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Research article

A propensity score matched analysis of COVID-19 ongoing symptoms in primary medical staff members with different levels of stress in Jiangsu Province, China

Hualing Chen [a,1], Yongjie Zhang [b,1], Yongkang Qian [a], Ya Shen [b], Haijian Guo [b], Rongji Ma [a], Beier Lu [a], Pengcheng Miao [a], Biyun Xu [c], Jinshui Xu [b,**], Bingwei Chen [a,*]

[a] *Department of Epidemiology and Biostatistics, School of Public Health, Southeast University, Nanjing, China*
[b] *Jiangsu Provincial Center for Disease Control and Prevention, Nanjing, China*
[c] *Medical Statistics and Analysis Center, Nanjing Drum Tower Hospital, Nanjing University Medical School, Nanjing, China*

A R T I C L E I N F O

Keywords:
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A B S T R A C T

Objective: Ongoing symptoms which originated from coronavirus disease 2019 (COVID-19) infections threaten the health of a broad population of patients. With recent changes in COVID-19 control measures in China, medical staff members are currently experiencing a high level of stress. This study aimed to investigate the prevalence of ongoing symptomatic COVID-19 and explore the potential association between stress and ongoing COVID symptoms.
Methods: From January 17th to February 2, 2023, primary medical staff members in Jiangsu Province were surveyed using a self-designed questionnaire. Univariate multinomial logistic analysis was used to illustrate the relationship between stress and ongoing symptoms after matching the low- and high-stress groups in a 1:1 ratio based on propensity scores.
Results: Analysis revealed that 14.83 % (3785/25,516) of primary medical staff members infected with COVID-19 experienced ongoing symptoms, the most common of which included cough (9.51 %), dyspnea (9.51 %), sleep problems (4.40 %), anxiety (2.29 %), and reproductive system symptoms (1.89 %). In matched patients, higher stress levels were associated with a greater risk of ongoing symptoms than in patients without ongoing symptoms for 14 of the 15 reported symptoms in this study (odds ratios [ORs] > 1 and $P < 0.05$). Moreover, higher levels of stress were associated with a greater risk of more ongoing symptoms, and the overall ORs increased with the number of symptoms (ORs >1 and $P < 0.05$).
Conclusion: To mitigate the possibility of experiencing ongoing symptoms, healthcare organizations and local authority agencies should institute helpful measures to decrease stress levels such as medical staff augmentation and enabling all staff to have a reasonable work-life balance.

* Corresponding author. No.87 Dingjiaqiao, Hunan Road, Gulou District, Nanjing, 210009, China.
** Corresponding author. No. 172 Jiangsu Road, Gulou District, Nanjing, 210009, China.
E-mail addresses: 220223663@seu.edu.cn (H. Chen), 371578804@qq.com (Y. Zhang), 353112354@qq.com (J. Xu), drchenbw@seu.edu.cn (B. Chen).
[1] These authors contributed equally to this work.

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1. Introduction

Since its emergence in Wuhan, China in late 2019, coronavirus disease 2019 (COVID-19) has rapidly become a global pandemic, with severe and lasting consequences for public health and lives of individuals [1,2]. Caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), COVID-19 primarily spreads through droplets and can also be transmitted indirectly or via aerosols [3,4]. The highly contagious nature of the virus, coupled with rapid transmission and the emergence of variants such as Omicron, has led to widespread outbreak [5,6]. While the majority of COVID-19 cases are mild, infection can progress to severe respiratory distress or failure, posing a major threat to human health [7]. Recent evidence indicates that COVID-19 has a severe impact on human life and health, not only in the acute phase but also with the onset of chronic symptoms following infection, otherwise known as long COVID [8]. The World Health Organization (WHO) defines long COVID as an infection with symptoms that remain present three months after COVID-19 infection, persisting for at least two months, and is not explainable by another diagnosis [9]. Similarly, the National Institute for Health and Clinical Excellence (NICE) in the UK defines long COVID as signs and symptoms that develop during or following an infection consistent with COVID-19 and cannot be explained by other diagnoses, including ongoing symptomatic COVID-19 at 4–12 weeks, and post-COVID-19 syndromes for more than 12 weeks [10]. Our study data collection spanned less than three months, which does not align with the WHO's definition of long COVID. Therefore, we focused on ongoing symptomatic COVID-19 in this research. Long COVID, characterized by persistent symptoms following COVID-19 infection, can manifest as a spectrum of acute illnesses involving multiple systems, such as neurological, respiratory, cardiovascular, gastrointestinal, and musculoskeletal systems. Common symptoms include fatigue, headaches, dizziness, and sleep disturbances, among others [8].

