Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Review article

The psychological and mental impact of coronavirus disease 2019 (COVID-19) on medical staff and general public – A systematic review and meta-analysis

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ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic has caused enormous psychological impact worldwide. We conducted a systematic review and meta-analysis on the psychological and mental impact of COVID-19 among healthcare workers, the general population, and patients with higher COVID-19 risk published between 1 Nov 2019 to 25 May 2020. We conducted literature research using Embase, PubMed, Google scholar and WHO COVID-19 databases. Among the initial search of 9207 studies, 62 studies with 162,639 participants from 17 countries were included in the review. The pooled prevalence of anxiety and depression was 33% (95% confidence interval: 28%-38%) and 28% (23%-32%), respectively. The prevalence of anxiety and depression was the highest among patients with pre-existing conditions and COVID-19 infection (56% [39%-73%] and 55% [48%-62%]), and it was similar between healthcare workers and the general public. Studies from China, Italy, Turkey, Spain and Iran reported higher-than-pooled prevalence among healthcare workers and the general public. Common risk factors included being women, being nurses, having lower socioeconomic status, having high risks of contracting COVID-19, and social isolation. Protective factors included having sufficient medical resources, up-to-date and accurate information, and taking precautionary measures. In conclusion, psychological interventions targeting high-risk populations with heavy psychological distress are in urgent need.

1. Introduction

The coronavirus disease 2019 (COVID-19) outbreak is posing a serious public health threat worldwide. According to the World Health Organization (WHO), as of 1 June 2020, 6,040,609 confirmed cases and 370,657 deaths have been reported globally (World Health Organization, 2020). A recent large-scale study has shown that multifaceted public health interventions are temporarily associated with improved control of COVID-19 pandemic (Pan et al., 2020). However, in addition to the physical health, the potential psychological and mental health impacted by the COVID-19 pandemic should also be taken seriously. Although previous research has suggested that the mental impact of a major disaster had a wider and longer effect on people compared to physical injuries, mental health attracts far fewer personnel for planning and resources (Allsopp et al., 2019).

Studies conducted on the psychological impact of previous infectious outbreaks, such as the severe acute respiratory syndrome (SARS) that is similar to the COVID-19 pandemic, have found heavy psychological burdens among healthcare workers and the general public such as anxiety, depression, panic attacks, or psychotic symptoms (Maunder et al., 2003; Xiang et al., 2020). Healthcare workers who were quarantined, worked in SARS units, or had family or friends infected with SARS, had considerably more anxiety, depression, frustration, fear, and post-traumatic stress than those who had no such experience (Xiang et al., 2020; Wu et al., 2009). Similarly, many published studies have assessed the psychological impact of COVID-19 and have also found high levels of psychological distress (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Chew et al., 2020; Consolo et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020;

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Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Zhang and Ma, 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Qian et al., 2020; Hao et al., 2020; Guo et al., 2020; Tang et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Durankuş and Aksu, 2020; Saccone et al., 2020; Salari et al., 2020; Nguyen et al., 2020; Zhou et al., 2020). A recent systematic review and meta-analysis has summarized the prevalence of depression and anxiety among healthcare workers during the COVID-19 (Pappa et al., 2020). The review was conducted at the early phase of the COVID-19 (before April 17th, 2020) and mainly included early studies published in Asia (China, Singapore). After the publication of the review (Pappa et al., 2020), many more studies from other countries (e.g. Italy, Spain, Iran, Israel) have been published (Consolo et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Nachimuthu et al., 2020; Durankuş and Aksu, 2020; Saccone et al., 2020; Salari et al., 2020; Nguyen et al., 2020; Amin, 2020; Shacham et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis et al., 2020; Suzuki, 2020), and some of these studies extended the study population from healthcare workers to the general public (Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis et al., 2020) and patients with pre-existing conditions (e.g. cancer, psychiatry, epilepsy, type 2 diabetes) (Qian et al., 2020; Hao et al., 2020; Nachimuthu et al., 2020; Salari et al., 2020; Hao et al., 2020) or infected by COVID-19 (Guo et al., 2020, Zhang et al., 2020; Bo et al., 2020). A few studies have suggested that the psychological impact of COVID-19 may be different among healthcare workers, the general public and patients (Zhang et al., 2020; Huang and Zhao, 2020; Huang and Zhao, 2020; Ni et al., 2020; Hao et al., 2020; Salari et al., 2020; Hao et al., 2020). Since the case number of COVID-19 is still rapidly increasing in many countries, psychological disturbances may have impacted and will continue to impact millions of people around the world. Understanding the psychological impact from different populations and countries would provide theoretical basis for the identification of high-risk people and designing interventions, as well as planning resources and promulgating national and governmental policies, which is of critical importance and public health implication at a global level.

