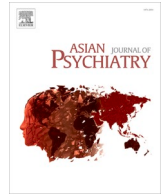




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Different prevalence trend of depression and anxiety among healthcare workers and general public before and after the peak of COVID-19 occurred in China: A meta-analysis

Yongyan Deng^{a,b}, Yifang Chen^{a,b}, Bin Zhang^{a,b,*}

^a The Affiliated Brain Hospital of Guangzhou Medical University (Guangzhou Huiai Hospital), Guangzhou, China

^b Guangdong Engineering Technology Research Center for Translational Medicine of Mental Disorders, Guangzhou, China

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ABSTRACT

Objective: We aim to evaluate the prevalence of depression and anxiety among general public and healthcare workers during COVID-19 in China and the changes of prevalence before and after the peak of the epidemic occurred.

Methods: Studies were searched from following database: PubMed, Web of Science, Cochrane Library, China National Knowledge Infrastructure (CNKI), WANGFANG DATA, from inception to 1 st May 2020. Random-effects model was applied to pool the prevalence. Comparative analysis was also applied to evaluate the changes of prevalence before and after the peak of the epidemic occurred.

Results: 34 articles were finally included. Prevalence of depression and anxiety was higher among healthcare worker than general public. Among general public, 26 % (95 %CI: 17 %–36 %) were suffering from depression and 22 % (95 %CI: 15 %–30 %) were having anxiety during COVID-19, while the prevalence of depression and anxiety among healthcare workers was 31 % (95 %CI: 25 %–37 %) and 40 % (95 %CI: 33 %–46 %) respectively. Comparative analysis showed healthcare workers (depression: 40 %, anxiety: 38 %) had higher percentage of having depression and anxiety than the general public (depression: 33 %, anxiety: 24 %) before the peak. Then a descended prevalence among healthcare workers (depression: 22 %, anxiety: 22 %) was detected compared with that before, while the prevalence among the general public raised (depression: 62 %, anxiety: 44 %) after the peak occurred.

Conclusion: The COVID-19 epidemic had a potential psychiatric impact on general public and healthcare workers in China, which is more severer among healthcare workers. However, the psychiatric status of the general public trend to deteriorated, while healthcare workers trend to improve after the peak of epidemic.

1. Introduction

In December 2019, a cluster of cases of “pneumonia of unknown cause” were first detected in Wuhan, China, which has been identified as coronavirus-related pneumonia with continuously increasing number of cases later on in many Chinese cities and in other countries around the world (Li et al., 2020a; Munster et al., 2020). It was proclaimed as the infectious diseases outbreak of Corona Virus Disease 2019 (COVID-19) epidemic by the World Health Organization (WHO), causing 34 million confirmed cases and 1 million deaths globally by October 2020. (World Health Organization (WHO), 2020a, 2020b).

As a highly infectious and fatal disease, COVID-19 not only impairs

physical health but also has impact on the mental health of healthcare workers and the general public (Chew et al., 2020). Faced with the stress of interpersonal isolation for minimizing the risk of infection and the worries of virus exposure to oneself and loved ones, high prevalence of depression and anxiety may be detected in the general population due to stressful situation, which can be especially severe among the healthcare workers, who fight in the frontline (Yeen and Ning, 2020; Maunder, 2009). Emerging outcomes of the mental health status of the general public and healthcare workers are reported in China. With higher risk of being infected and exposure to long and distressing work shifts to meet health requirements during COVID-19 epidemic, healthcare workers may be more psychologically affected than the general public (Zhang

* Corresponding author at: 510370, Mingxin Rd.36, Guangzhou, Guangdong, China.

E-mail address: zhang.bin845@gzhmu.edu.cn (B. Zhang).

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et al., 2020c). During the initial phase of COVID-19 outbreak in China, a nationwide study observed 30 % of the general public were having depression and 37 % were suffering from anxiety (Wang et al., 2020a). Another study conducted at the same time reported that among healthcare workers, the prevalence of depression and anxiety was 50 % and 45 % respectively in China (Lai et al., 2020).

On February 8th 2020, the peak of the epidemic occurred with 37,251 cases confirmed infection in China, and then there was a rapid decline in the number of new and suspected cases and the downtrends continued afterward, with recovered cases substantial increasing (Wang et al., 2020b; World Health Organization (WHO), 2020b). Compared with studies conducted before the peak occurred, different trend was discovered in the later studies. After February 8th 2020, the prevalence of depression and anxiety were 62 % and 44 % respectively among the general public according to an observational study (Zhang et al., 2020a), while a cross-section study showed that 12 % healthcare workers were having depression and 26 % were having anxiety (Lu et al., 2020).

Outcomes of the reported prevalence vary widely and the status trend of the general public and healthcare workers are inconsistent before and after the peak. However, few comprehensive studies summarized the comparable overall prevalence and the trend changes among general public and healthcare workers pre- and post- the peak in China.

In present study, a systematic review and meta-analysis was performed to assess the prevalence of depression and anxiety among the general public and healthcare workers in China during COVID-19 epidemic. Moreover, comparative analysis was also conducted to evaluate the changes of prevalence before and after the peak of the epidemic occurred among both populations.

2. Method

This systematic review and meta-analysis were conducted according to PRISMA (Moher et al., 2015) statement.

2.1. Search strategy and selection process

Our search strategy was decided by consensus. In present study, we searched PubMed, Web of Science, Cochrane Library, China National Knowledge Infrastructure (CNKI), WANGFANG DATA from database inception to 1st May 2020, with language restricted to Chinese and English. Two independent researchers identified published studies that are relevant to the prevalence of depression and anxiety among the general public and healthcare workers during the COVID-19 pandemic in China, using following keywords: novel coronavirus pneumonia, NCP, 2019-ncov, COVID-19, coronavirus disease-2019, SARS-CoV-2, mental health, depression, stress, psycho*.

A study would be included if: 1) The population group consists of the general public or healthcare workers or both. 2) Prevalence of anxiety, depression or relative symptoms is evaluated. 3) It is cross-sectional study, cohort study, case control study or other type of observational study. 4) Its symptomatic evaluation data is available. 5) Study area restricts in China.

Case reports, systematic reviews, meta-analyses and other second-hand studies were excluded. Studies without available full text were also excluded. Duplicates were removed.

For initial selectiveon, two author YD and YC examined titles and abstracts and excluded irrelevant studies according to selective criteria independently. After that, full texts were obtained for further details to complete final inclusion. Any conflict would be discussed and determined by the third author (BZ). All studies were imported into EndNote X7 software (Thomson Reuters, NY, US) to conduct selection process.

2.2. Quality assessment

Quality of included studies was evaluated using an 11-item checklist,

which was recommended by the Agency for Healthcare Research and Quality (AHRQ) (Hu et al., 2015). If the answered was 'NO' or 'UNCLEAR', an item would be scored '0', while the item would score '1' when the answer was 'YES'. An article would be rated as: 1) high quality if total score equals 8–11; 2) moderate quality if total score equals 4–7; 3) low quality if total score equals 0–3. Studies of low quality would be excluded.