Between December 2022 and January 2023, China adjusted its COVID-19 prevention and control strategies, leading to a significant increase in the number of SARS-CoV-2 infections. This situation poses challenges for healthcare institutions nationwide, with medical staff at the forefront of providing essential services despite the risk of infection [11,12]. Primary medical staff members are individuals employed in primary medical institutions, including community health service centers, township health centers, and village health offices [13]. Jiangsu Province has a total of 692,000 health professional workers, of which primary medical staff members account for approximately 33.8 % (234,000) [14]. Nonetheless, members played an integral role in upholding the seamless operation of primary healthcare institutions by providing basic public health services and serving as the mainstay of COVID-19 epidemic prevention and control. A meta-analysis revealed that healthcare workers experienced significant mental health issues during the early phase of the COVID-19 pandemic [15]. Recent research in Hefei, China, highlighted the mental health status of primary medical staff members during the initial outbreak of COVID-19, indicating that their mental health was poorer than that of healthy people [16].

A retrospective cohort study conducted at Wuhan Hospital indicated that overloading is an important risk factor for COVID-19 infection among health personnel [17]. The known risk factors for long COVID include advanced age, female sex, body mass index, severe clinical status, preexisting health conditions, hospitalization, and oxygen supplementation during hospitalization [18,19]. However, it is unclear whether stress is a risk factor for long COVID.

The aim of this study was to investigate the prevalence and predominant symptoms of ongoing symptomatic COVID-19 as well as to explore variations in stress levels across the population and the potential correlation between stress and ongoing symptoms. We anticipate that the findings of this study will contribute to initiatives aimed at decreasing the occurrence of ongoing symptoms and offering timely assistance to primary healthcare professionals for the improved management of COVID-19 patients experiencing ongoing symptoms, while also enhancing preparedness for other infectious diseases.

2. Methods

2.1. Study methodology

In January 2023, we conducted a cross-sectional survey on the COVID-19 infection status of primary medical staff members from all cities and counties in Jiangsu Province, China.

2.2. Procedure and participants

All questionnaires were distributed using Questionnaire Star through the Integrated Business Management Office of the Jiangsu Provincial Center for Disease Control and Prevention through the Jiangsu Provincial Basic Public Health Services Work Network. Questionnaire Star is an online survey tool which has been widely used in various scientific studies and is equipped with features such as online polling, examination commands, survey management, synchronized data collection, and intelligent statistical analysis [20–22]. Data were collected by designated personnel through project-specific survey software accounts and the outputs were managed using a desensitized database generated by a dedicated device.

Participants were primary medical staff members involved in the direct diagnosis, care, and treatment of COVID-19 patients. The inclusion criteria for this study were as follows: (1) primary medical staff members in Jiangsu Province, and (2) voluntary completion of the questionnaire between January 17, 2023, and February 2, 2023. The exclusion criteria were as follows: (1) questionnaire completion time <300 s for infected individuals (answering 78 questions) and <210 s for uninfected individuals (answering 50 questions), and (2) logical inconsistencies in completing the questionnaire.

2.3. Study measures

A self-designed survey was conducted to elicit general demographic information, COVID-19 infection-related details, and the respondents' workload. Specifically, the collected information included age, sex, region, vaccination status, smoking and drinking history, time and testing status of COVID-19, acute and ongoing symptoms, education level, employment duration, position, and working hours.

As COVID-19 prevention and control strategies have been modified in China, nucleic acid testing is no longer mandatory for all individuals. Identifying asymptomatic individuals without nucleic acid or antigen test results is challenging. Therefore, in this study, uninfected individuals were characterized as those who had not undergone prior testing and displayed no symptomatic features associated with COVID-19, or those with negative results from nucleic acid or antigen tests. Infected individuals were defined as those who tested positive through nucleic acid or antigen tests, or those who exhibited symptoms consistent with COVID-19 but had not undergone testing.

In addition, stress was classified into four levels, as reported by the participants, according to their self-perception: low, moderate, high, and very high. We defined 'low' and 'moderate' as indicative of low stress, while 'high' and 'very high' were considered as representing high stress.