Therefore, we conducted the current systematic review and meta-analysis to assess the updated psychological and mental impact of the COVID-19 pandemic among healthcare workers, the general public and patients with pre-existing conditions or COVID-19. We searched on Embase, PubMed, Google Scholar, and the daily updated WHO COVID-19 database (World Health Organization, 2020). Our primary aim was to evaluate the psychological and mental impacts of COVID-19. Our secondary aims was to explore factors associated with higher psychological distress.

2. Methods

2.1. Search process

To perform a systematic review and meta-analysis on studies evaluating the psychological and mental impact of COVID-19, we followed the Preferred reporting items for systematic reviews and meta-analyses guideline (Liberati et al., 2009). We conducted a comprehensive literature search on original articles published from 1 Nov 2019 to 25 May 2020 in electronic databases of Embase, PubMed, Google Scholar and the daily updated WHO COVID-19 database (World Health Organization, 2020). Our search terms were ('COVID-19'/exp OR COVID-19 OR 'coronavirus'/exp OR coronavirus) AND ('psychological'/

exp OR psychological OR 'mental'/exp OR mental OR 'stress'/exp OR stress OR 'anxiety' OR anxiety OR 'depression' OR depression OR 'post-traumatic' OR 'post-traumatic'/exp OR 'trauma' OR 'trauma'/exp) for Embase, ("COVID-19"[All Fields] OR "coronavirus"[All Fields]) AND ("Stress, Psychological"[Mesh] OR "mental" OR "anxiety" OR "depression" OR "stress" OR "post-traumatic" OR "trauma") for PubMed, (tw:(psychological)) OR (tw:(mental)) OR (tw:(stress)) OR (tw:(anxiety)) OR (tw:(depression)) OR (tw:(post-traumatic)) OR (tw:(trauma)) for the WHO COVID-19 database, and ("COVID-19" OR "coronavirus") AND ("Psychological" OR "mental" OR "anxiety" OR "depression" OR "stress" OR "post-traumatic" OR "trauma") for Google Scholar.

2.2. Eligibility criteria

We included original research of quantitative studies examining the psychological distress of COVID-19 among medical staff, the general public, and patients with pre-existing conditions or infected by COVID-19. We excluded studies if they: 1) were irrelevant to the exposure (COVID-19) or the outcome (psychological impact, mental impact); 2) were animal studies, experimental studies or genetic studies; 3) did not use a validated instrument to measure the psychological impact; 4) were not in English language.

The search was performed by two independent researchers (M.L. and L.G.). A total of three rounds of screening were performed. During the first round, the titles of the articles were screened, and the potential articles were further examined for abstracts in the second round. The potential articles identified after the second round were further reviewed for full paper to examine the eligibility. If two researchers had discrepancies on whether to include a certain study, the senior author (H.W.) was consulted to make the final decision.

2.3. Data extraction and appraisal of study quality

We extracted information from each study including author, population (medical staff, general population or patients, and country), socio-demographic characteristics (sample size, response rate, gender proportion, age, and study time), areas assessed, instrument used and prevalence. The study quality was assessed by the McMaster University critical appraisal tool (Law et al., 1998), which has been used in previous reviews of studies on infectious disease outbreaks (Ebola, H1N1, and SARS) (James et al., 2019; Chew et al., 2020). The appraisal tool assessed the research design, recruitment strategy, response rate, reliability of outcome determination, statistical analyses, and clinical implications of included articles with a total score of 12.

2.4. Statistical analysis

The overall prevalence and 95% confidence interval of the psychological distress was pooled with random effects models using the *Metaprop* module in STATA (Bacigalupo et al., 2018; Nyaga et al., 2014). The heterogeneity between studies was assessed by the Cochran χ^2 and I^2 statistics (Higgins et al., 2003). The 95% confidence of the psychological distress was calculated using the formula assuming a Poisson distribution of the phenomenon: $\pi \pm 1,96 \times$ square ($\pi \times$ [1-π]/n), where π was the prevalence and n was the number of participants (Bacigalupo et al., 2018; Schoenberg, 1983).

