PTSD onset could exacerbate depression, anxiety, and sleep disorders. Seto et al. [40] contended that anxiety and depression are symptomatic manifestations of PTSD. Moreover, sleep disorders signify a consequential diagnostic criterion for PTSD, whose presence could prognosticate the severity and progression of PTSD [41], and it has been demonstrated that the treatment of sleep disorders could assuage PTSD symptoms and severity [42]. The present study proffers that during the COVID-19 outbreak, all nurses reported elevated levels of anxiety, depression, and sleep disorders, as attested in previous research [35,37]. Furthermore, the SDS, SAS, and PQSI scores exhibited a direct positive correlation with the PTSD scores, revealing that nurses with depression, anxiety, or sleep disorders had a greater propensity to develop PTSD. This corroborates the assertion that symptoms of anxiety and depression may culminate in sleep quality impairment, whereas sleep disorders often instigate varying degrees of depression and anxiety. Therefore, during the COVID-19 outbreak, it is crucial to prioritize the psychological well-being of nurses and introduce appropriate measures to assuage anxiety, depression, and sleep disorders, thereby mitigating the incidence of PTSD.

### 4.5. Mechanism for resource integration of MA

The MA model offers several advantages that can enhance healthcare responses to large-scale events such as the COVID-19 pandemic. The incidence of PTSD among clinical nurses in MA was 15.6%, which is slightly lower than the expected range of 22–32.1% observed in previous studies [33,43]. One possible reason for this is the arrangement and cooperation within MA. During the early stages of COVID-19, the head hospitals of MAs implemented various epidemic prevention and control measures, including the homogeneous management of all units, technical assistance, and professional training of lower-level units [44], which helped improve the quality of medical care and promote resource integration among the units. Furthermore, epidemic preventive measures, such as disinfection and the allocation of medical materials, could be accomplished quickly through resource integration to ensure that all units within the MA are well equipped to face COVID-19. The head unit also provided mental health training and care, as well as online and offline psychological counseling for nurses in all units of the MA. These reasons may explain the relatively low incidence of PTSD compared with earlier studies in other countries. The MA management model offers a promising means of improving healthcare responses to large-scale events, such as pandemics, by providing centralized, large-scale management of resources.

Bae et al. [45] reported that nurses were more likely to experience PTSD when their managers were incompetent. However,

centralizing MA management requires competence and ability, which can increase the confidence of nurses in their management. This model warrants further study to explore its potential benefits in enhancing healthcare responses to large-scale events.

## 5. Practical implications

These findings have several implications for theory, policy, and practice. We observed a specific association between psychosocial factors and poor mental health among clinical nurses in MA during the COVID-19 pandemic. In addition, given the reciprocal causation between PTSD and other mental health problems, such as anxiety, depression, and sleep disorders, healthcare administrators should provide comprehensive and integrated interventions that consider these commodities, including psychological counseling, cognitive-behavioral therapy, stress management, and relaxation techniques. Healthcare authorities should develop policies, practices, and guidelines to support mentally disturbed medical staff, particularly nurses in tertiary hospitals of MA, older age, more severe depression, more severe anxiety, and prevalent sleep disorders. At the same time, clinical psychiatrists, psychologists, and psychotherapists should consider these issues and design specific intervention plans while dealing with this population. Moreover, the results suggest that the management of large-scale events, such as pandemics, could benefit from the centralization of resources and coordination of care through the MA model, as demonstrated in this study. Future research should focus on evaluating and refining interventions aimed at preventing and treating PTSD and other mental health problems among clinical nurses during large-scale events.

## 6. Limitations and strengths

This study has some limitations. First, the cross-sectional nature of the study did not allow for the interpretation of causality. While we found a strong association between the presence of physical symptoms and the incidence of psychological distress, we could not conclude whether psychological distress resulted in the manifestation of these physical symptoms or vice versa. Second, owing to stringent hospital infection control protocols to minimize contact, the questionnaire was not used in the field, and the information provided regarding symptoms could not be verified by a medical professional, which could have influenced our results. Third, only nurses from tertiary and secondary hospitals under MA were investigated; nurses from community hospitals were not included because of limited manpower and material resources. Finally, the number of nurses with moderate-to-severe anxiety and depression was relatively small. The results of this study need to be further verified using multicenter, large-sample, and long-term clinical studies.