2.3. Data extraction and analysis

We extracted data from the included studies on study name, author, year of publication, the time of the investigation, study type, total number of participants, demographics of the participants, the number of participants with anxiety or depression, rate of anxiety and depression detection.

We used I^2 to indicate the heterogeneity among the included studies (Higgins and Green, 2011). Due to the huge heterogeneity, random-effects model was applied to pool the prevalence rate. Forest plot was utilized to displayed the prevalence together with a 95 % confidence interval (95 % CI) and weight for every study. The final pooled prevalence rates were also reflected in the forest plot. Potential publication bias was assessed by funnel plots, whose symmetry was evaluated using egger test (Luo et al., 2013). A $P \leq 0.05$ would indicate significant.

Trend of prevalence change before and after the peak was comparatively analyzed by synthesizing related articles from different phases of the epidemic and pooling the final prevalence.

All statistical analyses were done using R package (4.0–2; R foundation for statistical Computing, Vienna, Austria) and Stata 11.0 (Stata Corp., TX, USA).

3. Results

3.1. Study selection

1856 studies were found after searching process (Fig. 1), and 185 duplicates were removed. After screening titles and abstracts, 322 studies were assessed and 288 were excluded due to data unavailability. Finally, 34 articles were included.

3.2. Quality assessment

The quality of all selected studies were assessed using the checklist recommended by AHRQ. The quality of each article was presented in Table 1. Sixteen studies were of high quality and eighteen articles were of moderate quality. No low-quality studies were detected among inclusion.

3.3. Study characteristics

Study characteristics of the 34 included study was displayed in Table 1 (Ahmed et al., 2020; Cai and Yuan, 2020; Chen et al., 2020; Chung and Yeung, 2020; Dong et al., 2020; Gao et al., 2020; Huang et al., 2020; Huang and Zhao, 2020; Lai et al., 2020; Lei et al., 2020; Li et al., 2020b; Li et al., 2020c; Lin et al., 2020; Liu et al., 2020a; Liu et al., 2020b; Lu et al., 2020; Luo et al., 2020; Mu, 2020; Nong et al., 2020; Qi et al., 2020; Sun et al., 2020; Tang et al., 2020; Wang et al., 2020c; Xiao et al., 2020; Xu et al., 2020; Zhang et al., 2020a, b; Zhang et al., 2020c; Zhang et al., 2020d; Zheng et al., 2020; Zhong et al., 2020). The 34 studies comprised 29,996 participants. Of 34 studies, all selected studies were cross-section study. 11 studies were published in English, and 23 were in Chinese. 11 studies evaluated the prevalence of mental symptoms of general public, and 11 reported the status of healthcare workers. Only 1 article assessed both groups. 7 articles conducted assessments before 8th February, 2020, and 5 articles assessed after 8th February. While 6 articles were still conducting evaluation before and after 8th

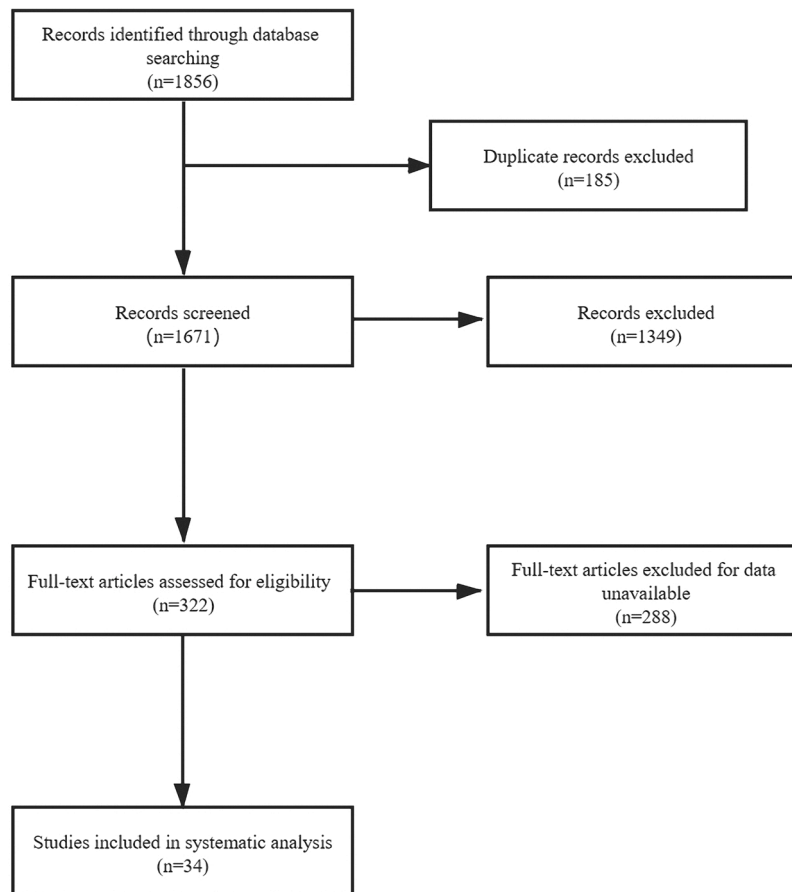


Fig. 1. Flowchart of study selection procedure.

February, and 16 didn't provide the exact time of investigation.

3.4. Prevalence of depression and anxiety

Prevalence of depression and anxiety were both higher among healthcare workers than among the general public. The prevalence of depression among the general public for each public ranged from 6% to 62% (Fig. 2) (Ahmed et al., 2020; Gao et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Li et al., 2020c; Mu, 2020; Wang et al., 2020a; Wang et al., 2020c; Yang et al., 2020; Zhang et al., 2020a). The pooled prevalence was 26% (95%CI: 17%–36%, $I^2 = 99.5\%$) with 16,094 sample size. While the prevalence of depression among healthcare workers for each public ranged from 4% to 82% (Fig. 3) (Cai and Yuan, 2020; Chen et al., 2020; Chung and Yeung, 2020; Dong et al., 2020; Duan et al., 2020; Huang and Zhao, 2020; Lai et al., 2020; Liu et al., 2020a; Liu et al., 2020b; Lu et al., 2020; Luo et al., 2020; Nong et al., 2020; Qi et al., 2020; Sun et al., 2020; Tang et al., 2020; Xiao et al., 2020; Xu et al., 2020; Zhang et al., 2020c; Zhang et al., 2020d; Zheng et al., 2020). The pooled prevalence was 31% (95%CI: 25%–37%, $I^2 = 98.4\%$) with 11,438 sample size. As for anxiety, the prevalence of anxiety among general public for each public ranged from 8% to 44% (Fig. 4) (Ahmed et al., 2020; Gao et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Li et al., 2020c; Lin et al., 2020; Munster et al., 2020; Wang et al., 2020a; Wang et al., 2020c; Zhang et al., 2020a). The pooled prevalence rate was 22% (95%CI: 15%–30%, $I^2 = 99.3\%$) with 16,386 sample size. At the same time, the prevalence of anxiety among healthcare workers ranged from 8% to 90% (Fig. 5) (Cai and Yuan, 2020; Chen et al., 2020; Dong et al., 2020; Duan et al., 2020; Huang et al., 2020; Huang and Zhao, 2020; Lai et al., 2020; Li et al., 2020b; Liu et al., 2020a; Liu et al., 2020b; Lu et al., 2020; Luo et al., 2020; Nong et al., 2020; Qi et al., 2020; Sun et al., 2020; Tang et al., 2020; Xiao et al.,

2020; Xu et al., 2020; Zhang et al., 2020b; Zhang et al., 2020c; Zhang et al., 2020d; Zhong et al., 2020). The pooled prevalence rate was 40% (95%CI: 33%–46%, $I^2 = 98.6\%$) with 11,438 sample size.