3. Results

3.1. Search results

The original search identified 9207 references from three databases (Embase: $n = 1287$; PubMed: $n = 1823$; WHO COVID-19: $n = 1217$; Google Scholar: $n = 4880$). Among these articles, 3514 were deleted due to duplications, and 5613 were deleted due to the irrelevance of the exposure or outcome to the current review. A total of 80 articles were

reviewed for full text, and 62 eligible studies were included in the current review (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Chew et al., 2020; Consolo et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Zhang and Ma, 2020; Li et al., 2020; Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Qian et al., 2020; Hao et al., 2020; Guo et al., 2020; Tang et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Durankuş and Aksu, 2020; Saccone et al., 2020; Salari et al., 2020; Nguyen et al., 2020; Zhou et al., 2020; Amin, 2020; Shacham et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis et al., 2020; Suzuki, 2020; Hao et al., 2020, Bo et al., 2020; Kang et al., 2020; Wang et al., 2020; Li et al., 2020; Zhang and Ma, 2020; Qiu et al., 2020; Cao et al., 2020; Sun et al., 2020; Roy et al., 2020; Cai et al., 2020; Li et al., 2020; Liang et al., 2020; Liu et al., 2020). Two reviewers disagreed on 5 papers that only reported the mean score of the instrument but omitted the prevalence of the psychological distress, and the senior author decided to exclude these papers. The detailed search process is shown in **Supplemental Figure S1**.

These 62 studies included 162,639 participants from 17 countries around the world (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Chew et al., 2020; Consolo et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Zhang and Ma, 2020; Li et al., 2020; Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020; Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Qian et al., 2020; Hao et al., 2020; Guo et al., 2020; Tang et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Durankuş and Aksu, 2020; Saccone et al., 2020; Salari et al., 2020; Nguyen et al., 2020; Zhou et al., 2020; Amin, 2020; Shacham et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis et al., 2020; Suzuki, 2020; Hao et al., 2020, Bo et al., 2020; Kang et al., 2020; Wang et al., 2020; Li et al., 2020; Zhang and Ma, 2020; Qiu et al., 2020; Cao et al., 2020; Sun et al., 2020; Roy et al., 2020; Cai et al., 2020; Li et al., 2020; Liang et al., 2020; Liu et al., 2020). Among them, 46 were from Asia (40 from China, 2 from Singapore, 2 from India, 1 from Japan, 1 from Pakistan, and 1 from Vietnam), 5 were from Middle East (4 from Iran and 1 from Israel), 10 were from Europe (4 from Italy, 2 from Spain, 2 from Turkey, 1 from Denmark and 1 from Greece), and 1 was from Latin America (Argentina, Brazil, Chile and Mexico). In addition, 19 studies were conducted among healthcare workers (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Chew et al., 2020; Consolo et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Amin, 2020; Shacham et al., 2020; Kang et al., 2020; Cai et al., 2020), 36 were among the general public (Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Zhang and Ma, 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Guo et al., 2020; Tang et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Durankuş and Aksu, 2020; Saccone et al., 2020; Nguyen et al., 2020; Zhou et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis

et al., 2020; Suzuki, 2020; Qiu et al., 2020; Li et al., 2020; Liang et al., 2020; Liu et al., 2020) and 7 were among patients (1 on cancer patients, 1 on psychiatric patients, 1 on epilepsy patients, 2 on COVID-19 patients, 1 on patients with type 2 diabetes, and 1 on patients with Parkinson's disease and their caregivers) (Qian et al., 2020; Hao et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Salari et al., 2020; Hao et al., 2020, Bo et al., 2020). The detailed characteristics of all these studies were shown in **Supplemental Tables S1-S3**. Furthermore, no study used standardized clinical interviews to diagnose the presence of an actual disorder or the severity level. All studies used validated instruments and corresponding cut-off values for the evaluation.

3.2. Quality appraisal

Of the 62 studies, 11 studies scored 10 out of 12, 22 studies scored 11, and 29 studies scored 12 (**Supplemental Table S4**). All studies did well in study design, data analysis and clinical importance. A few studies failed to provide the response rate of the studies (Zhang et al., 2020; Du et al., 2020; Cao et al., 2020; Zhang et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Li et al., 2020, Ren et al., 2020; Zhu et al., 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; Sønderskov et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Saccone et al., 2020; Shacham et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis et al., 2020; Suzuki, 2020; Kang et al., 2020; Qiu et al., 2020; Cai et al., 2020) or mentioning the limitations of the studies (Chen et al., 2020; Du et al., 2020; Cao et al., 2020; Zhang et al., 2020; Li et al., 2020; Ni et al., 2020; Li et al., 2020, Ren et al., 2020; Zhu et al., 2020; González-Sanguino et al., 2020; Qian et al., 2020; Hao et al., 2020; Cao et al., 2020; Xie et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Salari et al., 2020; Voitsidis et al., 2020; Bo et al., 2020; Qiu et al., 2020).

