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Emergency nurses' burnout levels as the mediator of the relationship between stress and posttraumatic stress disorder symptoms during COVID-19 pandemic

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Abstract

Aims: To examine the association of the working stress with posttraumatic stress disorder symptoms (PTSD), and burnout as the mediator for this association among emergency nurses during COVID-19 pandemic.

Design: Longitudinal survey study.

Methods: Online survey was used to collect data during the period from August to November 2020 with a sample of 169 emergency nurses. They were invited to complete the following questionnaires at the 6th and 9th months after COVID-19 outbreak: Posttraumatic Symptom Scale (PTSS-10), the emergency nurses' COVID-19 stress questionnaire and Chinese version of 21-item Copenhagen Burnout Inventory (CBI).

Results: During the 3-month follow-up, there were no changes in the number of suspected PTSD cases (6 and above symptoms): 41% at the 6th month and 33.3% at the 9th month. The increases of the personal burnout levels and living apart from families were the main factors associated with the PTSD symptoms. The risk for emergency nurses suffering from PTSD is through stress levels increasing their burnout levels.

Conclusions: Over 30 percent of emergency nurses remained at high risk for suspected PTSD. The burnout levels mediated the relationship between the stress levels and the risks of PTSD.

Impact: Little as know about the impact of COVID-19 on emergency nurses' stress. This study found emergency nurses remained to be the high risk for the suspected PTSD cases. It is urged to develop a stress-reduction program targeting at causes of stress and improving burnout for emergency nurses during COVID-19 pandemic.

1 | INTRODUCTION

The review study by Cabarkapa et al., (2020) indicated that during the COVID-19 pandemic, the most common cause of stress arose from fear of uncertainty or becoming infected among the frontline health care workers (HCWs). Other causes of stress also included increased workloads, wearing protective gear, rapidly changing guidelines, burden of adhering to strict protective measures and insufficient personal protective equipment (PPE), and a fear of passing infection to loved ones. This review indicated that among the HCWs, female nurses are at the highest risk of suffering from mental health problems because they were in close contact with the suspected and confirmed COVID-19 patients. The previous study found that the SARS pandemic had its long-term impact on mental health among

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HCWs (Su et al., 2007). The recent studies have consistently found that the HCWs, in particular, nurses were the high-risk group for suffering from posttraumatic stress disorder (PTSD) during COVID-19 outbreak (Chew et al., 2020; Fattori et al., 2021). The early identification of the potential PTSD cases can not only prevent HCWs from psychological impairment but also can be easily treated at the early diagnostic stage (Greenberg et al., 2020; Moazzami et al., 2020). It is therefore important to understand nurses' stress and its relation to their mental health in particular PTSD symptoms during pandemic.

Denning et al. (2021) conducted a multinational survey and found that over 60% of HCWs, in particular, nurses and doctors presented with a significant burden of burnout. Their burnout levels were associated with their perceptions of safety in their workplace. Burnout characterized by physical and psychological exhaustion (Yes, 2008) is caused by excessive job demands and limited job recourses (Demerouti et al., 2001). HCWs during the COVID-19 pandemic commonly experience burden from increasing job demands with limited resources such as insufficient PPE (Cabarkapa et al., 2020) might influence HCWs' perceptions of working environment safety, as a result of their occupational burnout. Chor et al. (2020) found almost 50% of HCWs in the emergency department had moderate-to-severe personal burnout levels and the emergency nurses had higher burnout levels than doctors. Stress from being at the frontline in direct contact with suspected or confirmed COVID-19 patients, physical distress from care burden with prolonged wearing PPE, social isolation, poor social supports were related to emergency nurses' vulnerability to high burnout levels. The questions about the changes in burnout levels after COVID-19 outbreak and its correlations with stress levels, PTSD symptoms remain unclear.

2 | BACKGROUND

Emergency nurses were the high-risk group for suffering from posttraumatic stress disorder (PTSD) at the postepidemic stage (Naushad et al., 2019). The previous studies using retrospective and cross-sectional designs showed that HCWs had the greatest risk for PTSD symptoms, at 1 month of MERS outbreak (Lee et al., 2018) and 2 months after SARS outbreak (Chan & Huak, 2004). The recent review study found that the occurrence of PTSD indicated by the posttraumatic stress scale (PTSS) during COVID-19 ranged between 2.1% and 73.4% with the highest occurrence in HCWs working in an emergency unit (d'Ettorre et al., 2021). The recent studies with a prospective design found that there was a trend of decrease of PTSD symptoms after COVID-19 outbreak during the follow-ups among HCWs (Dufour et al., 2021; Fattori et al., 2021; Sampaio et al., 2021; Van Steenkiste et al., 2021; Zhou et al., 2021). Nevertheless, Dufour et al. (2021) noted that about 30% of HCW presented PTSD symptoms at clinical level during the 4th-month follow-up. Steenkiste et al. identified higher PTSD symptoms were found in ICU nurses than non-ICU nurses (2021). The results suggest that nurses who were exposed to direct care for COVID-19 patients were more vulnerable to have PTSD symptoms. Emergency nurses

are the frontline workers to screen and care for COVID-19 patients. However, up to date, there is a lack of research using a prospective longitudinal design to examine the changes in stress levels and their long-term impact on the prevalence of PTSD symptoms among emergency nurses during the COVID-19 pandemic.

