

# Prevalence and dynamic features of psychological issues among Chinese healthcare workers during the COVID-19 pandemic: a systematic review and cumulative meta-analysis

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## ABSTRACT

**Background** The COVID-19 pandemic has placed tremendous pressure on healthcare workers who are at the frontline in the battle against it, causing various forms of psychological distress.

**Aims** To outline the prevalence and dynamic changing features of medical workers' psychological issues and to review the related national policies during the COVID-19 pandemic in China.

**Methods** We systematically searched for studies on the psychological states of Chinese medical staff from 1 January 2020 to 8 May 2020. The aggregate prevalence of each psychological issue was calculated and plotted to observe the changes over time. Policies on psychological support for medical staff during the pandemic were reviewed to explore their link to the prevalence of psychological problems.

**Results** In total, 26 studies were included in this study. A total of 22 062 medical workers were surveyed from 31 January to 27 February 2020. Medical staff exhibited a substantial prevalence of anxiety symptoms, depression symptoms, stress-related symptoms and sleep problems during the survey period, with aggregate prevalence rates of 27.0%, 26.2%, 42.1% and 34.5%, respectively. Cumulative meta-analyses revealed that the prevalence of psychological distress peaked at the beginning of the pandemic and subsequently exhibited a slow downward trend.

**Conclusion** Chinese medical staff displayed significant psychological disturbance during the outbreak of the COVID-19 pandemic, which was especially severe at the early stage. Implementing supportive policies may help alleviate ongoing psychological problems in healthcare workers.

## INTRODUCTION

COVID-19 is an ongoing pandemic of SARS-CoV-2,<sup>1,2</sup> which spread nationally over a short period. By 8 May, COVID-19 had spread to 215 countries or territories around the world, resulting in more than 3.7 million confirmed cases of infection and nearly

260 000 deaths.<sup>3</sup> In China, the confirmed cases also amounted to over 82 000.<sup>4</sup> The National Health Commission of China classified COVID-19 as a class B infectious disease on 20 January and quickly issued a multitude of preventive measures and treatments for the disease.<sup>5,6</sup>

The arduous 'war' against COVID-19 has been inseparable from the efforts of medical health workers. Since the outbreak of the pandemic, a total of 344 national medical teams have been dispatched nationwide, and the total number of medical personnel exceeded 40 000. Additionally, numerous healthcare workers have stayed in their local hospitals to battle the pandemic. In this situation, medical workers are under tremendous pressure.<sup>7,8</sup> They are faced with a higher risk of infection and increased workload. The deterioration of the patients' physical and psychological health may cause exhaustion, even result in job burnout.<sup>9</sup> Moreover, because of the increased workload, healthcare workers found it difficult to fulfil social roles such as looking after children or elderly family members. Studies have shown that workers feared the risk of transmitting the disease to family members or friends. Thus, they were often increasingly isolated over extended periods of time, which caused further aggravation of psychological conditions and stress.

Several cross-sectional studies have been designed to assess the mental status of healthcare workers in China during the pandemic, and the studies have found a higher prevalence of mental health and psychosocial problems among healthcare workers than in the general population.<sup>10</sup> Depression and anxiety are particularly prominent.<sup>11</sup> Therefore, the psychological problems of medical

workers have received attention at the policy level in China.<sup>12</sup> From the early stage of the pandemic, a series of related national policies have been issued to promote the care of mental well-being among healthcare workers, such as ensuring adequate supplies of medical equipment, improving the work environment and increasing psychological support for frontline workers.<sup>13,14</sup> However, a previous study had found that the mental well-being of frontline medical workers was still impacted despite these measures. Indeed, data indicate that healthcare workers may have a higher prevalence of sustained symptoms of depression and anxiety even after the pandemic.<sup>15,16</sup>

To our knowledge, no systematic review on the changing features of frontline medical workers' psychological status in China during the COVID-19 pandemic has been conducted. In this study, we reviewed previous cross-sectional studies and the main public intervention policies aimed at supporting frontline workers' mental well-being. The aims of this article were as follows: (1) to describe the psychological status of medical workers at different time points during the COVID-19 pandemic in China, and (2) to preliminarily explore the impact of national policies on the psychological well-being of medical workers.