2.4. Data analyses

All statistical analyses in the present study were performed using R 4.2.3. Categorical data are presented as proportions and percentages and were analyzed using Pearson's chi-square test. A stacked bar chart was used to illustrate the differences in the duration of ongoing symptoms. Due to the heterogeneous nature of the data, demographic and stress-related variables were imbalanced. To control for covariates in the high- and low-stress groups, propensity scores were calculated using multivariate logistic regression models. Propensity score matching (PSM) was implemented using the R package "MatchIt" [23] to control for variables such as age, sex, education level, exposure to COVID-19 patients, duration of employment, position, daily working time, weekly working time, break during weekends or holidays, pride in participating in COVID-19 work, and extra allowances. The low- and high-stress groups were matched in a 1:1 ratio based on the propensity score with a caliper value of 0.10. After matching, univariate multinomial logistic analysis and forest plot were used to present the relationship between stress level and ongoing symptoms through the R package "forestploter" (https://cran.r-project.org/web/packages/survminer/index.html). Odds ratios (OR) and 95 % confidence intervals (CI) were also determined. Differences were considered statistically significant if the significance level was not explicitly stated at $P < 0.05$ (two-sided).

2.5. Ethical consideration

The study protocol was approved by the Ethics Committee of the Jiangsu Provincial Center for Disease Control and Prevention (No. JSJK2023-B010-01). Moreover, all participants willingly enrolled in the study and informed consent was obtained at the beginning of the questionnaire.

3. Results

A total of 34,090 primary medical staff members completed the questionnaire, and the final analysis included responses from 30,572 primary medical staff members based on the exclusion criteria. Among these, 25,516 members were infected with COVID-19, whereas 5056 remained uninfected.

3.1. Characteristics of ongoing symptoms

At the time of the survey, 14.83 % (3785/25,516) of COVID-19 patients reported ongoing symptoms; however, ongoing symptoms were more common in those with high stress levels (21.72 % vs. 17.2 %). Those with high stress were also more likely to report more than one symptom after four weeks compared to those with low stress: one symptom (3.6 % vs. 3.0 %), two symptoms (6.9 % vs. 6.0 %), three symptoms (2.8 % vs. 1.8 %), four symptoms (1.5 % vs. 0.7 %), and five or more symptoms (2.3 % vs. 0.9 %). The greatest number of individuals with symptoms was two in both the low-stress group (3.3 %) and the high-stress group. The symptoms were

Table 1
The difference between the low and high stress groups in the number of ongoing symptoms.

Variable	Overall (N = 25,516)	Low stress (n = 12,875)	High stress (n = 12,641)	P-value
Number of ongoing symptoms				<0.001
0	21,731 (85.2 %)	11,262 (87.5 %)	10,469 (82.8 %)	
1	843 (3.3 %)	387 (3.0 %)	456 (3.6 %)	
2	1649 (6.5 %)	774 (6.0 %)	875 (6.9 %)	
3	593 (2.3 %)	236 (1.8 %)	357 (2.8 %)	
4	286 (1.1 %)	94 (0.7 %)	192 (1.5 %)	
≥5	414 (1.6 %)	122 (0.9 %)	292 (2.3 %)	

significantly more common in patients with high stress levels than in those with low stress levels (Table 1). A total of 15 common symptoms were observed. The most common symptoms were cough (9.51 %), dyspnea (9.51 %), sleep problems (4.40 %), anxiety (2.29 %), and reproductive system symptoms (1.89 %), as shown in Fig. 1.

3.2. Baseline characteristics of COVID-19 patients between the low and high stress groups before and after propensity score matching

Table S1 shows the differences in the baseline characteristics between the low- and high-stress groups and the results after PSM. Overall, as seen from the age distribution, the high-stress group was older than the low-stress group ($P < 0.001$). There were more male patients in the high-stress group than in the low-stress group (4098 [56.7 %] vs. 3124 [43.3 %], $P < 0.001$). Education levels were significantly higher in the high-stress group than in the low-stress group ($P < 0.001$). After December 1, 2022, more than half of the high-stress group were involved in the treatment, care, and accompaniment of infected persons in designated areas, such as fever clinics (7352 [59.7 %] vs. 4958 [40.3 %] patients; $P < 0.001$). This was significantly more than the low-stress group. The high-stress group had higher working seniority and longer daily and weekly working hours than the low-stress group (all $P < 0.001$). Significantly more leaders and middle-level administrators belonged to the high-stress group, while the low-stress group had more staff members. Moreover, 65.0 % of patients in the high-stress group were unable to get the needed breaks on weekends or holidays, whereas 83.0 % of patients in the low-stress group had sufficient breaks. Patients in the low-stress group expressed more pride in their participation in COVID-19 work. Patients who received additional compensation or other forms of motivation experienced higher stress levels.