In addition to PTSD, the review study also showed that a significant number of emergency nurses suffered a moderate to high level of burnout after they experienced a traumatic event (Naushad et al., 2019). The recent studies consistently found that there are a significant number of frontline HCWs experiencing at least moderate levels of burnout during the COVID-19 pandemic (Chor et al., 2020; Hu et al., 2020). Moreover, the emergency nurses had the highest personal burnout levels than doctors during the first 3 months of the COVID-19 outbreak (Chor et al., 2020). Their burnout levels might be associated with job strain, physical discomfort from wearing PPE (Hu et al., 2020). Stress from fear of infecting their loved ones and being separated from family due to travel restrictions are also associated with HCWs' burnout levels (Tan et al., 2020). There is little known about the relationship between burnout levels and PTSD among emergency nurses in the context of COVID-19. The previous study (Kim et al., 2019) on the firefighter found the association of increased burnout with PTSD symptoms and work-stress-related burnout mediated the relationship between traumatic experience and PTSD. The results suggest that working-related burnout levels characterized by chronic physical and psychological exhaustion likely predict the increased risk of PTSD.

In summary, emergency nurses are at the highest risk of suffering from PTSD and work-related burnout. It remains not clear whether the increased burnout would result in more emergency nurses at the risk of developing PTSD. Our emergency nurses were first exposed to the COVID-19 stress event since the first patient was identified on January 21, 2020, in Taiwan. This study with the prospective design aimed to examine how nurses' working stress is related to their posttraumatic stress disorder symptoms and whether the burnout mediates this relationship.

3 | THE STUDY

3.1 | Aims

The study aims were to explore the association of the working stress levels with posttraumatic stress disorder symptoms, and burnout as the mediator for this association among emergency nurses during the COVID-19 pandemic.

3.2 | Design

This study adopted the prospective design and used an online survey to collect emergency nurses' perceptions of stress levels, burnout levels, and PTSD symptoms at two time points: at the 6th and 9th months after the first COVID-19 patients was diagnosed in January, 21 in Taiwan.

3.3 | Setting and participants

Nurses were recruited to participate in this study if they currently worked at the department of emergency at the general hospital in the north of Taiwan which had 2600 inpatient beds and about 300 patients per day at the department of emergency. Total, 169 emergency nurses working in the hospital at time of first survey were all invited to participate in this study.

3.4 | Data collection

Online survey was used to collect data during the period from end of July to November 2020. After this study was approved by the hospital institution review board (No. 202006097RIND), the questionnaire was administered using Google Forms. The survey administration method is via work email communications at the end of July, 2020. In the invitation email, all nurses were explained about the purposes and the procedure of this study and they were provided with a link to the online survey website. Moreover, they were informed that their completion of the survey would be regarded as their consent to participate in this study, and their participants to the survey would get a gift voucher from 7-ELEVEN stores worth 10 US dollars. For each time of survey, they would be asked to complete the survey within 2 weeks after they received the invitation email (7/21–8/5 for the first-time survey; 10/21–11/3 for the second time survey). The total numbers of the emergency nurses in our hospital at the time of study was 169. A total of 163 nurses completed the first survey and 13 of them dropped out at the second survey as a result of dropped out rates of 8%. Online survey might be vulnerable to self-selection bias which might affect the generalizability of the results. However, for this sample, the data with a high response rate (96%) could be considered valid and representable.

Emergency nurses were invited to complete the following questionnaires at the 6th and 9th months after COVID-19 outbreak: the emergency nurses' COVID-19 stress questionnaire, Posttraumatic Symptom Scale (PTSS-10) and Chinese version of 21-item Copenhagen Burnout Inventory (CBI). The online questionnaire started with demographic questions (age, gender, education, marital status, religion) and pandemic-related information (experiences of caring for suspected or confirms cases), as shown in Table 1. Then, participants were asked to rate the perceived overall stress level before and during COVID-19 pandemic and the degree of stress caused by pandemic-related stressor (as shown in Table 2). Finally, we assessed posttraumatic symptoms and occupational burnout through a set of validated questionnaires: Posttraumatic Symptom Scale (PTSS-10), Copenhagen Burnout Inventory (CBI). Each survey would open for approximately 2 weeks for all participants to access and complete the survey. Questionnaire responses were secured using a 'Cloud' database where the data were password protected and automatically stored in Excel format.