## METHODS

### Source of data

#### Prevalence of psychological distress among Chinese healthcare workers

Data on the psychological status of healthcare workers were retrieved from electronic databases. Two researchers (CZ and JL) systematically and independently searched the following electronic databases: PubMed, Embase, the Cochrane Library, E. B. Stephens Company database, Web of Science, ALOIS, PsycINFO, Cumulative Index to Nursing and Allied Health Literature database (CINAHL), ClinicalTrials.gov, the Chinese National Knowledge Infrastructure (CNKI), Sinomed, Wanfang Data and Chongqing VIP database. Included results were from the period of onset of COVID-19 to 8 May 2020. English keywords included 'novel coronavirus', '2019-nCoV', 'COVID-19', '2019 n-COV', 'coronavirus disease', 'COVID-19', 'mental', 'psycho\*', 'depress\*', 'anxiety\*', 'stress', 'trauma\*', 'insomnia\*', 'sleep', 'medical staff', 'healthcare worker\*', 'doctor\*' and 'nurse\*'. Search words in Chinese were '新型冠状病毒肺炎', '新冠病毒', '新冠肺炎', '2019冠状病毒', '2019新型冠状病毒感染', '2019-nCoV肺炎', '\*新型冠状病毒\*', '心理\*', '抑郁', '焦虑', '应激', '危机', '失眠', '睡眠障碍', '创伤', '医护\*', '医务\*', '医生' and '护士'. We included cross-sectional studies that met the following criteria: (1) the research subjects were Chinese medical staff, such as doctors, nurses and technicians; (2) the research time was after the outbreak of the pandemic; and (3) studies included were those that measured the prevalence of a specific mental illness with validated rating instruments. Details of selected articles were collected using standardised data

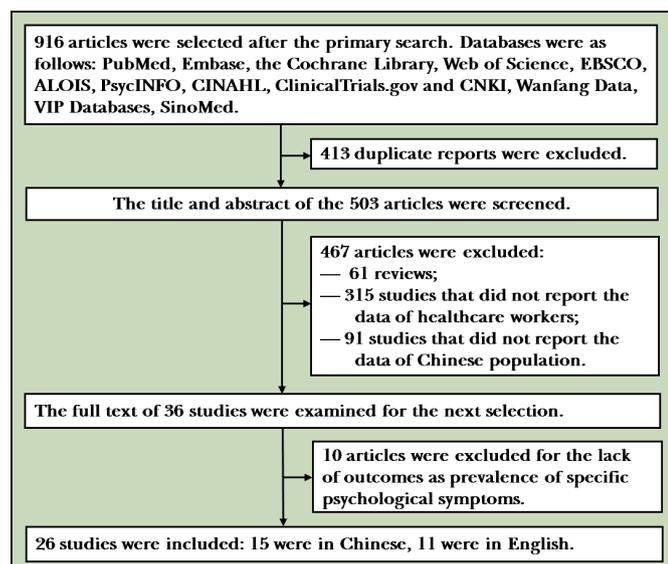
extraction templates, including general study information (trial name, author, publication date and study location), study characteristics (study design, assessment tools and survey time span), population characteristics (sample size, age, gender and occupation), results of psychological symptom scales, as well as information needed for assessment of risk of bias and evaluation of research quality. In the articles that provided survey time, we chose the date of the survey or the midpoint of survey time as the sampling time. For articles that did not provide survey time, we contacted the authors to obtain the information or chose the submission time as the sampling time. Two researchers (WL and HL) individually screened the articles and extracted the data. The 14-item Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies<sup>17–19</sup> was used to evaluate the quality of the studies. There are 14 questions in the scale, two researchers (HZ and WL) scored each item with Y (which indicates 'yes'), N (which means 'no'), CD (which means 'cannot determine') or NA (which means 'not applicable'). Study quality was rated according to the percentage of 'Y' allocations out of the total score (50% as good, 30%–50% as fair and below 30% as poor). This study was registered in the International Prospective Register of Systematic Reviews (CRD 42020171485).

### Psychological support policy for healthcare workers

We searched the Chinese government website ([www.gov.cn](http://www.gov.cn)) for all national policies on the topic of healthcare starting from 1 January 2020. We recorded policies relevant to the psychological support of healthcare workers. Document-issuing authorities included the State Council, the National Disease Control and Prevention Bureau, the State Council Joint Prevention and Control Team to Respond to the Novel Coronavirus Pneumonia and the National Health Commission.

### Statistical analysis

R software V.3.5.1 was used to calculate the aggregate prevalence of individual psychological issues using the data extracted from the included studies. The 'metaprop' function in the 'meta' package was used to calculate the aggregate prevalence of each psychological issue. A cumulative meta-analysis was performed to show the changing trend of effect size over time: we sorted the included studies according to the date of research survey or publication, subsequently used the 'metacum' function in the meta package to present the cumulative forest plots. Heterogeneity was examined using  $I^2$  statistics. According to the Cochrane handbook, an  $I^2$  index ranging from 0% to 40% indicates that heterogeneity might not be important; 30%–60% may represent moderate heterogeneity; 50%–90% may represent substantial heterogeneity; and 75%–100% may represent considerable heterogeneity. In cases where heterogeneity among studies was regarded as low, a fixed-effect model was used to compute the pooled estimate of prevalence. Otherwise, a random-effects model was used for the analysis. We also performed



**Figure 1** Flowchart of collecting and evaluating articles.

a sensitivity analysis in cases of moderate to high heterogeneity to identify the study that could account for more than 10% of heterogeneity. Publication bias was examined using Egger's test.