To further investigate the relationship between stress and COVID-19 ongoing symptoms, PSM was used to control for potential covariates, and 25,516 infected individuals were matched. Jitter-type plots of the propensity scores of both the low- and high-stress groups before and after matching are presented in Fig. 2.

Previous studies identified certain demographic variables as risk factors for ongoing symptoms. Moreover, variables such as working seniority and working time were associated with stress levels, indicating that individuals with longer working hours and administrative positions were more likely to experience higher stress levels. According to Rubin and Thomas, it is important to include all variables that may impact the outcome in PSM [24].

The patients were carefully matched with regard to age, sex, education level, exposure to COVID-19 infected persons, duration of employment, position, daily working time, weekly working time, taking breaks during weekends or holidays, pride in participating in COVID-19 work, and extra allowance, where the standardized mean difference (SMD) was less than 0.1 for most variables. The only exception was for pride in participating in COVID-19 work, which had an SMD of 0.117. There were 8087 matches between the stress groups after PSM (Table S1 and Fig. 3).

3.3. Univariate analysis of stress related to ongoing symptoms after propensity score matching

Fifteen ongoing symptoms were studied in the matched patients, with high stress posing a risk factor for 14 of these symptoms. The higher the stress level, the greater the risk of ongoing symptoms. Groups with symptoms lasting more than 28 days had the largest OR for anxiety (OR 2.69, 95%CI 2.16–3.36), chest pain (OR 2.57, 95%CI 1.92–3.44), cognitive impairment (OR 2.50, 95%CI 1.84–3.40), heart-related symptoms (OR 2.47, 95%CI 1.94–3.15), and dyskinesia (OR 2.39, 95%CI 1.73–3.30), as compared to groups without ongoing symptoms. It was observed that OR for symptoms lasting 1–28 days were smaller than that for symptoms lasting more than 28 days (anxiety: 2.69 (2.16–3.36) vs 1.22 (1.15–1.30)) (Fig. 4).

Among patients with similar characteristics, those with ongoing symptoms had a higher risk of high stress than those without ongoing symptoms (OR 1.20, 95%CI 1.01–1.42). As the number of ongoing symptoms increased, the risk due to high stress also increased, with a maximum OR of 2.61 (95%CI 2.02–3.37) (Table 2).

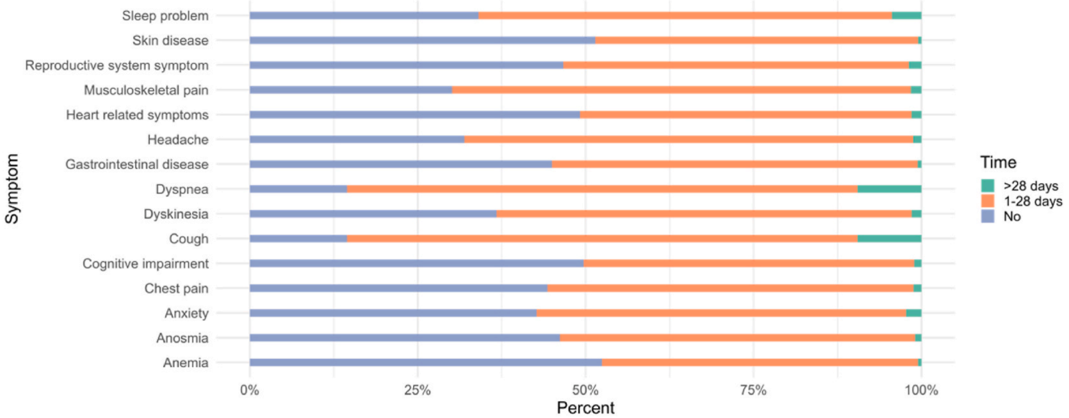

Fig. 1. The characteristics of ongoing symptoms of primary medical staff members.