The emergency nurses' COVID-19 stress questionnaire measured perceived stress levels and causes of stress. Perceived stress levels before COVID-19 pandemic and within first 3 months of COVID-19 pandemic were assessed with two single-item: '*What stress level you perceived before COVID-19 pandemic?*' and '*What stress level you perceived within first 3 months of COVID-19 pandemic?*'. Nurses were then asked about current working stress levels on a 10-point scale from 0 = 'no stress' to 10 = 'very stressful' at the time of this survey (at the 6th and 9th months of COVID-19). A 29-item causes of stress questionnaire measured different types of causes: Fear of being infected by COVID-19, a heavy workload and body–mind-social distress. Nurses responded on a 10-point scale from 0 = 'no distress' to 10 = 'very distress'. The reliability of this 29-item questionnaire was good based on our sample ($\alpha = 0.97$).

TABLE 1 Demographic information (*n* = 163)

	Mean/SD	Range	%
Age, years	30.88/7.21	20–60	
Experience in nursing care, years	8.06/7.35	0–35	
Experience in emergency department, years	6.33/6.54	0–32	
Gender			
Female/Male			85.89/14.11
Marital status			
Single/ Married			73.62/26.38
Religion			
No/Yes			68.71/31.29
Had worked in the triage and critical areas in ER			80.98
Had experiences of caring for the suspected or confirmed COVID-19 patients			90.80
Lived apart from their families due to COVID-19 pandemic			32.52

TABLE 2 Stress levels and causes of stress across two time points

	1st survey (n = 163) Mean/SE	2nd survey (n = 150) Mean/SE	Difference[a] Wald x^2	p value
Stress before COVID-19 pandemic	6.76/0.14	6.64/0.15	0.546	.460
Stress levels within first 3 months of COVID-19 pandemic (1/21–4/30)	8.52/0.12	8.38/0.14	1.038	.308
Current perceived stress levels	6.96/0.14	7.01/0.13	0.159	.690
Causes of stress				
1. Fear of being infected with COVID-19	6.63/0.20	6.12/0.21	7.064	.008
2. Fear of family getting infected by me	7.07/0.22	6.63/0.23	4.784	.029
3. Patients/families concealing their TOCC history	8.15/0.18	7.89/0.20	2.113	.146
4. Being on the front line	7.98/0.17	7.70/0.17	2.936	.087
5. Uncertainty about patients' condition regarding COVID-19 infection	8.05/0.16	7.83/0.17	1.927	.165
6. Patients not complying with infection control rules	8.27/0.16	8.08/0.17	1.433	.231
7. Calming patients' and their families' anxieties	7.94/0.16	7.74/0.18	1.188	.276
8. Restrictions on travelling overseas	7.42/0.22	7.50/0.23	0.210	.647
9. Unable to take days off due to a shortage of nurses	7.37/0.20	7.12/0.20	1.461	.227
10. Insufficient PPE	7.05/0.21	6.72/0.21	2.352	.125
11. Lack of knowledge about COVID-19	6.28/0.20	5.61/0.21	11.399	.001
12. Frequent changes of infection control procedures	7.83/0.18	7.07/0.20	13.659	<.001
13. Physicians not familiar with wearing PPE	6.96/0.21	6.35/0.22	9.492	.002
14. Physicians having different criteria for defining high-risk COVID-19 patients	7.32/0.21	6.69/0.22	10.562	.001
15.Communication problems with inpatient unit and laboratory	6.99/0.18	6.43/0.21	8.566	.003
16. Implementing entry access controls	7.19/0.20	6.65/0.24	6.740	.009
17. Arranging patient numbers in the triage assignment area	6.36/0.21	5.54/0.24	18.318	<.001
18.Persistently working in the triage assignment area and the critical area	5.75/0.29	5.30/0.28	4.034	.045
19. Increasing non-nursing work, e.g. distributing PPE	6.87/0.22	5.70/0.25	28.023	<.001
20. Physical distress due to wearing PPE	7.06/0.20	6.17/0.22	18.400	<.001
21. Unable to drink water or go to the toilet due to wearing PPE	7.33/0.22	6.39/0.23	17.062	<.001
22. Insufficient meal breaks	6.22/0.23	5.60/0.24	8.473	.004
23. Emotional distress, such as anxiety and depression	6.37/0.23	6.37/0.23	---[b]	---[b]
24. Feeling unsafe due to coworkers being admitted to hospital for quarantine	5.53/0.24	4.97/0.25	5.547	.019
25. Colleagues' emotional outbursts during working hours	6.47/0.22	6.18/0.23	2.201	.138
26. My family worrying I will be infected	6.79/0.22	5.86/0.24	19.507	<.001
27. Feeling being labelled and discriminated because of my job	5.85/0.23	5.09/0.24	14.149	<.001
28. My family feeling being labelled and discriminated because of my job	5.50/0.25	4.71/0.24	11.330	<.001
29. Assistant worker not complying with infection control rules (e.g. wearing PPE)	6.90/0.22	6.44/0.23	4.409	.036

[a]Statistical Method: GEE with AR(1) correlation.