## RESULTS

### Characteristics of included studies

A flowchart outlining the literature screening process is presented in [figure 1](#). A total of 26 articles were included in this review<sup>10 20–44</sup> ([table 1](#)), with a total of 22 062 medical workers surveyed. Fifteen articles were in Chinese, and 11 were in English. Eighteen studies<sup>10 21 23 25–32 35–38 41 42 44</sup> reported the investigation time in the articles, and two studies' survey times were obtained from the authors.<sup>22 24</sup> For the remaining six studies<sup>20 33 34 39 40 43</sup>, admission time was used to estimate the approximate research time. The median survey time was from 31 January to 27 February, and the average duration of the survey was 2–14 days. The number of sampled populations in the studies ranged from 37 to 4369. Ten studies provided the information on the average age of the participants<sup>20 21 23–25 30 39 40 42 44</sup>; the mean age of the participants in these studies varied from 29.0 to 38.28 years old. Nineteen studies reported gender proportions<sup>10 21–23 26–28 30 31 34–42 44</sup>, and the ratio of men to the total population varied from 0% to 82.7%. Overall, the included studies involved healthcare workers in 12 different provinces or municipalities. Four studies were nationwide surveys or had no location limitations<sup>10 26 31 32</sup>; five studies were conducted in Hubei province<sup>25 29 30 36 41</sup>; and the other studies were conducted in Guangdong<sup>40</sup>, Beijing<sup>20 23</sup>, Tianjin<sup>21</sup>, Henan<sup>34</sup>, Hunan<sup>43</sup>, Anhui<sup>42 44</sup>, Zhejiang<sup>35 38</sup>, Fujian<sup>28</sup>, Shanghai<sup>22 27</sup>, Sichuan<sup>33 37 39</sup> and Guizhou<sup>24</sup> (see [table 1](#)). The psychological issues surveyed and their corresponding assessment tools were anxiety symptoms (assessed with the Hamilton Anxiety Scale, the Self-rating Anxiety Scale, Generalised Anxiety

Disorder (GAD)-7 or GAD-2 and the Beck Anxiety Inventory), depression symptoms (assessed with the Hamilton Depression Scale, the Self-rating Depression Scale, the Patient Health Questionnaire-9 or 2, Beck Depression Inventory-II and the Centre for Epidemiological Studies Depression Scale), sleep disturbance (assessed with the Insomnia Severity Index, the Impact of Events Scale—Revised and the Pittsburgh Sleep Quality Index) and stress-related problems (assessed with Perceived Stress Scale, Post-traumatic Stress Disorder Self-rating Scale, Maslach Burn-out Inventory and PTSD Checklist-Cuvukuab Version) (see details in [table 1](#)).

### Quality of included studies

As summarised in online supplemental table A1, using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, 7 studies were rated as good quality<sup>22 26 28–30 41 44</sup>; 18 studies were rated as fair quality<sup>10 20 21 23–25 27 31–39 42 43</sup> and 1 study was rated as poor quality.<sup>40</sup>

### Anxiety symptoms

In total, 23 studies<sup>10 21–35 37 39–44</sup> investigated the anxiety level of medical workers (n=21 447). The results were summarised and showed that from 31 January to 27 February, the aggregate prevalence of anxiety symptoms among medical staff was 27.0% (95% CI: 0.21% to 0.34%, I<sup>2</sup>=99.0%). Sensitivity analysis revealed that I<sup>2</sup> did not decrease significantly when any study was performed. Publication bias was not present, as confirmed by Egger's regression test (intercept=−0.553, p=0.58), and cumulative meta-analysis found that a downward trend was observed over the time period (see [figure 2](#)). Between 31 January and 5 February, the detection rate of anxiety levels ranged from 37.7% to 56.3%. An obvious decline in the detection rate was observed between 10 and 12 February, with a decrease from 37.2% to 32.0% from 13 and 27 February, and the rates of anxiety levelled off (27.0%–30.8%).