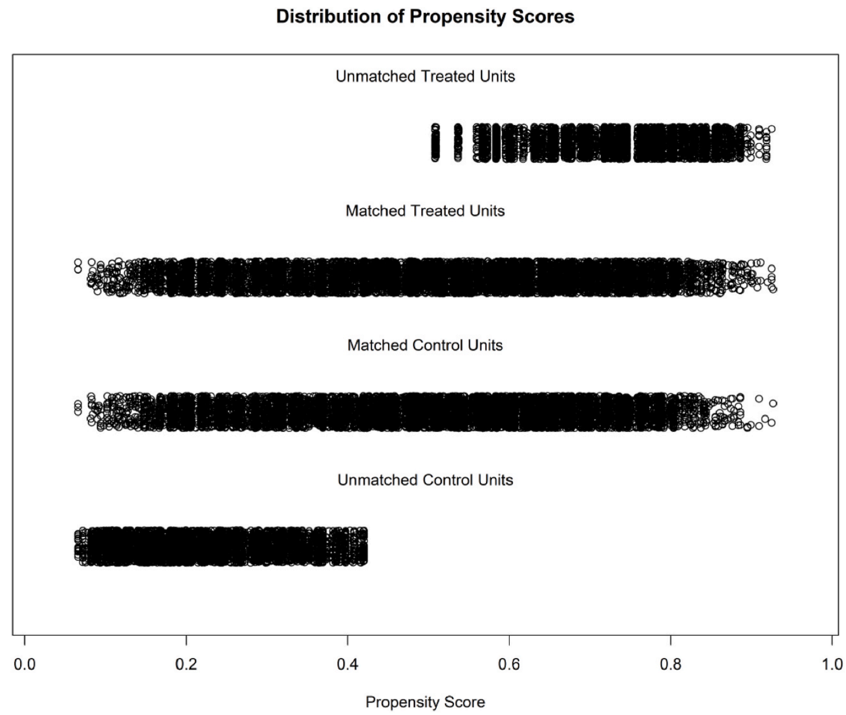

Fig. 2. Jitter-type plot before and after matching between the low and high stress groups.

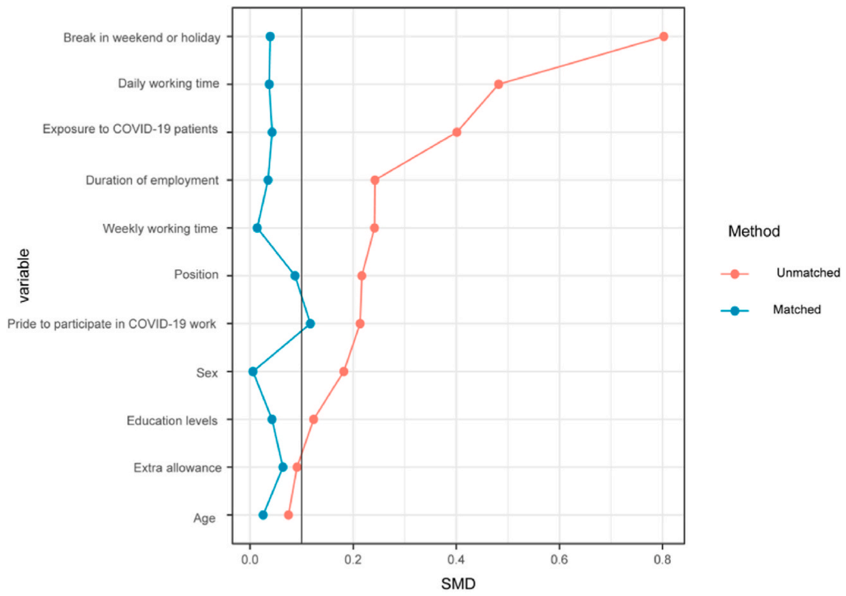

Fig. 3. Standardized mean difference between unmatched and matched groups.

4. Discussion

This study showed that 14.83 % of primary medical staff who were newly infected with COVID-19 in Jiangsu, China, experienced ongoing symptoms. Symptoms of COVID-19 include cough, dyspnea, sleep problems, anxiety, and reproductive system symptoms. Stress is a risk factor for ongoing symptoms, and higher stress levels are directly associated with a greater risk of multiple ongoing symptoms. To the best of our knowledge, this is the first study to reliably assess the prevalence of ongoing symptomatic COVID-19 among primary medical staff members newly infected with COVID-19 and to explore the relationship between stress levels and