3.3. Primary outcome: psychological and mental impacts

Anxiety. A total of 41 studies measured anxiety as an indicator for psychological impact (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Tan et al., 2020; Chew et al., 2020; Consolo et al., 2020; Zhang et al., 2020; Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Qian et al., 2020; Hao et al., 2020; Guo et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Saccone et al., 2020; Salari et al., 2020; Zhou et al., 2020), among them 13 were conducted among medical staff (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Tan et al., 2020; Chew et al., 2020; Consolo et al., 2020; Zhang et al., 2020), 24 were among the general public (Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Saccone et al., 2020; Zhou et al., 2020), and 4 were among patients (1 on cancer patients, 1 on COVID-19 patients, 1 on patients with type 2 diabetes, and 1 on patients with Parkinson's and their caregivers) (Qian et al., 2020; Hao et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Salari et al., 2020) **(Fig. 1)**. Studies used different validated scales to measure anxiety including the Beck Anxiety Inventory, the Depression, Anxiety and Stress Scale-21, the Generalized Anxiety Disorder-2/-7, the Hamilton Anxiety Rating Scale, the Hospital Anxiety and Depression Scale, the Patient Health
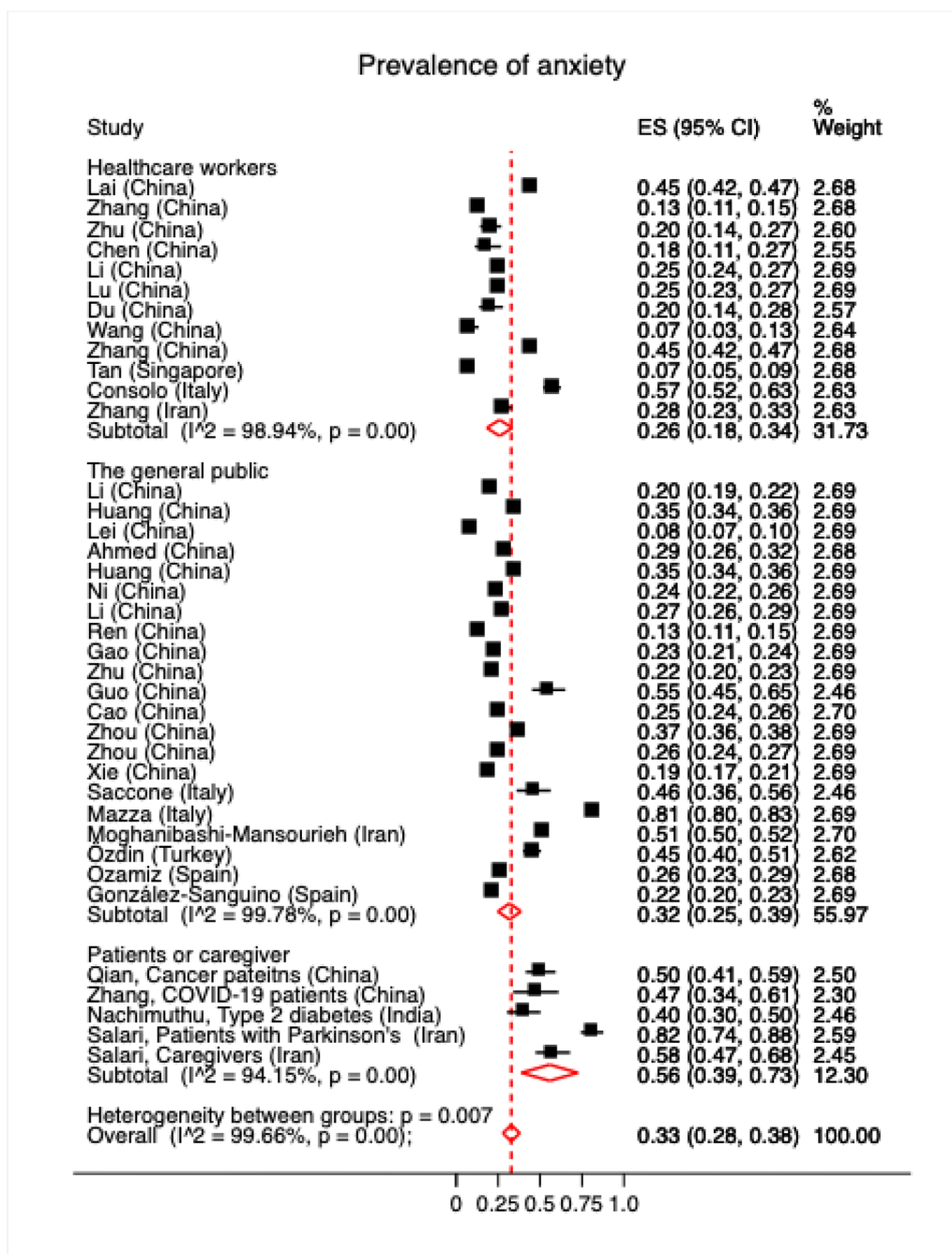
Fig. 1. Forest plot of the prevalence of anxiety.
Figure legend: The square markers indicate the prevalence of anxiety. The size of the marker correlates to the inverse variance of the effect estimate and indicates the weight of the study. The diamond data marker indicates the pooled prevalence.