3.5. Publication bias

Funnel plots were used to assess publication bias. Egger's test was also performed on the prevalence of depression among the general public ($p = 0.20$) (Fig. 6), depression among healthcare workers ($p = 0.78$) (Fig. 7), anxiety among general public ($p = 0.11$) (Fig. 8), anxiety among healthcare workers ($p = 0.56$) (Fig. 9), which shows no publication bias was detected.

3.6. Prevalence before and after the peak

Final pooled prevalence of depression and anxiety among the general public and healthcare workers group pre- or post- peak was displayed in Table 2.

13 articles were available to extract specific time of investigation and were included in subgroup analysis. For the general public group, the prevalence of depression and anxiety before 8th February, 2020 were 33% (95%CI:16%–51%) and 24% (95%CI:17%–31%) respectively. After 8th February, the prevalence of depression and anxiety both increased in varying degrees, which were detected 62% (95%CI:53%–72%) and 44% (95%CI:34%–54%). As for the healthcare workers, the prevalence of depression and anxiety before the peak of the epidemic occurred were 40% (95%CI:19%–62%) and 38% (95%CI:12%–63%). While after 8th February, the prevalence was drop among healthcare workers. As shown, the prevalence of depression was 22% (95%CI:13%–31%), and 22% (95%CI:13%–31%) of anxiety (Table 2).

Table 1
Summary of characteristics of final inclusion.

Author	The time of the investigation	Study type	Study group	Study population	Depression % (n)	Anxiety % (n)	Quality score
Huang, Y.	From February 3 rd , 2020 to February 17 th , 2020	Cross-section study	General public	4986	20.22 % (1008)	34.84 % (1737)	7
			Healthcare workers	2250	19.82 % (446)	35.64 % (802)	
Zhang, J.	From February 15 th , 2020 to February 29 th , 2020	Cross-section study	General public	98	62.24 % (61)	43.88 % (43)	7
Chung, J.	N.A.	Cross-section study	Healthcare workers	69	34.80% (24)	N.A	5
Wang, C.	From January 31 st , 2020 to February 2 nd , 2020	Cross-section study	General public	1210	30.30 % (367)	36.70 % (444)	7
Ahmed, M. Z.	N.A.	Cross-section study	General public	1074	37.10%(398)	29 % (311)	7
Gao, J.	From January 31 st , 2020 to February 2 nd , 2020	Cross-section study	General public	4827	48.30 % (2331)	22.60 % (1091)	9
Lai, J. B.	From January 29 th , 2020 to February 3 rd , 2020	Cross-section study	Healthcare workers	1257	50.40 % (634)	44.60 % (561)	8
Lei, L.	Early February 2020	Cross-section study	General public	1593	14.60%(233)	8.30 % (132)	6
Lu, W.	From February 25 th , 2020 to February 26 th , 2020	Cross-section study	Healthcare workers	2299	12.10%(278)	25.50 % (586)	9
Wang, Y. N.	From February 6 th , 2020 to February 9 th , 2020	Cross-section study	General public	600	17.17 % (103)	6.33 % (38)	8
Zhang, W. R.	From February 19 th , 2020 to March 6 th , 2020	Cross-section study	General public	1255	9.5% (119)	8.5 % (107)	8
		Cross-section study	Healthcare workers	927	12.2% (113)	13 % (121)	
Zhong, Y.P.	In January 2020	Cross-section study	Healthcare workers	20	N.A	89.47 % (18)	6
Zhang, X. N.	In January to February 2020	Cross-section study	Healthcare workers	133	42.11% (56)	58.65 % (78)	8
Zhang, L.L.	N.A.	Cross-section study	Healthcare workers	89	N.A	58.43 % (52)	6
Xu, Y.	From February 7 th , 2020 to February 15 th , 2020	Cross-section study	Healthcare workers	360	38.33 % (138)	18.87 % (68)	8
Xiao, C.	From February 6 th , 2020 to February 8 th , 2020	Cross-section study	Healthcare workers	432	22.22 % (96)	12.27 % (53)	9
Tang, H.H.	N.A.	Cross-section study	Healthcare workers	44	45.40 % (20)	31.80 % (14)	8
Xun, X. Y.	N.A.	Cross-section study	Healthcare workers	110	16.36 % (18)	22.73 % (25)	7
Qi, J.J.	N.A.	Cross-section study	Healthcare workers	400	24.50 % (98)	31 % (124)	5
Nong, Q.X.	From January 31 st , 2020 to February 3 rd , 2020	Cross-section study	Healthcare workers	92	48.91% (45)	56.52 % (52)	7
Lin, G.T.	From January 31 st , 2020 to February 8 th , 2020	Cross-section study	General public	804	N.A	16.30 % (131)	9
Li, Y.F.	From January 30 th , 2020 to February 1 st , 2020	Cross-section study	General public	977	21.70% (212)	19.20 % (188)	9
Li, R.L.	In January to February 2020	Cross-section study	Healthcare workers	66	N.A	81.81 % (54)	8
Huang, J.Z.	From February 7 th , 2020 to February 14 th , 2020	Cross-section study	Healthcare workers	230	N.A	23.04 % (53)	8
Chen, Y.N.	In February 2020	Cross-section study	Healthcare workers	711	26.02% (185)	7.59 % (54)	6
Cai, F.F.	N.A.	Cross-section study	Healthcare workers	48	4.17 % (2)	87.5 % (42)	5
Zheng, C.M.	From February 18 th , 2020 to February 21 st , 2020	Cross-section study	Healthcare workers	373	31.37 % (117)	N.A	7
Luo, Q.Y.	N.A.	Cross-section study	Healthcare workers	171	39.77% (68)	49.03 % (77)	9
Liu, X. L.	From February 1 st , 2020 to February 18 th , 2020	Cross-section study	Healthcare workers	1097	37.19 % (408)	27.53 % (302)	7
Yang, L.Q.	In February 2020	Cross-section study	General public	512	9.38 % (48)	N.A	8
Mu, C.J.	From January 31 st , 2020 to February 11 th , 2020	Cross-section study	General public	217	5.53 % (12)	7.83 % (17)	9
Liu, L.	N.A.	Cross-section study	Healthcare workers	39	84.60%(33)	20.50 % (8)	6
Duan, L.S.	From February 14 th , 2020 to February 16 th , 2020	Cross-section study	Healthcare workers	530	33.02%(175)	26.42 % (140)	7
Dong, B.J.	From January 31 st , 2020 to February 10 th , 2020	Cross-section study	Healthcare workers	96	11.46 % (11)	70.83 % (68)	6

Note: N.A. = not available.