This study also has several strengths. First, to the best of our knowledge, this is the first investigation to evaluate four important psychological factors (PTSD, anxiety, depression, and sleep disorders) among clinical nurses in the MA during the COVID-19 pandemic. Second, we used self-evaluated scales for PTSD, anxiety, and depression for better clarification of the participants, who were subjected to subgroup analysis. Third, our study had a relatively larger sample size ($n = 1286$) compared to most similar studies and included individual nurses from hospitals of varying classes and departments.

## 7. Conclusion

This study suggests that, during a pandemic, it is crucial to pay attention to the mental health of nurses, especially those at high risk of developing PTSD, and to provide timely mental health interventions to reduce further harm. It also highlights the potential benefits of a centralized management model such as the MA in improving healthcare responses to large-scale events.

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## Compliance with ethical standards

The study was approved by the First Affiliated Hospital of Shantou University Medical College Ethics Committee (No. 2020-008).

## Author contribution statement

Yanchun Wu: Yulian Guo: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Nuo Xu: Yuqi Xiu: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Hong Zhang: Danna Lin: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Wenjuan Ying: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

## Data availability statement

The authors do not have permission to share data.

## 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 related to this article can be found at https://doi.org/10.1016/j.heliyon.2023.e20289.

## References

[1] B.S. Lai, A.M. La Greca, A. Brincks, C.A. Colgan, M.P. D'Amico, S. Lowe, M.L. Kelley, Trajectories of posttraumatic stress in youths after natural disasters, JAMA Netw. Open 4 (2021), e2036682, https://doi.org/10.1001/jamanetworkopen.2020.36682.
[2] X.R. Miao, Q.B. Chen, K. Wei, K.M. Tao, Z.J. Lu, Posttraumatic stress disorder: from diagnosis to prevention, Mil Med Res 5 (2018) 32, https://doi.org/10.1186/s40779-018-0179-0.
[3] E. Lehinger, D.E. Reed, P. Nabity, N. Brackins, R. Villarreal, C. McGeary, T. Blount, B. Cobos, C. Jaramillo, B.C. Eapen, M.J. Pugh, J. Potter, A. Peterson, S. Young-McCaughan, T. Houle, D.D. McGeary, An examination of chronic pain indices and the updated posttraumatic stress disorder checklist for diagnostic and statistical manual of mental-disorders-fifth edition, Mil. Med. 186 (2021) e1199–e1206, https://doi.org/10.1093/milmed/usaa529.
[4] B. Hu, H. Guo, P. Zhou, Z.L. Shi, Characteristics of SARS-CoV-2 and COVID-19, Nat. Rev. Microbiol. 19 (2021) 141–154, https://doi.org/10.1038/s41579-020-00459-7.
[5] S. Platto, Y. Wang, J. Zhou, E. Carafoli, History of the COVID-19 pandemic: origin, explosion, worldwide spreading, Biochem. Biophys. Res. Commun. 538 (2021) 14–23, https://doi.org/10.1016/j.bbrc.2020.10.087.
[6] J. Qiu, B. Shen, M. Zhao, Z. Wang, B. Xie, Y. Xu, A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: implications and policy recommendations, Gen Psychiatr 33 (2020), e100213, https://doi.org/10.1136/gpsych-2020-100213.
[7] Y. Li, N. Scherer, L. Felix, H. Kuper, Prevalence of depression, anxiety and post-traumatic stress disorder in health care workers during the COVID-19 pandemic: a systematic review and meta-analysis, PLoS One 16 (2021), e0246454, https://doi.org/10.1371/journal.pone.0246454.
[8] R.P. Rajkumar, COVID-19 and mental health: a review of the existing literature, Asian J Psychiatr 52 (2020), 102066, https://doi.org/10.1016/j.ajp.2020.102066.
[9] V.J. Clemente-Suárez, M.B. Martínez-González, J.C. Benitez-Agudelo, E. Navarro-Jiménez, A.I. Beltran-Velasco, P. Ruisoto, E. Diaz Arroyo, C.C. Laborde-Cárdenas, J.F. Tornero-Aguilera, The impact of the COVID-19 pandemic on mental disorders. A critical review, Int. J. Environ. Res. Publ. Health 18 (2021), https://doi.org/10.3390/ijerph181910041.