### Depression symptoms

In total, 18 studies<sup>10 20–32 34 35 38 42</sup> investigated the depression levels of Chinese medical workers during the COVID-19 pandemic under review (n=18 818). Pooled results found that from 31 January to 27 February, the aggregate prevalence of depression among medical workers was 26.2% (95% CI: 0.21% to 0.33%, I<sup>2</sup>=98.6%). Sensitivity analysis revealed that I<sup>2</sup> did not decrease significantly when any study was performed. Publication bias was not present, as confirmed by Egger's regression test (intercept=−0.644, p=0.52), and cumulative meta-analysis also indicated a downward trend ([figure 3](#)). From 31 January to 5 February, the detection rate of depression ranged from 37.2% to 50.6%. The detection rate of depressive symptoms decreased to 29.7% on 15 February. Then, until 27 February, the detection rate of depressive symptoms fluctuated between 26.2% and 29.2%.

**Table 1** Characteristics of included studies

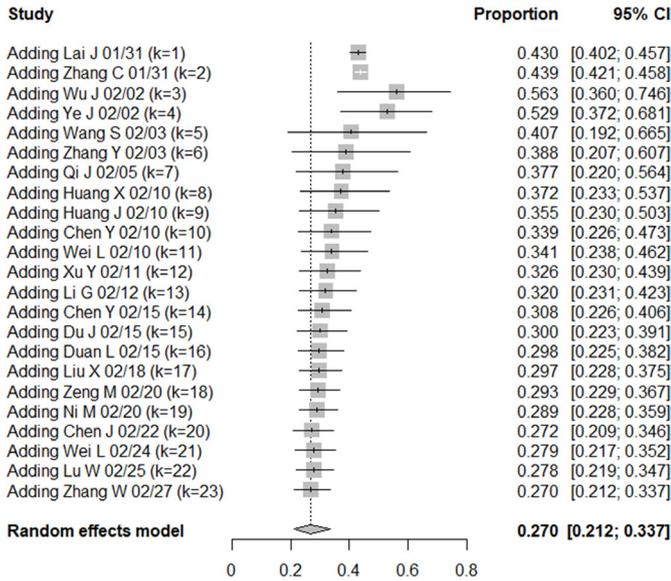
Study number	Author	Time of investigation	Age (years)	Sex (M/F)	Location of investigation (province)	Questionnaires	Sample size
			Mean (SD)				
1	Lai <i>et al</i> <sup>26</sup>	29 January–3 February	NA	293/964	China	PHQ-9, GAD-7, ISI and IES-R	1257
2	Liu <i>et al</i> <sup>23</sup>	1–18 February	29.0 (5.9)	19/1078	Beijing, China	PHQ-9, GAD-7 and ISI	1097
3	Duan <i>et al</i> <sup>21</sup>	14–16 February	32.8 (6.4)	136/506	Tianjin, China	GAD-7 and PHQ-9	642
4	Qi <i>et al</i> <sup>34</sup>	NA, submitted on 5 February	NA	105/295	Henan, China	SAS and SDS	400
5	Huang <i>et al</i> <sup>44</sup>	7–14 February	32.6 (6.2)	43/187	Anhui, China	SAS and PTSD-SS	230
6	Zhang <i>et al</i> <sup>41</sup>	29 January–6 February	NA	56/168	Hubei, China	SAS and SDS	224
7	Zeng <i>et al</i> <sup>43</sup>	NA, submitted on 20 February	NA	NA	Hunan, China	SAS and CPSS	152
8	Wu <i>et al</i> <sup>39</sup>	NA, submitted on 2 February	30.8 (4.5)	21/85	Sichuan, China	SAS and PSQI	106
9	Huang and Ke <sup>40</sup>	NA, submitted on 10 February	38.3 (11.9)	18/32	Guangdong, China	SAS	50
10	Wang <i>et al</i> <sup>30</sup>	30 January–7 February	33.8 (8.4)	12/111	Hubei, China	PSQI, SAS and SDS	123
11	Lu <i>et al</i> <sup>28</sup>	25–26 February	NA	451/1591	Fujian, China	HAMD and HAMA	2042
12	Cao <i>et al</i> <sup>20</sup>	NA, submitted on 26 February	32.8 (9.6)	NA	Beijing, China	PHQ-9 and MBI	37
13	Chen <i>et al</i> <sup>24</sup>	10–20 February	32.6 (6.5)	NA	Guizhou, China	SDS and SAS	105
14	Du <i>et al</i> <sup>25</sup>	13–17 February	36.0 (8.1)	NA	Hubei, China	BDI-II, BAI and PSS	134
15	Li <i>et al</i> <sup>27</sup>	8–15 February	NA	0/4369	Shanghai, China	PHQ-9, GAD-7 and IES-R	4369
16	Ni <i>et al</i> <sup>29</sup>	16–24 February	NA	NA	Hubei, China	GAD-2 and PHQ-2	214
17	Zhang <i>et al</i> <sup>31</sup>	29 January–3 February	NA	1293/270	China	ISI, PHQ-9, GAD-7 and IES-R	1563
18	Zhang <i>et al</i> <sup>10</sup>	19 February–6 March	NA	249/678	China	ISI, GAD-2 and PHQ-2	927
19	Huang and Zhao <sup>32</sup>	3–17 February	NA	NA	China	GAD-7, CES-D and PSQI	2250
20	Chen <i>et al</i> <sup>33</sup>	NA, submitted on 22 February	NA	NA	Sichuan, China	SAS	173
21	Chen <i>et al</i> <sup>35</sup>	3–16 February	NA	315/396	Zhejiang, China	PHQ-9 and GAD-7	711
22	Wei <i>et al</i> <sup>22</sup>	10–20 February	NA	873/1277	Shanghai, China	PHQ-9, GAD-7 and PSQI	2150
23	Xu <i>et al</i> <sup>42</sup>	7–15 February	34.8 (7.1)	69/291	Anhui, China	SAS and SDS	360
24	Ye <i>et al</i> <sup>37</sup>	29 January–5 February	NA	460/1644	Sichuan, China	GAD-7	2104
25	Zhen <i>et al</i> <sup>38</sup>	18–21 February	NA	95/278	Zhejiang, China	PSS-10 and PHQ-9	373
26	Li <i>et al</i> <sup>36</sup>	8–11 February	NA	30/175	Hubei, China	PCL-C	205