[b]Unable to conduct statistical analysis for this item, due to the scores at two time points are the same.

The 10-item Posttraumatic Symptom Scale (PTSS-10) measures the presence and intensity of PTSD symptoms and is regarded as a valid and reliable instrument in screening for PTSD (Raphael et al., 1989). The 10 symptoms are sleeping problems, nightmares, feeling of depression, startle/jumpiness, isolation, irritation, mood swings, feelings of guilt/lowered self-esteem, fear of places and situations that remind the subject of the traumatic event and bodily tension. The subject is asked whether they experience each

symptom with 'yes' or 'no'. A score of six and more 'yes' responses is considered as a potential PTSD case (high risk of PTSD). The PTSS-10 has a good internal consistency (α = 0.81) for this study.

A Chinese version of the 21-item Copenhagen Burnout Inventory (CBI) was used to measure emergency nurses' occupational burnout levels and it consists of four subscales to measure physical and psychological exhaustion from different factors of burnout: personal, work-related and client-related, personal, work, work with clients and over-commitment (Yeh et al., 2008). The Chinese version CBI includes an additional factor of job over-involvement to the original CBT (Kristensen et al., 2005). The respondents were asked about how often they feel distress from never, seldom, sometimes, often to always. Their responses are scored at 0, 25, 50, 75 and 100 with high scores indicating high levels of burnout. Internal consistency in the current study was good: 5-item personal burnout = 0.92, 5-item work-related burnout = 0.92, 6-item client-related burnout = 0.93, 5-item over-commitment = 0.87.

3.5 | Ethical considerations

After this study was approved by our hospital institution review board (No. 202006097RIND), nurses were informed about the purpose and the procedure of this study through the staff meeting and email exchange. To preserve private or confidential information, the name of the participants would be removed and replaced with case numbers. The study dataset was anonymized and uploaded to the independent researcher for management and analysis. Moreover, they were also told that nonparticipation would not influence their benefits and they would not be treated differently. To emphasize this, their managers would not access the data with their identification.

3.6 | Data analyses

To begin with, descriptive statistics were utilized to characterize the sample and self-report measure scores. Then we used generalized estimating equations analyses with an autoregressive correlation structure using all available observations to depict change over time. A logistic regression model was used to analyse the correlated binary responses, while a linear regression model was used to analyse the correlated continuous responses. Finally, the mediation models were analysed using the Model 4 of PROCESS macro for SPSS (Hayes, 2017). The bootstrapping methods (with 5000 bootstrap samples) were used to estimate indirect effects. A significant indirect effect was determined if zero did not fall within the 95% bias-corrected confidence intervals (CIs).

3.7 | Validity and reliability/rigour

The causes of stress questionnaire were developed based on the nursing supervisors' previous SARS experiences, and views from 50 emergency nurses about their experiences of COVID-19 stress through using open-ended questions. It was used to measure different types of causes: fear of being infected by COVID-19, a heavy workload and body–mind-social distress. The reliability of this 29-item questionnaire was good based on our sample (α = 0.97). The 10-item Posttraumatic Symptom Scale (PTSS-10) and the Chinese version of the 21-item Copenhagen Burnout Inventory (CBI) were a well-validated measure. Internal consistency for each scale was established with a Cronbach's ranging from 0.81 to 0.93.

4 | RESULTS

4.1 | Characteristics of the participants

As indicated in Table 1, the participants were mostly young adult, and their marital status was single. One-third of participants had religious beliefs. The average time working in nursing practice or in ER (Emergency Room) was more than 6 years with a wide range from 0 to 30+ years. The majority of participants had experiences of caring for the suspected or confirmed COVID-19 patients in ER and most of them had worked in the triage and critical areas in ER. About one-third of participants lived apart from their families due to COVID-19.

4.2 | Perceived stress and sources of stress

Table 2 showed the participants perceived stress levels at different periods: Before COVID-19 pandemic, the first 3 months of COVID-19 and at the time of the survey (the 6th and 9th months of COVID-19). The participants rated the highest levels of stress at the first 3 months of the COVID-pandemic. There were no significant changes in stress levels at the first and the second time survey.

Table 2 also indicated that there were significant reductions in distress levels from different causes of stress (especially heavy workload) across the 3-month follow-up ($p < .05$). For the cause of fear and uncertainty amid COVID-19, distress levels from the following causes: fear of self and family members being infected with COVID-19, and lack of knowledge about COVID-19 with workers not complying the infection control standard, were reduced. For physical/emotional and social distress, there were the reductions in the following causes: physical distress mainly from wearing PPE and insufficient break and social distress relating to self and family being discriminated due to nursing work.