Questionnaire-4/-9, and the Zung Self-Rating Anxiety Scale. A total of 37 studies reported the prevalence of having anxiety (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Zhang et al., 2020; Tan et al., 2020; Consolo et al., 2020; Zhang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Qian et al., 2020; Guo et al., 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Nachimuthu et al., 2020; Saccone et al., 2020; Salari et al., 2020; Zhou et al., 2020), and four studies reported the proportions of having

moderate-to-severe anxiety (Chew et al., 2020; Wang et al., 2020; Wang et al., 2020; Hao et al., 2020). The overall prevalence of anxiety was 33% (28%-38%) with substantial heterogeneity ($I^2 = 99.7\%$, $P < 0.001$). The prevalence of anxiety was higher among patients (56% [39%-73%]) compared to healthcare workers (26% [18%-34%]) and the general public (32% [25%-39%]), and the prevalence was similar between healthcare workers and the general public with overlapping 95% confidence intervals. Among healthcare workers, the prevalence ranged between 7% (5%-9%) in Singapore to 57% (52%-63%) in Italy, and the prevalence from three studies conducted in China and Italy was higher than the pooled anxiety prevalence. Among the general public, the highest prevalence of anxiety was observed in Italy (81% [80%-83%]), and the prevalence ranged between 8% (7%-10%) and 55% (45%-64%)

in other studies; in addition, the prevalence from six studies conducted in China, Italy, Iran, Turkey, and Spain was higher than the pooled anxiety prevalence. Among patients with pre-existing conditions and COVID-19, the prevalence of anxiety was consistently high; it ranged between 40% (30%-50%) among patients with type 2 diabetes in India and 82% (74%-88%) among patients with Parkinson's disease in Iran. The anxiety prevalence was 47% (34%-61%) among patients infected by COVID-19, and it was 50% (41%-59%) among cancer patients and 58% (47%-68%) among caregivers of patients with Parkinson's disease (Fig. 1). In addition, psychiatric patients reported a prevalence of moderate-to-severe anxiety of 24% (14%-33%) (Hao et al., 2020).