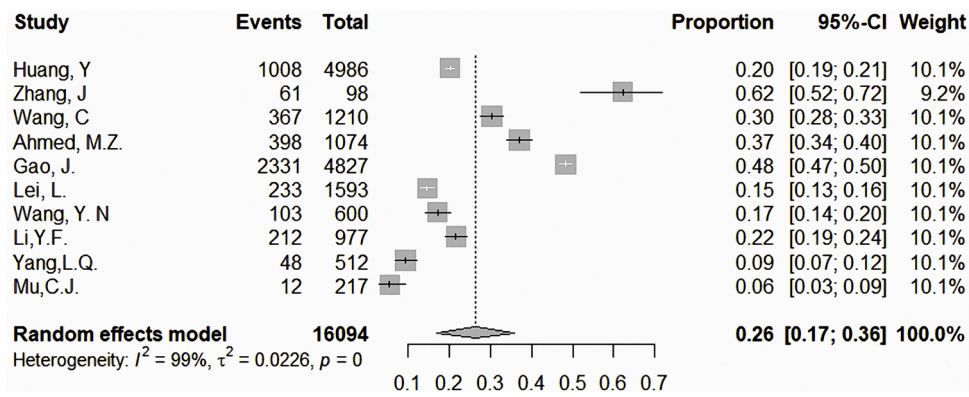


Fig. 2. The prevalence of depression among the general public in the included studies.

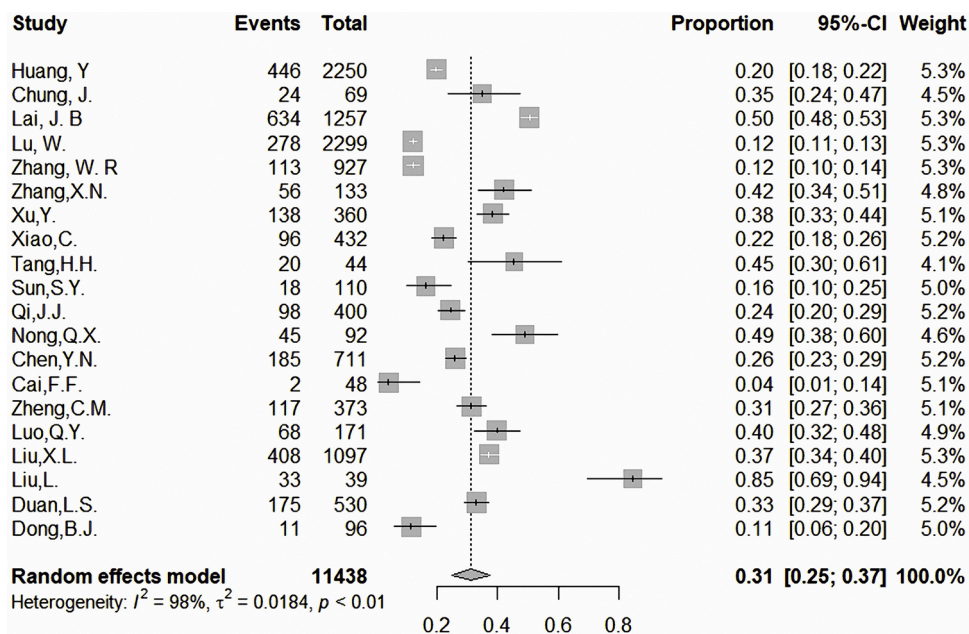


Fig. 3. The prevalence of depression among healthcare workers in the included studies.

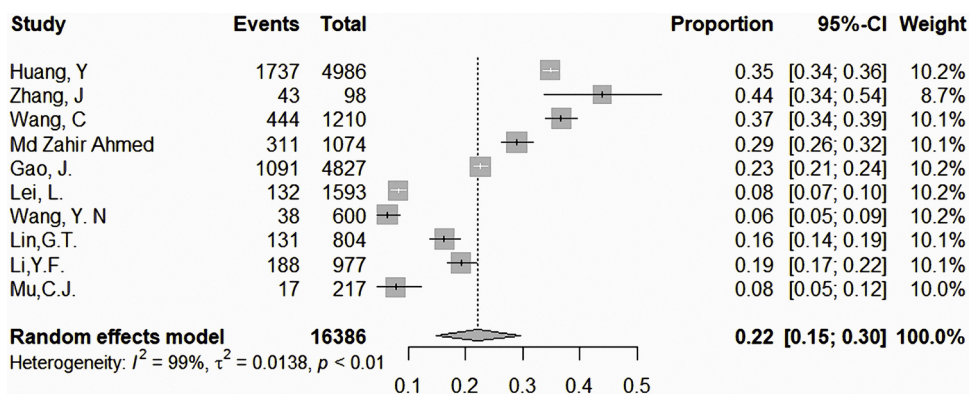


Fig. 4. The prevalence of anxiety among the general public in the included studies.

4. Discussion

In present study, we performed a meta-analysis to evaluate the prevalence of depression and anxiety during COVID-19 in China, and found that the prevalence of depression and anxiety among healthcare

workers was higher than the prevalence among general public. More importantly, we observed a different prevalence changing trends among healthcare workers and general public before and after the peak of COVID-19 in China. As present study result shown, after the peak, the prevalence among healthcare workers declined compared before, while

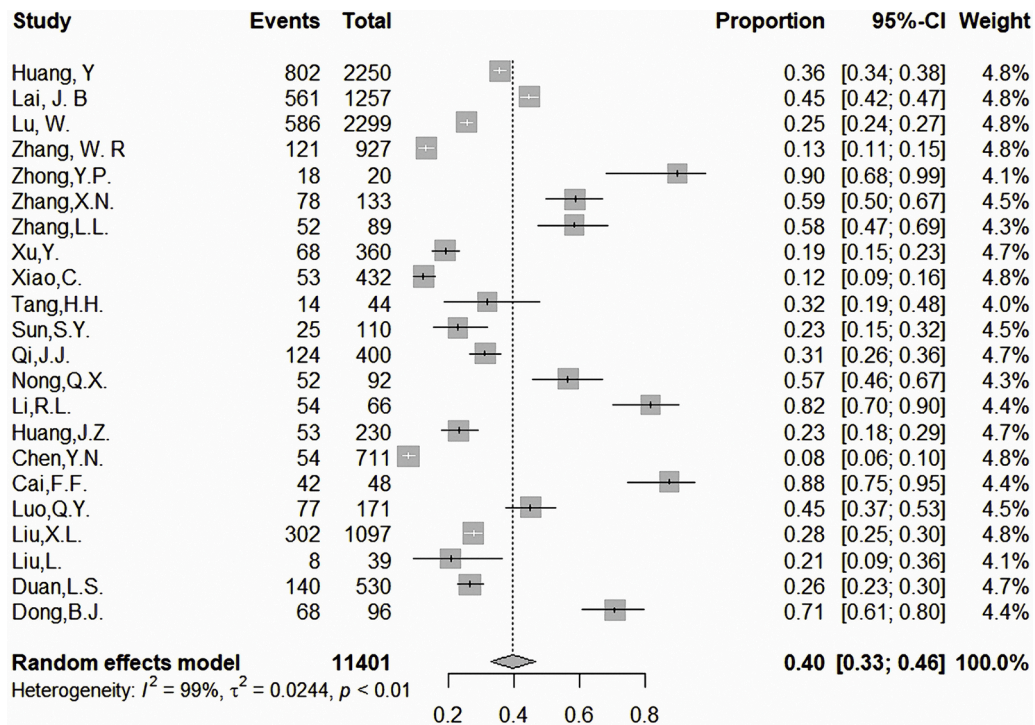


Fig. 5. The prevalence of anxiety among healthcare workers in the included studies.