However, the following causes of stress remained unchanged during 3-month follow-up. About fear and uncertainty amid COVID-19, the issues were mainly related to patient and family factors such as concealing their TOCC history (travel history, designated occupations, contact history and cluster history), not complying with infection control rules in addition to continually being on the front lines and insufficient PPE. Similarly, one issue related to a heavy workload was being able to calm patients' and their families' emotional distress. Most emotional distress and interpersonal conflicts remained unchanged.

4.3 | Occupational burnout and PTSD symptoms

Table 3 shows that the participants' occupational burnout levels of each domain were at moderate level and remained unchanged during the 3-month follow-ups. Work-related burnout levels were endorsed more than other domains. Table 4 showed that among PTSD symptoms, there were only changes in the percentage of those developing depression from over 50% to below 50% ($b = -0.583$, $SE = 0.166$, $Exp [B] = 0.558$, $p < .001$). As noted, over 50% of nurses remained having symptoms of irritability, emotional lability and bodily tension. There were no significant changes in the numbers of suspected PTSD cases (6 and above symptoms).

4.4 | Predictors of suspected PTSD cases

Among the demographic information, two factors of contact history (the experience of caring for the suspected or confirmed COVID-19 patients) and living apart from families due to COVID-19 were associated with more suspected PTSD cases ($b = 1.068$, $SE = 0.447$, *Wald chi-square* $(1) = 5.699$, $p = .017$, $Exp (B) = 2.909$; $b = 1.054$, $SE = 0.259$, *Wald chi-square* $(1) = 16.505$, $p < .001$, $Exp (B) = 2.869$). Therefore, they were included in the logistic-regression model with stress levels at time of survey and burnout levels to identify the main predictor of PTSD. Table 5 showed that in GEE model, the personal burnout levels and living apart from families predicted the suspected PTSD case over 3 months follow-ups. The increases of the personal burnout levels and living apart from families were correlated with the increasing numbers of the suspected PTSD cases during the 3-month follow-up. On the other hand, stress levels and other burnout domains were not correlated with the suspected PTSD cases over the 3-month follow-up.

4.5 | Relationships between stress, burnout and PTSD

Longitudinal mediator models were conducted to determine causal-ordering assumptions among stress levels, burnout levels and risk of PTSD over time. As shown in Figure 1, there were indirect effects of current stress levels at T1 on the risk of PTSD at T2 via personal burnout (IE = 0.307, BootSE = 0.095, 95% BootCI = 0.161 to 0.532), work-related burnout (IE = 0.320, BootSE = 0.092, 95% BootCI = 0.175 to 0.538) and client-related burnout (IE = 0.159, BootSE = 0.066, 95% BootCI = 0.054 to 0.313) at T1. However, the indirect effect via over-commitment was not significant (IE = 0.099, BootSE = 0.061, 95% BootCI = −0.013 to 0.229).

Figure 2 shows the results for a simple mediation analysis. Burnout levels at T1 mediated the relationship between T1 stress levels at the first 3 months of COVID-19 and the risk of PTSD at T2. The results showed that there was a significantly indirect effect of stress levels during the first 3 months of COVID-19 on the risk of PTSD via personal burnout (IE = 0.204, BootSE = 0.087, 95% BootCI = 0.079 to 0.417), work-related burnout (IE = 0.218, BootSE = 0.081, 95% BootCI = 0.104 to 0.415), client-related burnout (IE = 0.134, BootSE = 0.064, 95% BootCI = 0.040 to 0.285) and over-commitment (IE = 0.065, BootSE = 0.043, 95% BootCI = 0.005 to 0.168).

As shown in Figures 1 and 2, the simple mediated analysis showed that burnout levels mediated the association between current stress levels at the 6th month of COVID-19 outbreak or the stress levels at the first 3 months of COVID-19 with the risks of PTSD. As noted, all types of burnouts (personal, work-related, client-related and over-commitment) mediated the relationship between stress in particular in the first 3 months of COVID and PTSD. For the relationship between stress at 6th month and PTSD, except over-commitment, other burnout types were the mediator.

5 | DISCUSSION

In this study, most emergency nurses had the experiences of caring for the suspected or confirmed COVID-19 patients in ER. Their perceptions of stress levels at the two-wave survey (at the 6th and 9th months of COVID-19) remain unchanged. In their view, the stress levels were higher than before COVID-19 outbreak and the stress at the first 3 months of COVID-pandemic was endorsed with the highest levels compared with stress levels at the 6th month and the 9th month of COVID-19. The increases of the personal burnout levels and living apart from families were the main factors associated with the

TABLE 3 Occupational burnout across two time points

	1st survey (n = 163) Mean/SD	2nd survey (n = 150) Mean/SD	Difference[a] Wald x^2	p value
Occupational Burnout				
Personal burnout	60.86/1.59	59.25/1.58	1.593	.207
Work-related burnout	62.36/1.56	60.72/1.61	1.818	.178
Client-related burnout	56.98/1.66	54.80/1.65	2.533	.112
Over-commitment	51.53/1.62	49.67/1.47	1.831	.176

[a]Statistical Method: GEE with AR(1) correlation.