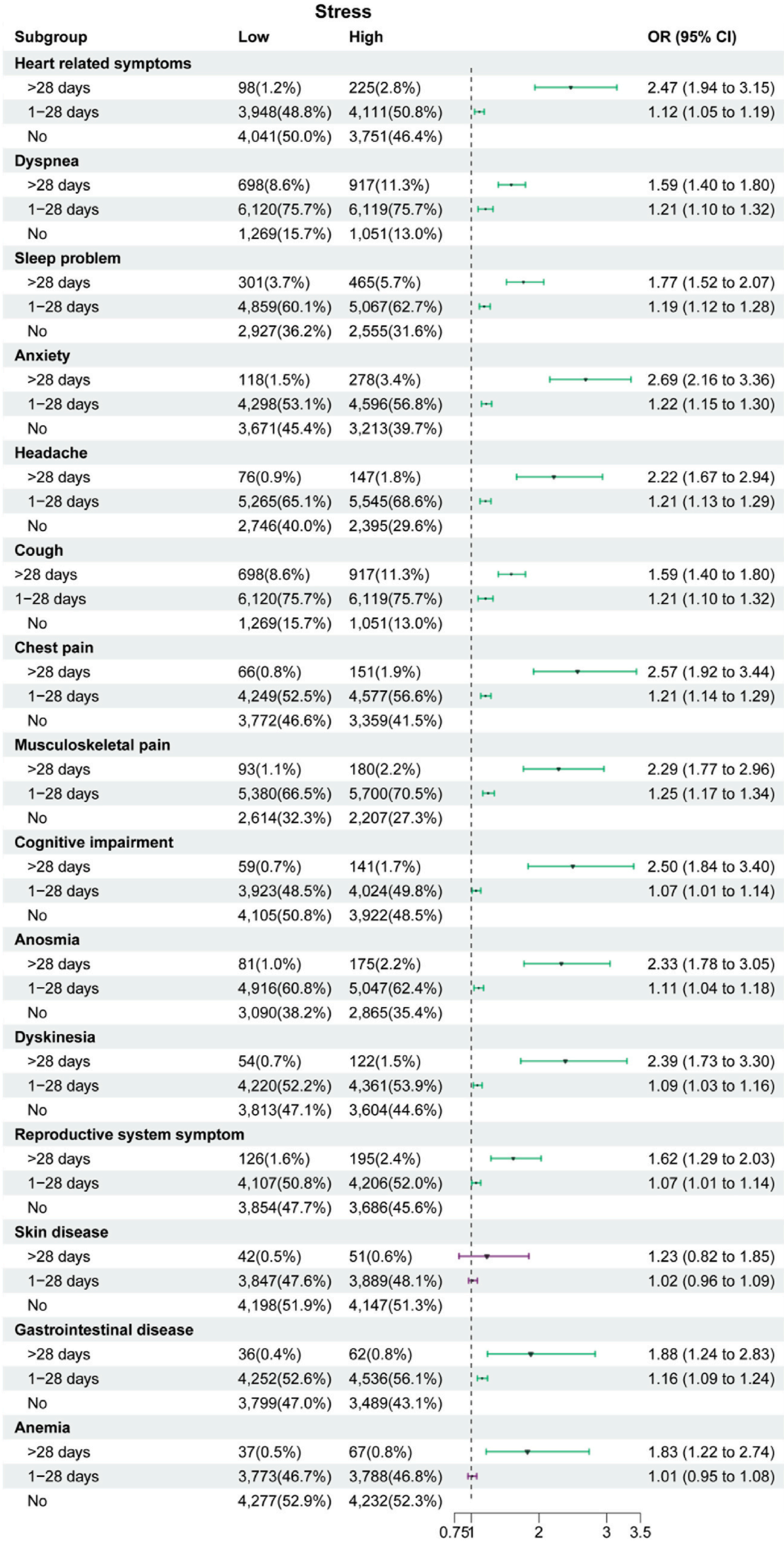

Fig. 4. Differences in the timing of ongoing symptoms in different stress groups after propensity score matching.

Table 2
Differences in the number of ongoing symptoms in different stress groups after matching after propensity score matching.

Variable	Overall (N = 16,174)	Low stress (n = 8087)	High stress (n = 8087)	OR (95%CI)	P value
Number of ongoing symptoms					
0	13,634 (84 %)	6996 (87 %)	6638 (82 %)	ref.	
1	551 (3.4 %)	258 (3.2 %)	293 (3.6 %)	1.20(1.01,1.42)	0.039
2	1074 (6.6 %)	511 (6.3 %)	563 (7.0 %)	1.16 (1.03,1.31)	0.019
3	419 (2.6 %)	167 (2.1 %)	252 (3.1 %)	1.59 (1.30,1.94)	<0.001
4	204 (1.3 %)	71 (0.9 %)	133 (1.6 %)	1.97 (1.48,2.64)	<0.001
≥5	292 (1.8 %)	84 (1.0 %)	208 (2.6 %)	2.61 (2.02,3.37)	<0.001

ongoing symptoms in matched and balanced COVID-19 patients using PSM. Increased knowledge of the nature of core symptoms and the prevalence of ongoing symptomatic COVID-19 among primary medical staff members represents an important step forward in designing studies that will ultimately provide an adequate healthcare response to the long-term effects of COVID-19.