Depression. A total of 41 studies measured depression as an indicator for the psychological distress (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Chew et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Qian et al., 2020; Hao et al., 2020; Guo et al., 2020; Tang et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Durankuş and Aksu, 2020; Nguyen et al., 2020; Zhou et al., 2020), among them 14 were conducted among medical staff (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Chew et al., 2020; Zhang et al., 2020; Guiroy et al., 2020), 14 were among the general public (Wang et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Wang et al., 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Özdin and Özdin, 2020, Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Guo et al., 2020; Tang et al., 2020; Zhou et al., 2020; Xie et al., 2020; Durankuş and Aksu, 2020; Nguyen et al., 2020; Zhou et al., 2020), and 3 were among patients (1 among cancer patients, 1 among psychiatric patients, and 1 among COVID-19 patients) (Qian et al., 2020, Hao et al., 2020; Zhang et al., 2020) (Fig. 2). Different validated scales used to measure depression included the Beck Depression Inventory, the Center for Epidemiologic Studies Depression Scale, the Children's Depression Inventory—Short Version, the Depression, Anxiety and Stress Scale-21, the Edinburgh Postnatal Depression Scale, the Hamilton Depression Rating Scale, the Hospital Anxiety and Depression Scale, the Patient Health Questionnaire-4/-9, and the Zung Self-Rating Depression Scale. A total of 37 studies reported the prevalence of having depression (Lai et al., 2020; Zhang et al., 2020; Zhu et al., 2020; Chen et al., 2020; Li et al., 2020; Lu et al., 2020; Du et al., 2020; Wang et al., 2020; Zhang et al., 2020; Cao et al., 2020; Tan et al., 2020; Zhang et al., 2020; Guiroy et al., 2020; Li et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Ahmed et al., 2020; Huang and Zhao, 2020; Ni et al., 2020; Li et al., 2020, Ren et al., 2020; Gao et al., 2020; Zhu et al., 2020; Mazza et al., 2020; Özdin and Özdin, 2020; Ozamiz-Etxebarria et al., 2020; González-Sanguino et al., 2020; Sønderskov et al., 2020; Qian et al., 2020; Guo et al., 2020; Tang et al., 2020; Zhou et al., 2020; Xie et al., 2020; Zhang et al., 2020; Durankuş and Aksu, 2020; Nguyen et al., 2020; Zhou et al., 2020), and four studies reported the proportions of having moderate-to-severe depression (Chew et al., 2020; Wang et al., 2020; Wang et al., 2020; Hao et al., 2020). The overall prevalence of depression was 28% (23%-32%) with substantial heterogeneity ($I^2 = 99.6\%$, $P < 0.001$). The prevalence of depression was higher among patients (55% [48%-62%]) compared to healthcare workers (25% [17%-33%]) and the general public (27% [22%-33%]), and the prevalence was similar between healthcare workers and the general public with overlapping 95% confidence intervals. Among healthcare workers, the prevalence ranged between 9% (7%-12%) in Singapore to 51%

(48%-53%) in China, and the prevalence from three studies conducted in China was higher than the pooled depression prevalence. Among the general public, the highest prevalence of depression was observed in Italy (67% [65%-69%]), and the prevalence ranged between 10% (9%-11%) and 60% (50%-70%) in other studies; in addition, the prevalence from five studies conducted in China and Italy was higher than the pooled depression prevalence. Among patients with cancer and COVID-19, the prevalence of depression ranged between 50% (41%-59%) among cancer patients and 65% (51%-77%) among patients with COVID-19 in China (Fig. 2). In addition, psychiatric patients reported a prevalence of moderate-to-severe depression of 22% (13%-32%) (Hao et al., 2020).

Other indicators. In addition to anxiety and depression, other less commonly reported indicators included distress (Lai et al., 2020; Tan et al., 2020; Chew et al., 2020; Zhang et al., 2020; Hao et al., 2020; Saccone et al., 2020; Shacham et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Qiu et al., 2020; Li et al., 2020), stress (Li et al., 2020; Du et al., 2020; Zhang et al., 2020; Tan et al., 2020; Chew et al., 2020; Wang et al., 2020; Wang et al., 2020; Zhang and Ma, 2020; Li et al., 2020, Ren et al., 2020; Ozamiz-Etxebarria et al., 2020; Hao et al., 2020), insomnia (Lai et al., 2020; Zhang et al., 2020; Zhang et al., 2020; Huang and Zhao, 2020; Li et al., 2020, Hao et al., 2020; Zhou et al., 2020; Voitsidis et al., 2020), and post-traumatic stress symptoms/disorders (Ren et al., 2020; González-Sanguino et al., 2020; Hao et al., 2020; Tang et al., 2020; Bo et al., 2020; Liang et al., 2020; Liu et al., 2020). The overall prevalence of distress, stress, and insomnia was 35% (23%-47%), 40% (20%-60%), and 32% (25%-39%), respectively, and the prevalence was similar between healthcare workers and the general public. The prevalence of post-traumatic stress symptoms/disorders was the highest among patients with COVID-19 (93% [92%-95%]), which was higher than that reported in healthcare workers and the general public (prevalence ranged between 3% [2%-4%] to 16% [15%-17%]). In addition, fiver studies reported the overall prevalence of psychological disturbances, and it ranged between 14% (12%-16%) and 72% (67%-78%) among healthcare workers (Amin, 2020; Kang et al., 2020; Cai et al., 2020); and it ranged between 40% (36%-44%) and 54% (51%-57%) in the general public (Wang et al., 2020; Liang et al., 2020).