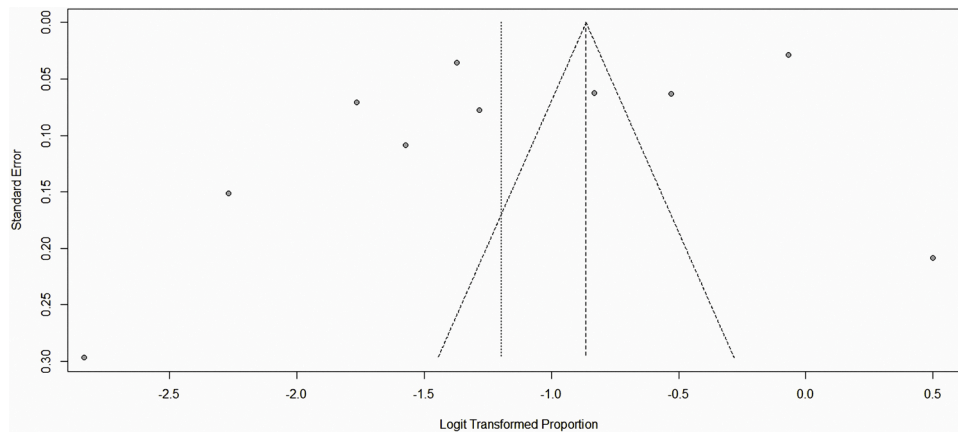


Fig. 6. Funnel plot of results of prevalence of depression among the general public.

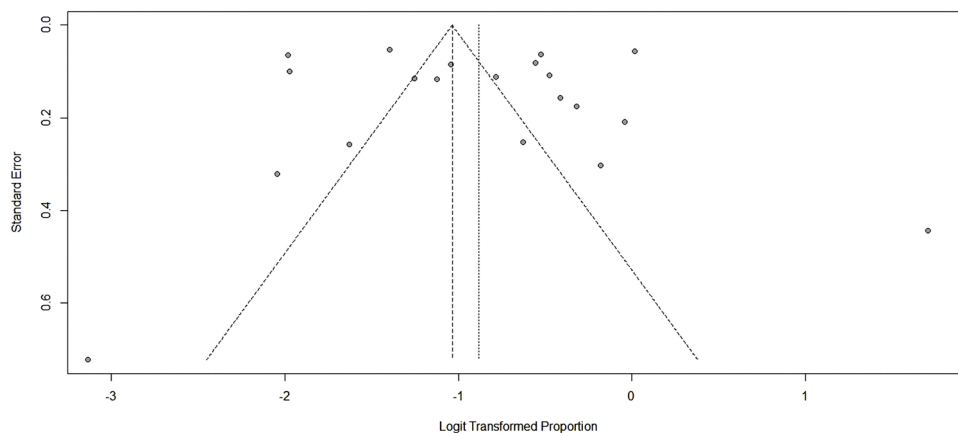


Fig. 7. Funnel plot of results of prevalence of depression among the healthcare workers.

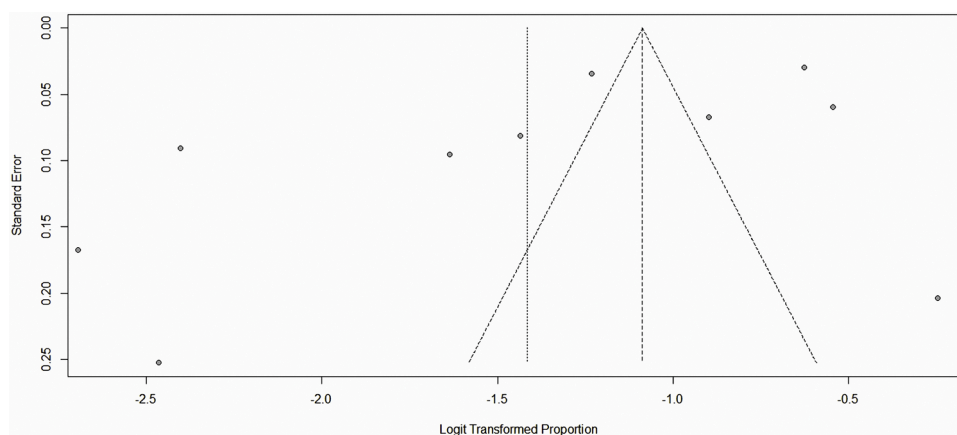


Fig. 8. Funnel plot of results of prevalence of anxiety among the general public.

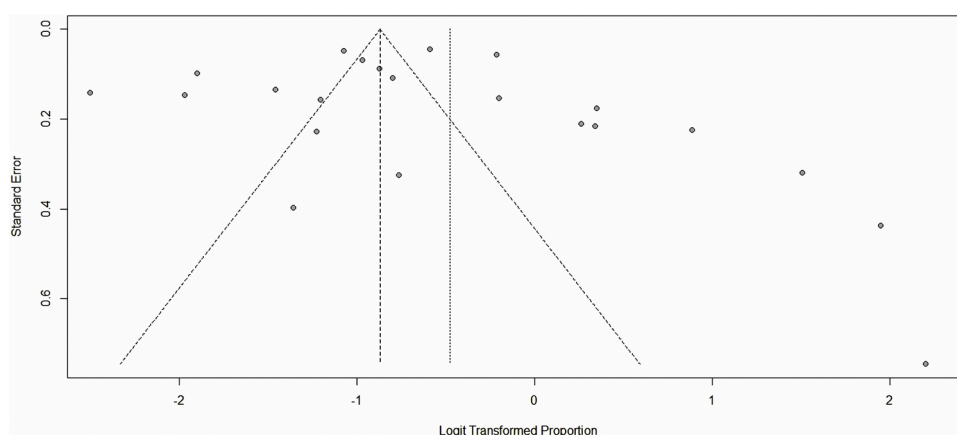


Fig. 9. Funnel plot of results of prevalence of anxiety among the healthcare workers.

Table 2

Prevalence before and after the peak among general public and healthcare workers.