A significant strength of this study is the inclusion of a large number of COVID-19 positive participants at the onset of China's outbreak prevention and control strategy adaptation. This characteristic offers an excellent opportunity to control a wide range of confounding factors when applying PSM. Moreover, all respondents had a thorough understanding of SARS-CoV-2, which aided the successful completion and acquisition of the questionnaire and provided a more comprehensive representation of primary medical staff members affected by new prevention and control scenarios. It is worth noting that most respondents were employed and exhibited exceptional adherence.

Several studies have investigated the persistence of COVID-19 symptoms, with follow-up periods ranging from 1 month to 2 years [25,26]. Examined studies have reported a prevalence rate of 48.1 % (95%CI 39.9–56.2 %) for the original COVID-19 strain, 35.9 % (95%CI 30.5–41.6 %) for the alpha variant, and 16.5 % (95%CI 12.4–21.4 %) for a mix of the Delta and Omicron variants [27]. A prevalence of less than 25 % has been reported in those infected with the Omicron variant [28]. The predominant viral strain at the time of our investigation was Omicron. Therefore, the prevalence of ongoing symptomatic COVID-19 in this study was consistent with that reported in the literature. In addition, a cross-sectional study conducted in all 50 states and the District of Columbia in the USA showed that those presenting with symptoms of long COVID accounted for 13.9 % of those testing positive for COVID-19 (re-weighted to reflect national sociodemographic distribution), which is comparable to our results [29]. Based on the data reported in the literature, the fifteen more common symptoms of long COVID were selected in our study, including cough [30,31], dyspnea [30,31], sleep problems [31,32], anxiety [31,32], reproductive system symptoms [33], musculoskeletal pain [30,32,33], heart related symptoms [31], anosmia [31–33], headache [30–32], chest pain [31,33], cognitive impairment [31,32], dyskinesia [32], gastrointestinal disease [30], anemia [34], and skin disease [30]. A meta-analysis, encompassing 72 articles, revealed that the most frequently reported long COVID-19 symptoms were fatigue (27.5 %, 95%CI 22.4–33.3 %), sleep disorder (20.1 %, 95%CI 14.7–26.9 %), anxiety (18.0 %, 95%CI 13.8–23.1 %), dyspnea (15.5 %, 95%CI 11.3–20.9 %), hypomnesia (13.4 %, 95%CI 8.4–20.7 %), arthralgia (12.9 %, 95%CI 8.4–19.2 %), depression (12.7 %, 95%CI 9.3–17.2 %), and alopecia (11.2 %, 95%CI 6.9–17.6 %) [35]. A higher prevalence of the listed symptoms was reported, mainly because hospitalized participants were included in the meta-analysis. However, our study mainly focused on non-hospitalized individuals, leading to divergent results. Notably, our study found that reproductive system symptoms were one of the most common ongoing symptoms of COVID-19, which is not commonly reported in most long COVID studies. According to previous studies, female patients with long COVID tend to report menstrual cycle changes, whereas males tend to report decreased libido and erectile dysfunction [36,37]. In a multinational survey of 1792 patients with long COVID who had menstrual cycles, 33.8 % reported menstrual problems, including abnormally irregular menstrual cycles (26 %) and increased menstrual flow (19.7 %) [38]. Results from a Boston University School of Public Health study showed that COVID-19 infection in men was associated with a transient reduction in fertility (for infection within 60 days, fecundability ratio = 0.82, 95%CI 0.47–1.45) [39].

Our findings indicated that medical staff members who worked over 8 h a day during the study period had a higher probability of experiencing stressful situations than those who worked less than 8 h a day ($P < 0.001$). Comparably, a cross-sectional study in China found that healthcare practitioners who treated COVID-19 patients for over 3 h daily had a greater prevalence of anxiety and depression than those who worked fewer hours [40]. A cross-sectional study conducted in March 2020 revealed that an increase in weekly working hours was associated with higher levels of depression, anxiety, and stress [41]. Interestingly, our research revealed that individuals with a bachelor's degree or lower had elevated stress levels, which contradicts the results of another cross-sectional multicenter study conducted in China in April 2020 [42]. This observation could be attributed to the fact that majority of the less-educated population is over 45 years old, and older people are generally more resistant to stress than the youth. Moreover, those who received additional payments or other incentives experienced elevated stress levels ($P < 0.001$). Contrary to conventional perceptions, this could be ascribed to the fact that individuals who receive additional overtime benefits are obliged to work overtime regularly, leading to stress build-up. Alternatively, those who receive additional payments or other incentives may have higher seniority or administrative status, resulting in increased stress levels. Therefore, it is plausible that overtime or additional incentives are not independent risk factors for stress.