[10] J.H. Feingold, A. Hurtado, A. Feder, L. Peccoralo, S.M. Southwick, J. Ripp, R.H. Pietrzak, Posttraumatic growth among health care workers on the frontlines of the COVID-19 pandemic, J. Affect. Disord. 296 (2022) 35–40, https://doi.org/10.1016/j.jad.2021.09.032.
[11] C. Felice, G.L. Di Tanna, G. Zanus, U. Grossi, Impact of COVID-19 outbreak on healthcare workers in Italy: results from a national E-survey, J. Community Health 45 (2020) 675–683, https://doi.org/10.1007/s10900-020-00845-5.
[12] N.W.S. Chew, J.N. Ngiam, B.Y. Tan, S.M. Tham, C.Y. Tan, M. Jing, R. Sagayanathan, J.T. Chen, L.Y.H. Wong, A. Ahmad, F.A. Khan, M. Marmin, F.B. Hassan, T. M. Sharon, C.H. Lim, M.I.B. Mohaini, R. Danuaji, T.H. Nguyen, G. Tsivgoulis, S. Tsiodras, P.C. Fragkou, D. Dimopoulou, A.K. Sharma, K. Shah, B. Patel, S. Sharma, R.N. Komalkumar, R. V Meenakshi, S. Talati, H.L. Teoh, C.S. Ho, R.C. Ho, V.K. Sharma, Asian-Pacific perspective on the psychological well-being of healthcare workers during the evolution of the COVID-19 pandemic, BJPsych Open 6 (2020) e116, https://doi.org/10.1192/bjo.2020.98.
[13] T. Cheung, C.P.W. Cheng, T.K.H. Fong, N.T. Sharew, R.L. Anders, Y.T. Xiang, S.C. Lam, Psychological impact on healthcare workers, general population and affected individuals of SARS and COVID-19: a systematic review and meta-analysis, Front. Public Health 10 (2022), 1004558, https://doi.org/10.3389/fpubh.2022.1004558.
[14] F. Yang, Y. Yang, Z. Liao, Evaluation and analysis for Chinese medical alliance's governance structure modes based on preker-harding model, Int. J. Integrated Care 20 (2020) 14, https://doi.org/10.5334/ijic.5417.
[15] W. Zeng, Y.P. Li, J.J. Ye, W. Wang, Comparison and study on the models of medical alliance in China, Chinese general practice, n.d.) 19 (2016) 3003–3007, https://doi.org/10.3969/j.issn.1007-9572.2016.25.001.
[16] C. Feng, J. Zhu, Y. Chen, The evolution and inter-sectoral interaction mechanism of China's national medical alliance: an analysis based on complex systems theory, Int J Health Plann Manage 37 (2022) 1454–1476, https://doi.org/10.1002/hpm.3413.
[17] J.R. Davidson, S.W. Book, J.T. Colket, L.A. Tupler, S. Roth, D. David, M. Hertzberg, T. Mellman, J.C. Beckham, R.D. Smith, R.M. Davison, R. Katz, M.E. Feldman, Assessment of a new self-rating scale for post-traumatic stress disorder, Psychol. Med. 27 (1997) 153–160, https://doi.org/10.1017/s0033291796004229.
[18] J.Z. Huang, M.F. Han, T.D. Luo, A.K. Ren, X.P. Zhou, [Mental health survey of medical staff in a tertiary infectious disease hospital for COVID-19], Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi 38 (2020) 192–195, https://doi.org/10.3760/cma.j.cn121094-20200219-00063.
[19] W.W.K. Zung, A self-rating depression scale, Arch. Gen. Psychiatr. 12 (1965) 63–70, https://doi.org/10.1001/archpsyc.1965.01720310065008.
[20] D.A. Dunstan, N. Scott, Clarification of the cut-off score for Zung's self-rating depression scale, BMC Psychiatr. 19 (2019) 177, https://doi.org/10.1186/s12888-019-2161-0.
[21] D.A. Dunstan, N. Scott, Norms for zung's self-rating anxiety scale, BMC Psychiatr. 20 (2020) 90, https://doi.org/10.1186/s12888-019-2427-6.
[22] B.O. Olatunji, B.J. Deacon, J.S. Abramowitz, D.F. Tolin, Dimensionality of somatic complaints: factor structure and psychometric properties of the Self-Rating Anxiety Scale, J. Anxiety Disord. 20 (2006) 543–561, https://doi.org/10.1016/j.janxdis.2005.08.002.
[23] D.J. Buysse, C.F. Reynolds 3rd, T.H. Monk, C.C. Hoch, A.L. Yeager, D.J. Kupfer, Quantification of subjective sleep quality in healthy elderly men and women using the Pittsburgh Sleep Quality Index (PSQI), Sleep 14 (1991) 331–338.
[24] P.S. Tsai, S.Y. Wang, M.Y. Wang, C.T. Su, T.T. Yang, C.J. Huang, S.C. Fang, Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects, Qual. Life Res. 14 (2005) 1943–1952, https://doi.org/10.1007/s11136-005-4346-x.