Group	Mental disorder	Time of the investigation	number of inclusions	Sample size	I ² (%)	Prevalence(95 %CI)
General public	Depression	Before 8 th February,2020	3 ^a	7014	99.5	33 % (95 %CI :16 %-51 %)
		After 8th February,2020	1 ^b	98	–	62 % (95 %CI:53 %-72 %)
	Anxiety	Before 8th February,2020	4 ^c	7818	97.8	24 % (95 %CI:17 %-31 %)
		After 8th February,2020	1 ^d	98	–	44 % (95 %CI:34 %-54 %)
Healthcare workers	Depression	Before 8th February,2020	3 ^e	1781	98.5	40 % (95 %CI:19 %-62 %)
		After 8th February,2020	4 ^f	1429	98.0	22 % (95 %CI:13 %-31 %)
	Anxiety	Before 8th February,2020	3 ^g	1781	99.2	38 % (95 %CI:12 %-63 %)
		After 8th February,2020	3 ^h	3756	97.6	22 % (95 %CI:13 %-31 %)

Note: a= (Gao et al., 2020; Li et al., 2020c; Wang et al., 2020a); b= (Zhang et al., 2020a); c= (Gao et al., 2020; Li et al., 2020c; Lin et al., 2020; Wang et al., 2020a); d= (Zhang et al., 2020a); e= (Lai et al., 2020; Nong et al., 2020; Xiao et al., 2020); f= (Duan et al., 2020; Lu et al., 2020; Zhang et al., 2020c); g= (Duan et al., 2020; Lu et al., 2020; Zhang et al., 2020c); h= (Lai et al., 2020; Nong et al., 2020; Xiao et al., 2020).

an upward trend of the prevalence among the general public was detected.

Previous studies reported a high prevalence of depression and anxiety among the general public during the severe acute respiratory syndrome (SARS) epidemic outbreak in Beijing and Hong Kong (Liu et al., 2012; Leung et al., 2003). A same phenomenon was detected during COVID-19 outbreak. With the new limitations in daily life and social activities for an unknown period of time, the mental health of the general public was also paid emerging concern by recent studies, whose results suggest the quite significant percentage of general public were suffering from depression and anxiety during COVID-19 pandemic in China (Wang et al., 2020c). Our study confirmed that 26 % general public were suffering from depression and 22 % were having anxiety.

Higher prevalence among healthcare workers was identified. The prevalences of depression and anxiety among healthcare workers were 31 % and 40 % respectively. Similar to our result, the higher prevalence of psychological symptom among healthcare workers than the general public was reported during the Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak (Alsubaie et al., 2019; Jeong et al., 2016). During an epidemic, healthcare workers were exposed to traumatic situation in their everyday work (Walton et al., 2020). In the fight against COVID-19, an unpredicted and rapidly- spread epidemic, challenges for healthcare workers not only included a high risk of infection, patients with negative emotions and exhaustion, but also the moral injury of making difficult ethical decisions on the rationing of care and lack of social supports under quarantine, which may imply higher risk of

mental health problem for healthcare workers (Kang et al., 2020; Walton et al., 2020). Besides, faced with occupational burnout caused by overwork to meet the need of overloaded medical facilities and inadequate protection due to the lack of personal protective equipment, healthcare workers were struggling in mental stress, worries of their health and concerns on spreading the virus to families and friends (Hu et al., 2020).

On February 8th 2020, the peak of the COVID-19 epidemic occurred in mainland China. After that the number of new and suspected cases was continuously declining and the recovery cases were increasing, which marked the improvement of the epidemic. We observed a different prevalence changing trend among healthcare workers and the general public before and after the peak of COVID-19 occurred in China for the first time. The result showed that before the peak, healthcare workers (depression: 40 %, anxiety: 38 %) had higher percentage of having depression and anxiety than the general public (depression: 33 %, anxiety: 24 %), as same as former result. However, a decreased prevalence among healthcare workers (depression: 22 %, anxiety: 22 %) was detected compared before, while the prevalence among the general public raised (depression: 62 %, anxiety: 44 %) after the peak occurred. This may suggest that healthcare workers have met an upturn in mental health status after the peak of the epidemic while the psychological status of general public deteriorated after the peak. In spite of stressful situation, mental health can be related to cognition, a critical factor for the onset and maintenance of depression and anxiety (Hallion and Ruscio, 2011). Infectious disease causes more psychosocial problems for people lack knowledge about newly emerging diseases (Ko et al., 2006). Recent survey reported the perceived level of knowledge relatively to COVID-19 and to its related socio-political situation was significantly different between healthcare workers and the general public, and healthcare workers had a higher odd of being properly informed about both COVID-19 and its related social situation, due cognitive bias and baseless rumors on the Internet (Simione and Gnagnarella, 2020). During COVID-19 epidemic, with overwhelmed misinformation and false reports about the COVID-19 bombarded social media, stoked unfounded fears among general public in China, which led to onset of anxiety and combination of depression and anxiety (Gao et al., 2020). Above evidences may suggest that the prevalence changing trend among healthcare workers and the general public before and after the peak of COVID-19 occurred in China may be related to different level of cognition. As close experiencers, healthcare workers are equipped with professional medical knowledge may have higher level of cognition on COVID-19 than the general public who lack knowledge about newly infectious disease surrounding with relative misinformation and rumors. As the epidemic progressed, the gap of cognition on COVID-19 between two groups was widening, which may explain the declined prevalence of depression and anxiety among healthcare workers and rise the prevalence among the general public after peak occurred.

Several limitations of this study must be considered. Firstly, all included studies were cross-section studies, and few other types of observational studies were searched. Secondly, our study focused in China whose generalizability might be limited due to different culture between China and western country. Lastly, a high inherent between-study heterogeneity existed when pooling prevalences of each group, probably for the inconsistent scales and cutoff to evaluate prevalence. Further study can be done to evaluate psychological and psychiatric prevalence at other phases of the COVID-19 epidemic in China, other countries or globally. Also, the relationship between cognition about the epidemic and the mental health status can be further studies.

5. Conclusion

The COVID-19 epidemic has a potential psychiatric impact on the general public and healthcare workers in China, which is more severe among healthcare workers illustrated by the higher overall prevalence of depression and anxiety. Moreover, the mental state among the general

public deteriorated after the peak of the epidemic, while healthcare workers, who spent more time with novel coronavirus infectors standing in the frontline of this crisis, tended to recover after the peak.

Authors contributions

BZ was responsible for this study. BZ, DY and YC conceived and designed the study. DY and YC participated in the literature searches, titles and abstracts evaluation, data extraction and analysis. DY and BZ participated the interpretation of the results. DY participated in drafting the protocol and preparing the manuscript. All authors read and approved the final manuscript.

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Declaration of Competing Interest

The authors report no declarations of interest.