BAI, Beck Anxiety Inventory; BDI-II, Beck Depression Inventory-II; CES-D, Centre for Epidemiological Studies Depression Scale; CPSS, Chinese Perceived Stress Scale; GAD-2, Generalised Anxiety Disorder-2; GAD-7, Generalised Anxiety Disorder-7; HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; IES-R, Impact of Events Scale—Revised; ISI, Insomnia Severity Index; MBI, Maslach Burn-out Inventory; NA, not applicable; PCL-C, PTSD Checklist—Civilian Version; PHQ-2, Patient Health Questionnaire-2; PHQ-9, Patient Health Questionnaire-9; PSQI, Pittsburgh Sleep Quality Index; PSS, Perceived Stress Scale; PTSD-SS, Post-Traumatic Stress Disorder Self Rating Scale; SAS, Self-rating Anxiety Scale; SDS, Self-rating Depression Scale; SQR-20, Self-reporting Questionnaires 20.

### Stress-related problems

In total, eight studies<sup>23 25–27 31 36 43 44</sup> reported the prevalence of stress-related symptoms among medical staff from 13 January to 18 February (n=9183). The aggregate prevalence of stress-related problems among medical workers during this period was 42.1% (95% CI: 0.26% to

0.60%,  $I^2=99.5\%$ ). Sensitivity analysis revealed that the  $I^2$  statistic did not decrease significantly when interpreting any study. Publication bias was not conducted using Egger's regression test because of the small number of studies. The cumulative meta-analysis revealed a general downward trend (figure 4). In the early stages of the

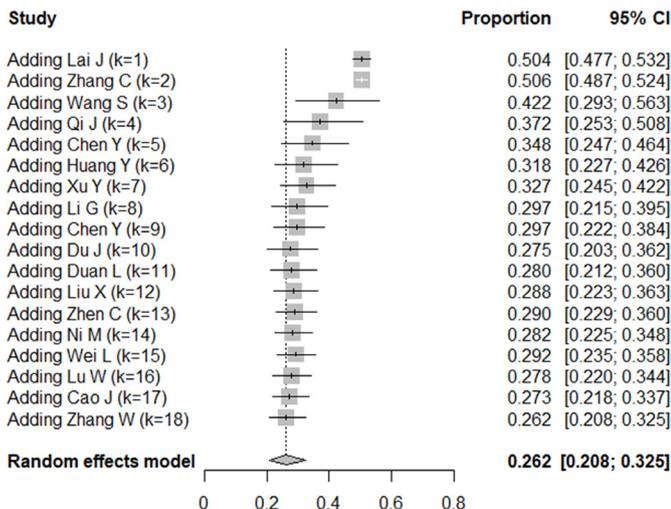


**Figure 2** Cumulative meta-analysis of anxiety prevalence among Chinese healthcare workers.

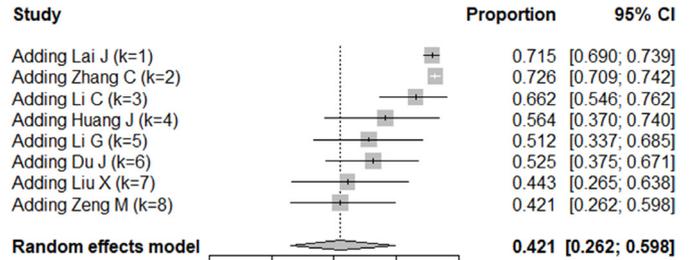
pandemic, the prevalence was relatively high, ranging from 66.2% to 72.6%, and on 12 February, the prevalence of stress-related problems ranged from 42.1% to 51.2%.