TABLE 4 Posttraumatic symptoms across two time points (PTSS)

	1st survey (n = 163)		2nd survey (n = 150)		Difference[a]	
	n	%	n	%	Wald x^2	p value
Sleep difficulties	61	37.42	47	31.33	1.746	.186
Feeling of depression	96	58.90	66	44.00	12.289	<.001
Startle reactions	86	52.76	71	47.33	1.398	.237
Irritation	92	56.44	75	50.00	2.053	.152
Fear of places or situations resembling the traumatic events	84	51.53	73	48.67	0.343	.558
Mood swings	89	54.60	78	52.00	0.319	.572
Bodily tension	108	66.26	88	58.67	3.538	.060
Isolate oneself from others	50	30.67	41	27.33	0.820	.365
Nightmares about the COVID-19 pandemic	39	23.93	33	22.00	0.427	.513
Feeling of guilt or self-blame	39	23.93	31	20.67	0.664	.415
Suspected PTSD (a score of six and more 'yes')	67	41.10	50	33.33	3.593	.058

[a]Statistical Method: Logistic GEE with AR(1) correlation.

TABLE 5 Factors associated with suspected PTSD

							95% CI	
	B	SE	Wald	Sig.	Exp (B)		Lower	Upper
Constant	−8.220	1.231	44.571	<0.001	0.001		0.001	0.003
Current perceived stress levels	0.135	0.102	1.761	0.185	1.145		0.938	1.398
Personal burnout	0.035	0.013	6.919	0.009	1.036		1.009	1.063
Work-related burnout	0.023	0.015	2.564	0.109	1.024		0.995	1.053
Client-related burnout	0.016	0.010	2.502	0.114	1.016		0.996	1.037
Over-commitment	0.012	0.010	1.523	0.217	1.012		0.993	1.032
Time	−0.304	0.261	1.356	0.244	0.738		0.442	1.231
Contact history	1.604	0.828	3.752	0.053	4.971		0.981	25.185
Living apart from their family	0.679	0.339	4.009	0.045	1.971		1.014	3.832

Note: Statistical Method: using a logistic-regression model with GEE.

FIGURE 1 Simple mediation analysis for the relationship between T1 current stress levels and T2 suspected PTSD. Unstandardized path coefficients and SE indicated above. $^{***}p < .001$, $^{**}p < .01$
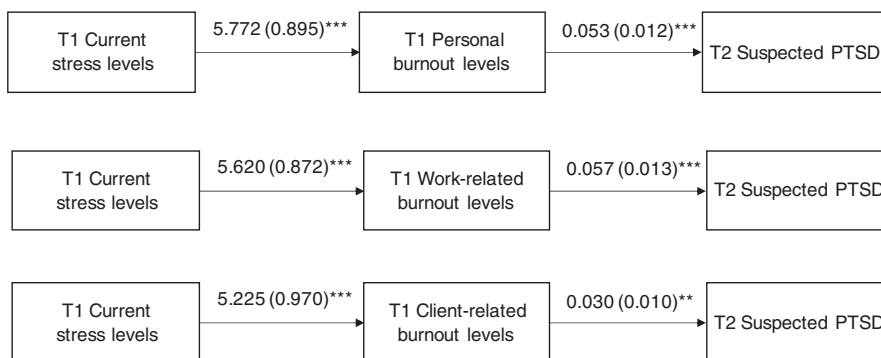
increased numbers of the suspected PTSD cases during the 3-month follow-up. This study also identified that burnout levels mediated the associations of the stress levels at the first 3 months and the 6th month of COVID-19 with the risks of PTSD. The results suggest that the mechanism of risk for emergency nurses' PTSD is through stress levels which increases their burnout levels. The ER nurses' personal burnout levels and living apart from families were also directly associated with the increased risk for them to suffer from PTSD.