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References

- Ahmed, M.Z., Ahmed, O., Aibao, Z., Hanbin, S., Siyu, L., Ahmad, A., 2020. Epidemic of COVID-19 in China and associated psychological problems. *Asian J. Psychiatr.* 51, 102092.
- Alsubaie, S., Hani Tamsah, M., Al-Eyadhy, A.A., Gossady, I., Hasan, G.M., Al-Rabiaah, A., Jamal, A.A., Alhaboob, A.A., Alshime, F., Somily, A.M., 2019. Middle East respiratory syndrome coronavirus epidemic impact on healthcare workers' risk perceptions, work and personal lives. *J. Infect. Dev. Ctries* 13, 920–926.
- Cai, F.F., Yuan, Q., 2020. Survey on psychological status of frontline healthcare workers in the fight against novel coronavirus pneumonia and related intervention strategy. *Chin. Gen. Pract. Nurs.* 18, 827–828.
- Chen, Y.N., Sun, J.H., Hu, J.B., Chen, P.L., Chen, S.H., 2020. Analysis of mental health status of residents during COVID-19 epidemic. *Clin. Educ. Gen. Pract.* 18, 237–239. +244.
- Chew, N.W.S., Lee, G.K.H., Tan, B.Y.Q., Jing, M., Goh, Y., Ngiam, N.J.H., Yeo, L.L.L., Ahmad, A., Ahmed Khan, F., Napoleon Shanmugam, G., Sharma, A.K., Komalkumar, R.N., Meenakshi, P.V., Shah, K., Patel, B., Chan, B.P.L., Sunny, S., Chandra, B., Ong, J.J.Y., Paliwal, P.R., Wong, L.Y.H., Sagayanathan, R., Chen, J.T., Ying Ng, A.Y., Teoh, H.L., Tsvigoulis, G., Ho, C.S., Ho, R.C., Sharma, V.K., 2020. A multinational, multicentre study on the psychological outcomes and associated physical symptoms amongst healthcare workers during COVID-19 outbreak. *Brain Behav. Immun.* 88, 559–565.
- Chung, J.P.Y., Yeung, W.S., 2020. Staff mental health self-assessment during the COVID-19 outbreak. *East Asian Arch. Psychiatry* 30, 34.
- Dong, B.J., Yuan, Y., Wang, L.X., Sun, L.P., 2020. Discussion on the first-line nurses' psychological state and prevention strategies of fighting against COVID-19. *J. Xinjiang Med. Univ.* 43, 273–275.
- Duan, L.S., Guo, Y.M., Jiang, Y.T., Jiang, R.H., Su, B., 2020. Mental health status of officers and soldiers in a military hospital amid the epidemic of COVID-19. *Med. J. Chin. People's Armed Police Force* 31, 191–194.
- Gao, J., Zheng, P., Jia, Y., Chen, H., Mao, Y., Chen, S., Wang, Y., Fu, H., Dai, J., 2020. Mental health problems and social media exposure during COVID-19 outbreak. *PLoS One* 15 e0231924.
- Hallion, L.S., Ruscio, A.M., 2011. A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychol. Bull.* 137, 940–958.
- Higgins, J.P.T., Green, S., 2011. *Cochrane Handbook for Systematic Reviews of Interventions*, Version 5.1.0. The Cochrane Collaboration. Wiley-Blackwell, Oxford.
- Hu, J., Dong, Y., Chen, X., Liu, Y., Ma, D., Liu, X., Zheng, R., Mao, X., Chen, T., He, W., 2015. Prevalence of suicide attempts among Chinese adolescents: a meta-analysis of cross-sectional studies. *Compr. Psychiatry* 61, 78–89.
- Hu, Y.R., Wang, M.Q., Zhang, B., 2020. In search of wise management of medical resources and personnel in the long combat with coronavirus. *Front. Sociol.* 5, 40.
- Huang, J.Z., Han, M.F., Luo, T.D., Ren, A.K., Zhou, X.P., 2020. Mental health survey of medical staff in a tertiary infectious disease hospital for COVID-19. *Chin. J. Ind. Hygiene Occup. Dis.* 38, 192–195.
- Huang, Y., Zhao, N., 2020. Chinese mental health burden during the COVID-19 pandemic. *Asian J. Psychiatr.* 51, 102052.
- Jeong, H., Yim, H.W., Song, Y.J., Ki, M., Min, J.A., Cho, J., Chae, J.H., 2016. Mental health status of people isolated due to Middle East respiratory syndrome. *Epidemiol. Health* 38 e2016048.
- Kang, L., Li, Y., Hu, S., Chen, M., Yang, C., Yang, B.X., Wang, Y., Hu, J., Lai, J., Ma, X., Chen, J., Guan, L., Wang, G., Ma, H., Liu, Z., 2020. The mental health of medical