**Sleep problems**

In total, eight studies<sup>10 22 23 26 30-32 39</sup> investigated the prevalence of sleep problems among medical workers (n=11 758). The results revealed that from 31 January to 27 February, the aggregate prevalence of sleep problems among medical workers was 34.5% (95% CI: 0.28% to 0.42%, I<sup>2</sup>=98.3%). Sensitivity analysis revealed that I<sup>2</sup> did not decrease significantly when any study was performed. Publication bias was not conducted using Egger’s regression test because of the small number of studies. The prevalence of sleep disturbance peaked around 2 January (43.8%), followed by a slight downward trend over time, which levelled off between 34.1% and 34.9% after 18 January (figure 5).



**Figure 3** Cumulative meta-analysis of depression prevalence among Chinese healthcare workers.



**Figure 4** Cumulative meta-analysis of stress-related problem prevalence among Chinese healthcare workers.

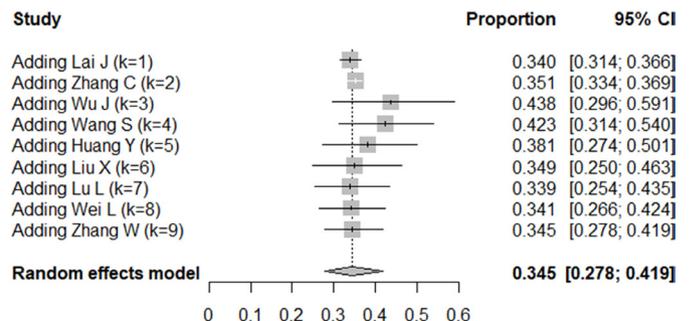
**National policies on psychological support for medical workers**

As shown in online supplemental table A2, the National Disease Control and Prevention Bureau launched the ‘Principles for Emergency Psychological Crisis Intervention for the COVID-19 Pandemic’,<sup>13</sup> which emphasised the priority of psychological support and intervention for frontline medical staff. On 7 and 10 February, several policies were issued to improve the care of medical personnel in terms of security, work environment, family needs and psychological support.<sup>14 45</sup> On 15 February, the National Health Commission launched a policy<sup>46</sup> requiring psychiatric medical personnel to support Hubei Province, and specific medical service lines and special areas were set up in the existing psychological hotline and psychological assistance network. From 25 February to 18 March, several subsequent policies were released to further improve the care for medical workers and their families.<sup>47-49</sup> Professional interventions such as psychological counselling and wholistic care were emphasised in these notices.

**DISCUSSION**

**Main findings**

This study reviewed papers surveying the psychological status of medical workers since the outbreak of the novel coronavirus epidemic in China. We found that from the early stage to the peak stage of the COVID-19 pandemic, medical workers had a high prevalence of psychological problems, including anxiety, depression, sleep problems and stress-related problems, which were several times higher than the equivalent prevalence of mental illness in the general population.<sup>50</sup> The psychological problems of



**Figure 5** Cumulative meta-analysis of sleep problem prevalence among Chinese healthcare workers.

medical workers were particularly prominent in the early stages of the pandemic, followed by a slight downward trend and later a levelling off.

The occurrence of the pandemic has brought tremendous changes to people's lives and has also caused great psychological challenges<sup>51</sup>, especially for vulnerable populations.<sup>52</sup> We observed that a significant proportion of healthcare workers dedicated to fighting COVID-19 are at-risk population, suffering from anxiety, depression, sleep problems and stress-related problems throughout the entire survey period. This result was consistent with previous studies investigating the SARS pandemic, in which psychological problems were also found to be severe and frequent among medical staff.<sup>53,54</sup> We further found that psychological problems were especially robust in the early stages of other pandemics. This is understandable, given that medical workers face high levels of stress during the early stages of a pandemic owing to a rapid increase in workload, a shortage of supplies, uncertainty about the disease and the risk of infection. The numerous challenges are a significant and continuous source of stress, which can lead to a higher prevalence of acute stress disorders, anxiety, insomnia and overall psychological problems, especially among frontline healthcare workers.<sup>55</sup> Studies have found that longer work hours and less social support are also related to depressive symptoms.<sup>56</sup> Furthermore, medical workers' sleep time and quality were also unavoidably affected by the challenging work environment and stressful mental state.<sup>57</sup>