This study found that while there were significant reductions in reporting depressive symptoms, over 50% of nurses remained
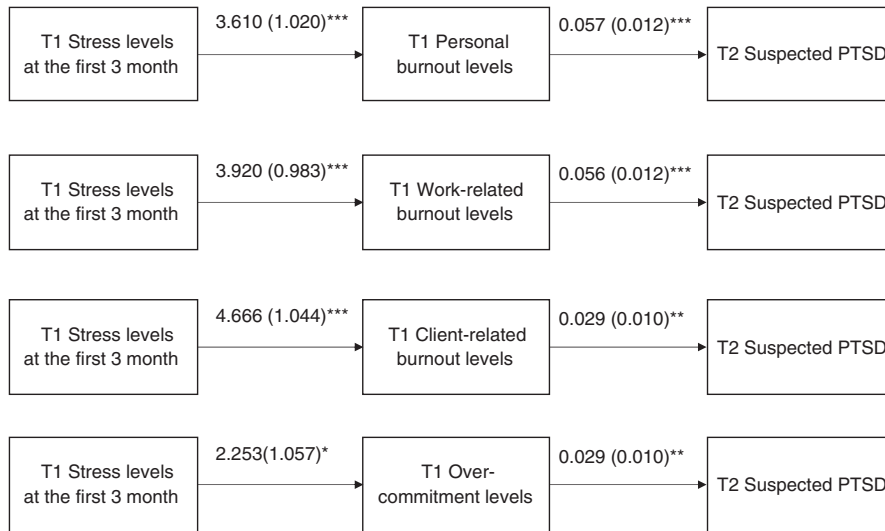
FIGURE 2 Simple mediation analysis for the relationship between T1 stress levels at the first 3 months and T2 suspected PTSD. Unstandardized path coefficients and SE indicated above. ***$p < .001$, **$p < .01$, *$p < .05$

having symptoms of irritability, emotional lability and bodily tension among PTSD symptoms during 3-month follow-up. During 3-month follow-ups, the percentage of the suspected PTSD cases (6 and above symptoms) remained unchanged at the 6th month (41%) and at the 9th month (33.33%). The review study pointed out that nurses were at a high risk for suffering from mental health problems when they worked in the frontline and were contacted with the suspected and confirmed COVID-19 patients (Cabarkapa et al., 2020). The previous studies with a retrospective design showed that HCWs had the greatest risk for PTSD symptoms with about 20% of HCWs at 1 month later of MERS outbreak (Lee et al., 2018) and 2 months after SARS outbreak (Chan & Huak, 2004). The recent review study found that the high PTSD rates occurred at the peak period of COVID-19 and among HCWs in the emergency unit (d'Ettorre et al., 2021). Similar to the recent study on HCWs (Dufour et al., 2021), our study suggests that with 3-month prospective observations, high percent (at least 30%) of emergency nurses remained to be the potential risk of PTSD cases after they were exposed to stress from COVID-19 outbreak for 9 months. Therefore, the psychological program needs to target at this high-risk group to prevent them from suffering from PTSD.

Our study showed that while about 30% of emergency nurses remained the PTSD potential cases, there was an increased rate from 58.9% to 66.67% of emergency nurses with blow clinical cut-off levels of PTSD symptoms from the 6th to 9th month of COVID-19, although this change did not achieve a statistically significant difference. This trend of decreased numbers of PTSD symptoms is consistent with other studies on HCWs (Dufour et al., 2021; Fattori et al., 2021; Sampaio et al., 2021; Van Steenkiste et al., 2021; Zhou et al., 2021). Dufour et al. (2021) identified over 60% of HCWs presenting the scores of the PTSD symptoms under clinical-cut, which suggested a resilient pattern after COVID-19 outbreak. Consistent with the previous prospective study on nurses' psychological adaptation during SARS, our study with the recent studies suggest that HCWs including nurses likely adapted to the crisis from COVID-19 event. In a qualitative study (Zhang

et al., 2020), there were three stages of nurses' psychological changes after the COVID-19 outbreak. These stages demonstrate that nurses' reactions from fear of being infected at the early stage, emotional distress such as anxiety, depression, somatisation, compulsiveness, fear and irritation in the middle stage and finally, the occurrence of psychological adaptation such as a sense of meaningful and valuable mission as a nurse.

Consistent with the recent studies on HCWs (Chor et al., 2020; Hu et al., 2020), our study also found emergency nurses experienced at least moderate levels of all domains of burnout (personal, client-related, work-related and over-commitment) (scored over 50) during the COVID-19 pandemic and no significant changes in burnout levels across the 3-months' follow-ups. The review study showed that emergency nurses suffered a moderate to high level of burnout after they experienced a traumatic event (Naushad et al., 2019). Exposure to COVID-19 seems to be a traumatic event for emergency nurses and our study suggests that their burnout levels remained for the 9th month after the first COVID patient was identified in Taiwan.

This longitudinal study showed that increasing personal burnout levels and living apart from their families due to COVID-19 were the two main factors associated with PTSD symptoms and suspected PTSD cases over the 3-month follow-up. The review study by d'Ettorre et al. (2021) also found the association of lack of social support and burnout with PTSD symptoms among HCWs during the current COVID-19 stage. A finding that differs from the previous study identified the lack of expertise in treating COVID-19 patients as the main factor increasing HCWs' mental health outcomes (Rossi et al., 2020; Tian et al., 2020). Differently, for our study, lived apart from families due to COVID-19 which suggested a lack of social support from the significant others among emergency nurses influenced them to be at the risk of PTSD, while stress levels and caring for suspected or confirmed COVID-19 were not significantly associated with PTSD. Cabarkapa et al. (2020) stated that inadequate support predicted the incidence of psychiatric disorders after the SARS outbreak. Our study suggests that emergency nurses' perception of a lack of support

from family is likely to be a long-term factor associated with PTSD during the COVID-19 outbreak.