- workers in Wuhan, China dealing with the 2019 novel coronavirus. *Lancet Psychiatry* 7, e14.
- Ko, C.H., Yen, C.F., Yen, J.Y., Yang, M.J., 2006. Psychosocial impact among the public of the severe acute respiratory syndrome epidemic in Taiwan. *Psychiatry Clin. Neurosci.* 60, 397–403.
- Lai, J., Ma, S., Wang, Y., Cai, Z., Hu, J., Wei, N., Wu, J., Du, H., Chen, T., Li, R., Tan, H., Kang, L., Yao, L., Huang, M., Wang, H., Wang, G., Liu, Z., Hu, S., 2020. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw. Open* 3 e203976.
- Lei, L., Huang, X., Zhang, S., Yang, J., Yang, L., Xu, M., 2020. Comparison of prevalence and associated factors of anxiety and depression among people affected by versus people unaffected by quarantine during the COVID-19 epidemic in Southwestern China. *Med. Sci. Monit.* 26, e924609.
- Leung, G.M., Lam, T.H., Ho, L.M., Ho, S.Y., Chan, B.H., Wong, I.O., Hedley, A.J., 2003. The impact of community psychological responses on outbreak control for severe acute respiratory syndrome in Hong Kong. *J. Epidemiol. Community Health* 57, 857–863.
- Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., Ren, R., Leung, K.S.M., Lau, E.H.Y., Wong, J.Y., Xing, X., Xiang, N., Wu, Y., Li, C., Chen, Q., Li, D., Liu, T., Zhao, J., Liu, M., Tu, W., Chen, C., Jin, L., Yang, R., Wang, Q., Zhou, S., Wang, R., Liu, H., Luo, Y., Liu, Y., Shao, G., Li, H., Tao, Z., Yang, Y., Deng, Z., Liu, B., Ma, Z., Zhang, Y., Shi, G., Lam, T.T.Y., Wu, J.T., Gao, G.F., Cowling, B.J., Yang, B., Leung, G.M., Feng, Z., 2020a. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N. Engl. J. Med.* 382, 1199–1207.
- Li, R.L., Xiong, Z.F., Liu, L.L., Zong, S.Q., Li, H.X., 2020b. Prevalence of anxiety and influencing factors in frontline nurses combating the COVID-19 epidemic: an analysis based on a survey from the first batch of designated hospitals for COVID-19 treatment in Wuhan. *Pract. J. Card. Cereb. Pulmonal Vasc. Dis.* 28, 19–23.
- Li, Y.F., Wang, X.Y., Zhang, J., Du, S.F., Zeng, L.X., 2020c. Study on the psychology of general public during novel coronavirus pneumonia. *Int. J. Infect. Dis.* 9, 308–310.
- Lin, G.T., Zhao, C.J., Huang, F., Feng, H.N., Lin, L.T., Zhai, Y.F., 2020. Survey and analysis of anxiety of 804 residents in Hainan during the COVID-19 epidemic. *J. Hainan Med. Univ.* 26, 646–650.
- Liu, X., Kakade, M., Fuller, C.J., Fan, B., Fang, Y., Kong, J., Guan, Z., Wu, P., 2012. Depression after exposure to stressful events: lessons learned from the severe acute respiratory syndrome epidemic. *Compr. Psychiatry* 53, 15–23.
- Liu, L., Li, N., Yang, S., Huang, L.Y., 2020a. The psychological state of nurses in the fight against the COVID-19 in the first echelon and relative countermeasures. *Int. Med. Health Guidance News* 26, 660–662.
- Liu, X.L., Cheng, Y.S., Wang, M.Y., Pan, Y., Guo, H., Jiang, R.H., Wang, Q.M., 2020b. Psychological state of nursing staff in a large scale of general hospital during COVID-19 epidemic. *Chin. J. Nosocomiol.* 30, 1641–1646.
- Lu, W., Wang, H., Lin, Y., Li, L., 2020. Psychological status of medical workforce during the COVID-19 pandemic: a cross-sectional study. *Psychiatry Res.* 288, 112936.
- Luo, M.L., Tan, H.Z., Zhou, Q., Wang, S.Y., Cai C. Guo, Y.W., Shen, L., 2013. Realizing the meta-analysis of single rate in r software. *J. Evid. Based Med.* 13, 181–184+188.
- Luo, Q.Y., Yan, C., Zhang, D.G., Deng, S.M., Zhou, L., Mai, W.Y., Ning, Y.P., He, H.B., Zhang, S.C., Li, Y.X., Nong, F., Liao, Y., Li, A.J., Wu, Y.R., Ge, J., Zhong, Y.P., Hu, Y. L., Li, F., Peng, H.J., 2020. Investigation of mental health status of frontline medical staff in COVID-19 treatment hospital in Guangdong Province. *Guangdong Med. J.* 41, 984–990.
- Maunder, R.G., 2009. Was SARS a mental health catastrophe? *Gen. Hosp. Psychiatry* 31, 316–317.
- Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L.A., 2015. PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst. Rev.* 4, 1.
- Mu, C.J., 2020. Survey on cognition about novel coronavirus pneumonia and psychological status of old aged residents. *Chin. Gen. Pract. Nurs.* 18, 952–955.
- Munster, V.J., Koopmans, M., van Doremalen, N., van Riel, D., de Wit, E., 2020. A novel coronavirus emerging in China - key questions for impact assessment. *N. Engl. J. Med.* 382, 692–694.
- Nong, Q.X., Mo, L.L., Zhou, F.Z., Song, L., Chen, J., Liao, H.C., Ling, Z., 2020. Investigation and analysis on mental health state and sleep quality of nurses in psychiatric hospital during novel coronavirus epidemic. *Intern. Med.* 15, 84–86.
- Qi, J.J., Liu, L.M., Li, W.T., Xu, Y.H., Shan, X., 2020. Investigation and analysis on psychological condition of clinical nurses faced novel coronavirus pneumonia. *Chin. Gen. Pract. Nurs.* 18, 703–704.
- Simione, L., Gnagnarella, C., 2020. Differences between health workers and general population in risk perception, behaviors, and psychological distress related to COVID-19 spread in Italy. *Front. Psychol.* 11, 2166.
- Sun, S.Y., Huang, Y., Wang, Z., 2020. Investigation and analysis of nurses' psychological problems in fever clinic during the outbreak of COVID-19. *Med. J. Natl. Defend. Forces Northwest China.* 41, 133–138.
- Tang, H.H., Lu, X.Y., Cai, S.X., Gong, J., Wang, L., Li, X., 2020. Investigation and analysis on mental health status of frontline nurses in Wuhan during COVID-19 epidemic. *Int. J. Infect. Dis.* 9, 296–297.
- Walton, M., Murray, E., Christian, M.D., 2020. Mental health care for medical staff and affiliated healthcare workers during the COVID-19 pandemic. *Eur. Heart J. Acute Cardiovasc. Care* 9, 241–247.
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C.S., Ho, R.C., 2020a. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int. J. Environ. Res. Public Health* 17, 1729.
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R.S., Choo, F.N., Tran, B., Ho, R., Sharma, V.K., Ho, C., 2020b. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav. Immun.* 87, 40–48.
- Wang, Y., Di, Y., Ye, J., Wei, W., 2020c. Study on the public psychological states and its related factors during the outbreak of coronavirus disease 2019 (COVID-19) in some regions of China. *Psychol. Health Med.* 30, 1–10.
- World Health Organization (WHO), 2020a. Timeline of WHO's Response to COVID-19 [WWW Document]. (Assessed 10.3.20). URL. <https://www.who.int/news-room/detail/29-06-2020-covidtimeline>.
- World Health Organization (WHO), 2020b. Coronavirus Disease (COVID-19) Weekly Epidemiological Update and Weekly Operational [WWW Document]. (Assessed 10.3.20). URL. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/>.
- Xiao, C., Wang, L., Liu, J.R., Shen, X.M., Li, B.R., Zhang, S.Y., Huang, G.P., 2020. Anxiety and depression status among non-first-line medical staff during the outbreak of COVID-19. *Sichuan Ment. Health.* 33, 15–18.
- Xu, Y., Zhao, M., Tang, X.L., Zhu, X.Y., Chen, J., 2020. Correlation study between mental health and coping style of medical staff during COVID-19 epidemic. *Anhui Med. J.* 41, 368–371.
- Yang, L.Q., Zhang, Y.F., Xu, Y., Zheng, J.S., Lin, Z.Q., 2020. Survey on psychological stress in fighting against corona virus disease 2019 among community residents. *Chin. Nurs. Res.* 34, 1140–1145.
- Zhang, J., Lu, H., Zeng, H., Zhang, S., Du, Q., Jiang, T., Du, B., 2020a. The differential psychological distress of populations affected by the COVID-19 pandemic. *Brain Behav. Immun.* 87, 49–50.
- Zhang, L.L., Li, X., Wang, J.J., Jing, Y.P., Chang, Y.P., Zhou, J.M., 2020b. The research on the anxiety status of the first nurses to participate in the care of patients with corona virus disease 2019 in Henan Province. *China J. Health Psychol.* 28, 1483–1487.
- Zhang, W.R., Wang, K., Yin, L., Zhao, W.F., Xue, Q., Peng, M., Min, B.Q., Tian, Q., Leng, H.X., Du, J.L., Chang, H., Yang, Y., Li, W., Shanguan, F.F., Yan, T.Y., Dong, H. Q., Han, Y., Wang, Y.P., Cosci, F., Wang, H.X., 2020c. Mental health and psychosocial problems of medical health workers during the COVID-19 epidemic in China. *Psychother. Psychosom.* 89, 242–250.
- Zhang, X.N., Liu, P.Z., Yu, S.Z., Li, H.J., Li, Y.L., Tang, X., Ouyang, Shuyi, 2020d. Survey of psychological status of frontline nursing staff during the period of COVID-19 epidemic and intervention measures. *Nurs. Pract. Res.* 18, 955–957.
- Zheng, C.M., Shen, F., Tian, G.Q., Zhang, L., 2020. Survey on stress levels and depression of healthcare workers during novel coronavirus pneumonia. *Zhejiang Med. J.* 42, 406-407+410+414.
- Zhong, Y.P., Huang, J.Y., Xie, Z.W., Yan, C., Li, Y.P., 2020. Study on mental health and intervention effect of first group of frontline medical staff in fight against novel coronavirus. *Chin. Gen. Pract. Nurs.* 18, 955–957.