Our study found that the prevalence of psychological problems among medical workers during the pandemic did not follow the upward growth curve of confirmed COVID-19 cases but instead showed a gentle decline. We speculated that this might be attributed to the implementation of comprehensive and timely measures during this period. As early as 27 January, the State Council declared the Principles for Emergency Psychological Crisis Intervention For the COVID-19 Pandemic<sup>13</sup>, which emphasised psychological interventions and support for medical staff. This indicated that policymakers paid close attention to the psychological problems of medical workers during the early stage of the pandemic. Moreover, 344 medical teams across the country were dispatched to Wuhan by 24 January<sup>58</sup>, and several makeshift hospitals were built in a very short time, which undoubtedly eased the workload of local medical staff. Through the efforts of government departments and civil organisations, the difficult situation at the beginning of the pandemic was gradually eased. Medical protective equipment was fully supplied, and the order of patients visiting the hospital was set up. Additionally, further policies were introduced to solve various problems and needs that medical staff might encounter, such as the need to take care of elderly family members<sup>14</sup>, the problem of children's schooling and other family-related problems.

Furthermore, from 15 February onwards, specialised psychiatrists were added to the medical assistance teams to provide psychological support for workers at the epicentre of the pandemic.<sup>47</sup> Moreover, online medical health services and psychological hotlines were also widely available during the pandemic<sup>59</sup> and also offered help to those who were in adverse situations. Institutions and organisations also responded actively to the calls of national policies and provided psychological services for medical staff during the pandemic. For example, the Chinese Psychological Association launched the 'Anxin' ('relief' in English) campaign against the pandemic, which provided many psychological services such as professional lectures, self-assessments, online short-term psychological intervention programmes and adaptive online psychological counselling.<sup>60</sup> The Shanghai Mental Health Centre cooperated with Shanghai People's Broadcasting Station and an online broadcasting platform to deliver psychological decompression lessons for medical staff on the radio.<sup>61</sup> Although no studies quantify the impact of each policy or measure, their positive effect is evident from the changes in the psychological status of medical workers.

### Limitations

This study has several implications. First, it was found that psychological issues peaked rapidly at the early stage of the pandemic, which suggests that psychological interventions for medical staff should be provided as early as possible. This is a call to reflect on the emergency response system of psychological interventions. First, it is undoubtedly necessary to ensure psychosocial preparedness by setting up specific mental health organisations and well-established emergency response systems for future pandemics. Various measures should be developed and integrated into the systems to help relieve the psychological burden of healthcare personnel, such as implementing self-coping strategies and psychosocial interventions and providing hospital support systems and occupational health policies.<sup>62</sup> Online mental health services and social media have also proved to be effective tools and have played a crucial role in the battle against this disease.<sup>59</sup> In the future, by improving the construction of policies and systems, policies can be implemented, and interventions can reduce the stress response and negative experiences of medical workers during health emergencies.<sup>63</sup> Second, we found that medical workers still exhibited a high level of psychological distress during the later period of the pandemic; therefore, greater attention should be paid to those enduring psychological effects. The prevalence of post-traumatic stress symptoms among frontline healthcare workers reached nearly 10% even several years after the SARS outbreak.<sup>64</sup> This indicated that it was vital to perform further follow-up visits and to provide support for medical staff after the acute phase of COVID-19.

It should be mentioned that our study did not reach a causal association or statistical relationship between policies and psychological status among healthcare workers. The time interval from the launch of policies to their specific implementation is unknown to us. Further, the implementation status of policies in different regions may also be different. Moreover, during the pandemic, other influencing factors would also have an impact on medical workers' psychological condition, such as support from civil society, the development phase of the pandemic, their personal support structures, and the differences in individuals' basic psychological characteristics. Therefore, the impact of policies on psychological status must be interpreted cautiously.

The following limitations should be considered when interpreting the findings of this study. First, the current number of the studies and the total number of samples included in the studies were relatively small, and the participants in most studies were enrolled by convenience sampling rather than probabilistic sampling, leading to a limited representativeness of the sample population. However, owing to the urgent and special situation at the beginning of the pandemic, it was not feasible to conduct large-scale epidemiological investigations on medical staff's psychological status at that time; thus, our meta-analysis may provide alternative information on that question. Second, there were significant heterogeneities between studies, which may arise from inter-regional differences in the sampled location or methodological differences in the assessment tools applied. Owing to the limited number of the studies, it is not feasible to conduct further subgroup analyses to analyse the source of heterogeneity. Several studies had a wide survey time span; thus, there were some errors in the method of selecting the median time of the survey to represent the incidence within the study period. Therefore, more large-scale and longitudinal studies are needed to reach firmer conclusions.