[25] M. The, Lancet Respiratory, Future pandemics: failing to prepare means preparing to fail, Lancet Respir. Med. 10 (2022) 221–222, https://doi.org/10.1016/s2213-2600(22)00056-x.
[26] H. Jiang, N. Huang, W. Tian, S. Shi, G. Yang, H. Pu, Factors associated with post-traumatic stress disorder among nurses during COVID-19, Front. Psychol. 13 (2022), 745158, https://doi.org/10.3389/fpsyg.2022.745158.
[27] I. Marcomini, C. Agus, L. Milani, R. Sfogliarini, A. Bona, M. Castagna, COVID-19 and post-traumatic stress disorder among nurses: a descriptive cross-sectional study in a COVID hospital, Med. Lav. 112 (2021) 241–249, https://doi.org/10.23749/mdl.v112i3.11129.
[28] R. Chen, C. Sun, J.J. Chen, H.J. Jen, X.L. Kang, C.C. Kao, K.R. Chou, A large-scale survey on trauma, burnout, and posttraumatic growth among nurses during the COVID-19 pandemic, Int. J. Ment. Health Nurs. 30 (2021) 102–116, https://doi.org/10.1111/inm.12796.
[29] M. Bassi, L. Negri, A. Delle Fave, R. Accardi, The relationship between post-traumatic stress and positive mental health symptoms among health workers during COVID-19 pandemic in Lombardy, Italy, J. Affect. Disord. 280 (2021) 1–6, https://doi.org/10.1016/j.jad.2020.11.065.
[30] D.J. Moon, M.A. Han, J. Park, S.Y. Ryu, Post-traumatic stress and related factors among hospital nurses during the COVID-19 outbreak in korea, Psychiatr. Q. 92 (2021) 1381–1391, https://doi.org/10.1007/s11126-021-09915-w.
[31] A. Kabunga, P. Okalo, Frontline nurses' post-traumatic stress disorder and associated predictive factors during the second wave of COVID-19 in central, Uganda, Neuropsychiatric Dis. Treat. 17 (2021) 3627–3633, https://doi.org/10.2147/ndt.S340771.
[32] A.E. Lazar, J. Szederjesi, O. Coman, A. Elekes, M. Suciaghi, B.L. Grigorescu, Survey on anxiety and post-traumatic stress disorder in intensive care personnel during the COVID-19 pandemic in a medically under-resourced country, Healthcare (Basel) 10 (2022), https://doi.org/10.3390/healthcare10071160.
[33] P. Li, H. Kuang, H. Tan, The occurrence of post-traumatic stress disorder (PTSD), job burnout and its influencing factors among ICU nurses, Am J Transl Res 13 (2021) 8302–8308.
[34] N.W.S. Chew, G.K.H. Lee, B.Y.Q. Tan, M. Jing, Y. Goh, N.J.H. Ngiam, L.L.L. Yeo, A. Ahmad, F. Ahmed Khan, G. Napolean Shanmugam, A.K. Sharma, R. N. Komalkumar, P. V Meenakshi, K. Shah, B. Patel, B.P.L. Chan, S. Sunny, B. Chandra, J.J.Y. Ong, P.R. Paliwal, L.Y.H. Wong, R. Sagayanathan, J.T. Chen, A. Y. Ying Ng, H.L. Teoh, G. Tsivgoulis, C.S. Ho, R.C. Ho, V.K. Sharma, A multinational, multicentre study on the psychological outcomes and associated physical symptoms amongst healthcare workers during COVID-19 outbreak, Brain Behav. Immun. 88 (2020) 559–565, https://doi.org/10.1016/j.bbi.2020.04.049.