3.4. Secondary outcomes: factors of psychological impacts

Risk factors for higher psychological impact of COVID-19 were substantially similar across healthcare workers, the general population, and patients. Common risk factors included being women (Lai et al., 2020; Zhang et al., 2020; Du et al., 2020; Wang et al., 2020; Li et al., 2020, Mazza et al., 2020, Moghanibashi-Mansourieh; 2020, Özdin and Özdin, 2020; Zhou et al., 2020; Jahanshahi et al., 2020; Moccia et al., 2020; Voitsidis et al., 2020; Qiu et al., 2020; Liu et al., 2020), having higher COVID-19 contraction risk (poorer health, contact with COVID-19 patients) (Zhang et al., 2020; Lu et al., 2020; Wang et al., 2020; Chew et al., 2020; Lei et al., 2020; Ni et al., 2020; Wang et al., 2020; Mazza et al., 2020; Moghanibashi-Mansourieh, 2020; Özdin and Özdin, 2020; Shacham et al., 2020), having lower socio-economic status (living in rural areas, having unstable income, having lower education) (Zhang et al., 2020; Du et al., 2020; Lei et al., 2020; Özdin and Özdin, 2020; Cao et al., 2020; Zhou et al., 2020; Xie et al., 2020; Liang et al., 2020), social isolation (Lei et al., 2020; Zhu et al., 2020; Guo et al., 2020; Durankuş and Aksu, 2020), and spending longer time watching COVID-19 related news (Li et al., 2020; Moghanibashi-Mansourieh, 2020; Hao et al., 2020); although some studies did not observed significant associations (Huang and Zhao, 2020; Ni et al., 2020; Gao et al., 2020; Özdin and Özdin, 2020; Nguyen et al., 2020; Shacham et al., 2020; Hao et al., 2020). Among healthcare workers, being nurses (Lai et al., 2020; Zhang et al., 2020; Cao et al., 2020), working in front-line with direct contact with COVID-19 patients (Lai et al., 2020; Wang et al., 2020; Zhang et al., 2020; Kang et al., 2020),
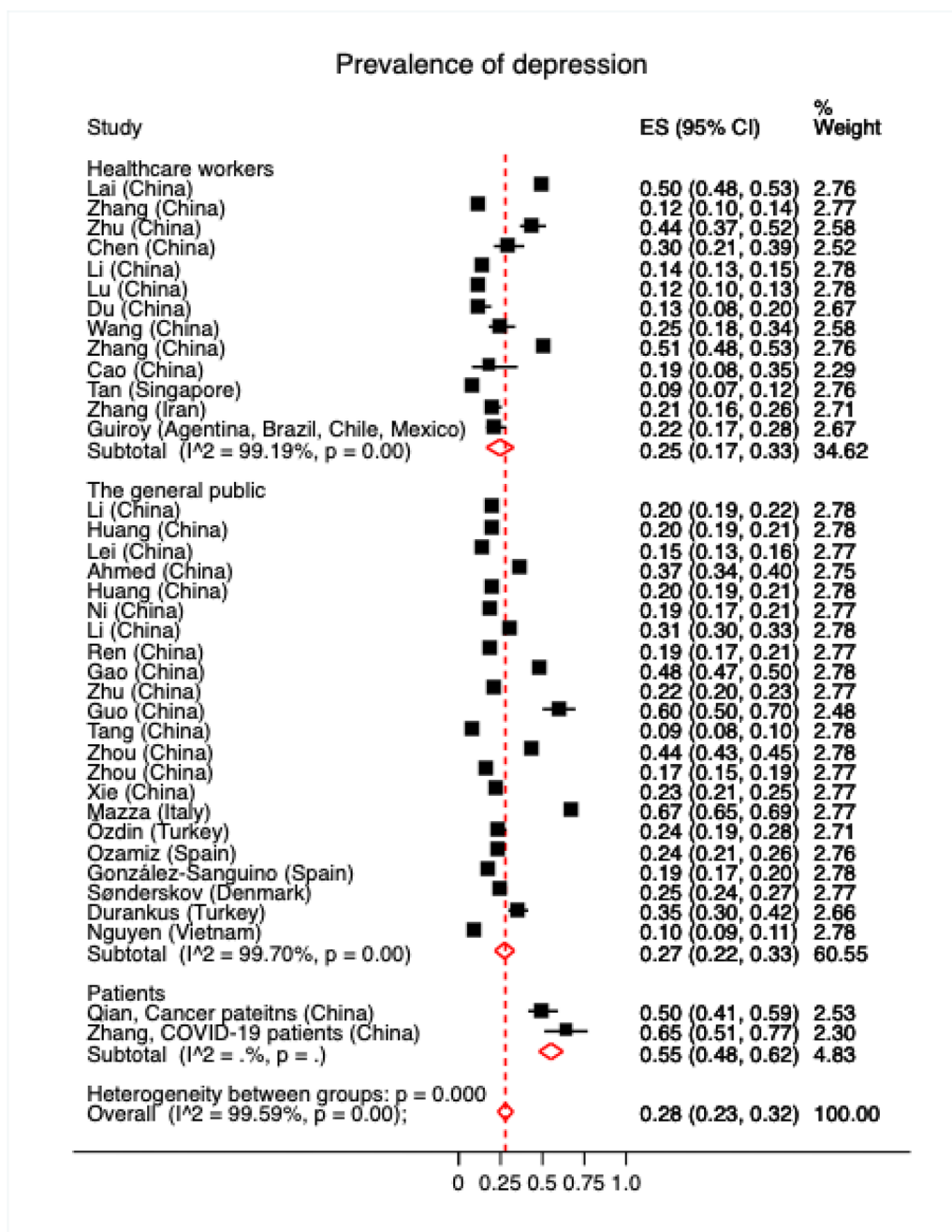
Prevalence of depression