### Implications

During the pandemic, Chinese medical workers exhibited significant psychological problems, with the peak occurring in the early stage of the pandemic and gradually showing a downward trend. However, there was still a high prevalence of psychological problems during the middle and later stages of the pandemic. Implementation of relevant supportive policies may help reduce psychological problems, especially in preventing the incidence of delayed mental health problems among this population.

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**Table.A1 Scores of included studies evaluated by 'Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies'**

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total	Rating
Lai J <sup>[1]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Liu X <sup>[2]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Duan L <sup>[3]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Qi J <sup>[4]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Huang J <sup>[5]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Zhang Y <sup>[6]</sup>	Y	Y	Y	Y	NR	Y	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Zeng M <sup>[7]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Wu J <sup>[8]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Huang X <sup>[9]</sup>	Y	N	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	N	4	Poor
Wang S <sup>[10]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Lu W <sup>[11]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Cao J <sup>[12]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	NR	5	Fair
Chen Y <sup>[13]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	NR	5	Fair
Du J <sup>[14]</sup>	Y	Y	Y	N	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	5	Fair
Li G <sup>[15]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Ni M <sup>[16]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Zhang C <sup>[17]</sup>	Y	Y	NR	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	5	Fair
Zhang W <sup>[18]</sup>	Y	Y	NR	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	5	Fair
Huang Y <sup>[19]</sup>	Y	Y	Y	N	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	5	Fair
Chen J <sup>[20]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Chen Y <sup>[21]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	N	6	Fair
Wei L <sup>[22]</sup>	Y	Y	Y	Y	Y	NA	NA	NA	NA	NA	Y	NA	NA	Y	7	Good
Xu Y <sup>[23]</sup>	Y	Y	NR	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	5	Fair
Ye J <sup>[24]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	Fair
Zhen C <sup>[25]</sup>	Y	Y	NR	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	5	Fair
Li C <sup>[26]</sup>	Y	Y	Y	Y	NR	NA	NA	NA	NA	NA	Y	NA	NA	Y	6	fair

\*CD, cannot determine; NA, not applicable; NR, not reported

Q1: Was the research question or objective in this paper clearly stated?

Q2: Was the study population clearly specified and defined?

Q3: Was the participation rate of eligible persons at least 50%?

Q4: Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?

Q5: Was a sample size justification, power description, or variance and effect estimates provided?

Q6: For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?

Q7: Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?

Q8: For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?

Q9: Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?

Q10: Was the exposure(s) assessed more than once over time?

Q11: Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?

Q12: Were the outcome assessors blinded to the exposure status of participants?

Q13: Was loss to follow-up after baseline 20% or less?

Q14: Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?

**Table.A2 Summary of national guidelines and instructions for mental health services for healthcare workers during the COVID-19 pandemic in China**

Date	Guidelines and instructions	Note
27 Jan	Principles For Emergency Psychological Crisis Intervention For COVID-19 pandemic	Classify the frontline medical staff as the key population for intervention.
7 Feb	Notice On Earnestly Ensure The Support Of Frontline Medical Personnel And Their Families	Provide medical personnel and their families with guarantees in terms of life, psychology and safety, the etc.
10 Feb	Several Measures To Improve The Working Conditions Of Frontline Medical Staff And To Care For Their Physical And Mental Health	Improve the working environment of medical workers; Strengthen medical staff's psychological crisis intervention.
15 Feb	Notice On The Implementation Of Several Measures To Improve The Working Conditions Of Frontline Medical Staff And To Care For Their Physical And Mental Health	Psychiatric medical personnel should be equipped in the medical teams dispatched to support Hubei; Set up medical staff service hotline and special area in the existing online platform.
23 Feb	Notice On The Comprehensive Implementation Of Several Measures To Further Protect And Care For Medical Staff	Emphasize on strengthening psychological intervention and counselling of frontline medical staff
25 Feb	Notice On Caring For The Elderly Relatives Of Medical Staff In The Frontline Of Prevention And Control Of COVID-19	Emphasis on solving the problems of elderly relatives of medical staff
5 Mar	Notice On Strengthening Psychological Assistance And Social Work Services In The Response To COVID-19	Strengthen psychological support and social work services for frontline workers
11 Mar	Notice On Implementation Of Protection And Care For The Frontline Medical Staff	Provide adequate living supply for medical staff
18 Mar	Notice On The Issuance Of The Work Plan For Psychological Counselling During COVID-19 Pandemic	Provide counselling and social support for vulnerable populations, including frontline healthcare workers

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