In patients who maintain balance after PSM, high stress levels are a significant risk factor for the development of multiple symptoms after COVID-19. The symptoms included anxiety, chest pain, cognitive impairment, cardiac complications, and dyskinesia. Our findings suggest that elevated stress levels increase the likelihood of patients experiencing ongoing symptoms. To our knowledge, no study to date has established a direct link between ongoing COVID-19 symptoms and high levels of stress. However, several studies have suggested that increased anxiety, depression, and stress levels in patients with acute COVID-19 infection were associated with ongoing symptoms. A study conducted in five major hospitals in Singapore and India among healthcare professionals involved in the care of patients with COVID-19 revealed that physical symptoms such as sore throat, nausea, vomiting, insomnia, and loss of appetite were strongly associated with increased anxiety, stress, and depression [43]. Another study conducted in Vietnam showed that healthcare workers who experienced multiple physical symptoms, including sore throat, diarrhea, runny nose, cough, fatigue, muscle pain, headache, insomnia, and loss of appetite, were associated with higher levels of depression, anxiety, and stress [44]. However, because our study was cross-sectional, we could not determine whether the post-infection symptoms were a cause or consequence of stress. However, further studies are required to clarify this relationship.

We will continue to monitor persistent symptoms in patients with COVID-19 to determine its prevalence and the predominant symptoms of long COVID. Future investigators should consider designing cohort studies to further explore the causal relationship between stress and persistent symptoms.

5. Limitation

Our study has several limitations that must be acknowledged. First, asymptomatic cases of COVID-19 may have been missed, potentially resulting in an underestimation of the prevalence of ongoing symptomatic COVID-19, which may have affected its overall occurrence [26]. Second, the cross-sectional methodology of our study prevented us from establishing a causal relationship between stress and ongoing symptoms. Furthermore, owing to the limited time period of this survey, data for long COVID could not be obtained. Additionally, our analysis was limited to primary medical staff members in the Jiangsu Province of China, limiting the generalizability of our findings to the entire country or to medical professionals outside of this setting. Lastly, it should be noted that stress levels were evaluated using self-defined as opposed to a standardized scale, introducing a subjective element into the analysis.

6. Conclusions

In conclusion, this study revealed that the prevalence of ongoing symptomatic COVID-19 among primary medical staff members in Jiangsu Province was approximately 15 %. The findings of this study indicate that higher stress levels among primary medical staff members are associated with an increased risk of ongoing and multiple ongoing symptoms following COVID-19. Furthermore, among the various risk factors contributing to increased stress identified in this study, longer working hours have emerged as a potentially modifiable factor that warrants attention from organizations and stakeholders. To address this issue, healthcare organizations must increase the number of primary medical staff and properly allocate working hours and break periods. Additionally, healthcare organizations should provide sufficient mental health support for medical staff. These interventions can effectively reduce the risk of ongoing symptoms and improve the overall well-being of medical staff. The results of this study may provide information for hospital administrators and local and national governments to develop appropriate programs and policies to safeguard the mental health of primary medical staff members during a pandemic.

Disclosure statement

The authors declare no conflicts of interest was reported by the author(s). The authors declare that this study was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

Ethics declarations

This study was reviewed and approved by the Ethics Committee of Jiangsu Provincial Center for Disease Prevention and Control (approval number: JSJK2023-B010-01). All the participants provided informed consent to participate in the study.

Data availability statement

The primary data used in this study is available from the authors upon request.

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CRediT authorship contribution statement

Hualing Chen: Conceptualization, Data curation, Formal analysis, Validation, Writing – original draft. **Yongjie Zhang:** Writing – original draft, Formal analysis, Data curation, Conceptualization. **Yongkang Qian:** Visualization, Methodology. **Ya Shen:** Resources. **Haijian Guo:** Investigation. **Rongji Ma:** Supervision, Software. **Beier Lu:** Validation, Supervision. **Pengcheng Miao:** Validation, Supervision. **Biyun Xu:** Project administration, Funding acquisition. **Jinshui Xu:** Writing – review & editing, Project administration. **Bingwei Chen:** Writing – review & editing, Project administration.

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.heliyon.2024.e30502.

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