[35] A. Lasalvia, C. Bonetto, S. Porru, A. Carta, S. Tardivo, C. Bovo, M. Ruggeri, F. Amaddeo, Psychological impact of COVID-19 pandemic on healthcare workers in a highly burdened area of north-east Italy, Epidemiol. Psychiatr. Sci. 30 (2020) e1, https://doi.org/10.1017/s2045796020001158.
[36] J. Raudenská, V. Steinerová, A. Javůrková, I. Urits, A.D. Kaye, O. Viswanath, G. Varrassi, Occupational burnout syndrome and post-traumatic stress among healthcare professionals during the novel coronavirus disease 2019 (COVID-19) pandemic, Best Pract. Res. Clin. Anaesthesiol. 34 (2020) 553–560, https://doi.org/10.1016/j.bpa.2020.07.008.
[37] S. Bahadirli, E. Sagaltici, Post-traumatic stress disorder in healthcare workers of emergency departments during the pandemic: a cross-sectional study, Am. J. Emerg. Med. 50 (2021) 251–255, https://doi.org/10.1016/j.ajem.2021.08.027.
[38] M. Mealer, J. Jones, P. Meek, Factors affecting resilience and development of posttraumatic stress disorder in critical care nurses, Am. J. Crit. Care 26 (2017) 184–192, https://doi.org/10.4037/ajcc2017798.
[39] B.M. Byllesby, T.A. Durham, D. Forbes, C. Armour, J.D. Elhai, An investigation of PTSD's core dimensions and relations with anxiety and depression, Psychol Trauma 8 (2016) 214–217, https://doi.org/10.1037/tra0000081.
[40] M.C. Seto, N.C. Rodrigues, E. Ham, B. Kirsh, N.Z. Hilton, Post-traumatic Stress Disorder, Depression, Anxiety Symptoms and Help Seeking in Psychiatric Staff: trouble de stress post-traumatique, dépression, symptômes d'anxiété et recherche d'aide chez le personnel psychiatrique, Can. J. Psychiatr. 65 (2020) 577–583, https://doi.org/10.1177/0706743720916356.
[41] V.I. Spoormaker, P. Montgomery, Disturbed sleep in post-traumatic stress disorder: secondary symptom or core feature, Sleep Med. Rev. 12 (2008) 169–184, https://doi.org/10.1016/j.smrv.2007.08.008.
[42] L. Dimitrova, V. Fernando, E.M. Vissia, E.R.S. Nijenhuis, N. Draijer, A. Reinders, Sleep, trauma, fantasy and cognition in dissociative identity disorder, post-traumatic stress disorder and healthy controls: a replication and extension study, Eur. J. Psychotraumatol. 11 (2020), 1705599, https://doi.org/10.1080/20008198.2019.1705599.
[43] G. Yang, J. Liu, L. Liu, X. Wu, S. Ding, J. Xie, Burnout and resilience among transplant nurses in 22 hospitals in China, Transplant. Proc. 50 (2018) 2905–2910, https://doi.org/10.1016/j.transproceed.2018.04.033.
[44] Y. Wei, Z. Ye, M. Cui, X. Wei, COVID-19 prevention and control in China: grid governance, J. Public Health 43 (2021) 76–81, https://doi.org/10.1093/pubmed/fdaa175.
[45] S.Y. Bae, H.J. Yoon, Y. Kim, J. Kim, Posttraumatic stress disorder and related factors among nurses working during the COVID-19 pandemic, J. Nurs. Manag. 30 (2022) 1096–1104, https://doi.org/10.1111/jonm.13615.