Consistent with the review study on HCWs during COVID-19 (d'Ettorre et al., 2021) and the study on emergency management professionals (LaFauci Schutt & Marotta, 2011), our study also found emergency nurses' personal burnout levels were associated with PTSD symptoms. The results suggest that prolonged physical and psychological exhaustion increased the risk of PTSD among emergency nurses during the COVID-19 pandemic. This study also identified that personal burnout levels with other domains of burnout mediated the relationship between perceived current stress levels at the 6th month or at the first 3 months of COVID-19 with the risks of developing PTSD. All burnout types (personal, work-related, client-related and over-commitment) were the mediator in the relationship between the perceived stress at first 3 months of COVID and PTSD. But as noted all burnout types except over-commitment burnout type remained as the mediator of the relationship between perceived stress at the 6th month and PTSD. The previous study (Kim et al., 2019) on the firefighter also found working-stress-related burnout mediated the relationship between traumatic experience and PTSD. The results suggest that burnout levels caused by exposure to traumatic work stress from COVID-19 likely predicted an increased risk of PTSD. Emergency nurses' burnout characterized by chronic physical and psychological exhaustion was regarded as the consequences of living with stress from their work during COVID-19. Their increased burnout levels further significantly resulted in more emergency nurses at PTSD risk. While in our study among emergency nurses, 33.33% were the PTSD potential clinical cases at the 9th month of post-COVID-19, in Steenkiste et al.'s study (2021) only 10% of nurses achieved clinical levels of PTSD cases at the 4th month. As noted, in Steenkiste et al.'s study hospital, a multidisciplinary psychological support team consisting of burnout prevention program for patients, families, HCWs including nurses, was provided soon after the first COVID-19 patient was admitted to their hospital. Their reductions of HCWs' burnout levels might be related to the potential effect of the burnout prevention program on decreasing the risk of PTSD symptoms.

Consistent with the review study (Cabarkapa et al., 2020), our study found that common causes of stress such as insufficient PPE did not change over the two-wave period. Moreover, this study also found that patient and family factors such as concealing their TOCC history, not complying with infection control rules, emotional distress remained the main causes of distress levels events for emergency nurses. As noted, when they were continually being on the front lines, stress from their own emotional distress and interpersonal conflicts remained unchanged. To reduce the impact of stress levels on emergency nurses' burnout, the causes of their stress need to be addressed in the stress-reduction intervention. Zhou et al. (2021) and Labrague and Santos (2020) both found that HCWs including nurses' perceptions of effective organizational support was negatively correlated with PTSD symptoms after COVID-19 outbreak. Zhou et al. (2021) found that perceived organizational support reduced PTSD symptoms through the sequential mediating effect of self-efficacy

and problem-focused coping. They demonstrated that consistent with social cognitive theory of posttraumatic recovery (Benight & Bandura, 2004), HCWs perceived effective organization supports including personal protective measures, clear instructions on changes in work routines and a supportive working environment could enhance their sense of in capacity and use of internal coping resources. Based on the findings of our study, to reduce PTSD symptoms, managers of emergency department need to provide the supports to manage the unchanged stress perceived by emergency nurses including insufficient PPE, insufficient rest and interpersonal conflicts.

6 | LIMITATIONS

Online survey might be vulnerable to self-selection bias which might affect the generalizability of the results. However, for this sample, the data with a high response rate (96%) could be considered valid and representable. Another limitation is that its participants are biased towards the younger female worker. The timing of data collection during pandemic might have an impact on the results of this study. Finally, due to the lack of data about their burnout levels and PTSD symptoms before COVID-19 pandemic, our findings need to be interpreted carefully for not all symptoms being related to the impact of COVID-19.

7 | CONCLUSION

This 3-month follow-up study found that over 30 percent of emergency nurses remained at high risk for suspected PTSD. The increase in personal burnout levels and living apart from families were the main factors associated with the risk of PTSD. Moreover, perceived stress levels were not directly associated with PTSD but working-related burnout mediated the relationship between perceived stress levels and PTSD symptoms/risk of PTSD cases. That is the risk for emergency nurses suffering from PTSD is through stress levels increasing their burnout levels. According to the results, the implication of this study is to develop a stress-reduction program for emergency nurses which targets the causes of COVID-19-related stress, and improves working conditions. The stress-reduction program might reduce the impact of stress levels on burnout characterized by occupationally physical and psychological exhaustion and to further prevent emergency nurses suffering from PTSD. The future intervention study can examine the effects of stress-reduction on burnout levels and PTSD symptoms.

CONFLICT OF INTEREST

None of the authors have any declared conflicts of interest.

PEER REVIEW

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on re-quest from the first or corresponding author.

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