Fig. 2. Forest plot of the prevalence of depression.
Figure legend: The square markers indicate the prevalence of depression. The size of the marker correlates to the inverse variance of the effect estimate and indicates the weight of the study. The diamond data marker indicates the pooled prevalence.

and working in the hardest-hit area were additional associated with higher psychological distress (Lai et al., 2020; Du et al., 2020). Nevertheless, protective factors against a greater psychological distress included having family support (Cao et al., 2020), having sufficient local medical resources (Qiu et al., 2020), having highly efficient health systems and effective prevention and control measures against the epidemic (Qiu et al., 2020), having up-to-date and accurate health information (e.g. treatment, local outbreak situation) (Wang et al., 2020; Wang et al., 2020; Wang et al., 2020), and taking precautionary measures (e.g. hand hygiene, wearing masks) (Wang et al., 2020; Wang et al., 2020; Qian et al., 2020; Wang et al., 2020).

4. Discussion

4.1. Main findings

In the current systematic review and meta-analysis, we have observed an overall high psychological impact of COVID-19 pandemic among healthcare workers, the general public, and patients with pre-existing conditions or COVID-19. The most common indicators of psychological impact reported across studies were anxiety and depression, and the respective prevalence was 33% (28%-38%) and 28% (23%-32%). Patients with pre-existing conditions or COVID-19 had significantly higher prevalence of anxiety and depression compared to healthcare workers and the general public, and studies reported higher-than-pooled prevalence of anxiety and depression among the latter two

groups included studies conducted in China, Italy, Turkey, Spain and Iran. Common risk factors of heavier psychological burden included being women, being nurses, having high risks of contracting COVID-19, having lower socioeconomic status, social isolation, and spending longer time watching COVID-19 related news; protective factors included having sufficient medical resources, having up-to-date and accurate health information, and taking precautionary measures.

4.2. In comparison with previous studies

Similar to the current study, a high prevalence of psychological symptoms, such as anxiety and depression, has been reported in frontline medical workers, the general public, and patients with suboptimal health across outbreaks of Ebola, H1N1 and SARS (Maunder et al., 2003; Xiang et al., 2020; Wu et al., 2009; Chew et al., 2020). Compared to the existing meta-analysis on psychological impact of COVID-19 on healthcare workers from 13 Asian studies that reported a pooled prevalence of 23.2% in anxiety and 22.8% in depression (Pappa et al., 2020), the current meta-analysis found a similar prevalence of anxiety (26% [18%-34%]) and depression (25% [17%-33%]) among healthcare workers. In addition, we extended the existing evidence by showing that the prevalence of anxiety and depression was significantly higher among patients with pre-existing conditions or COVID-19 infection compared to healthcare workers and the general public, which was supported by a few studies that showed higher prevalence of psychological distress among patients compared to healthy controls (Hao et al., 2020; Salari et al., 2020; Hao et al., 2020). Furthermore, our studies showed that the prevalence of anxiety and depression was similar between healthcare workers and the general public. A study conducted in China corroborated our finding by showing that the prevalence of anxiety and depression was similar between healthcare workers and the general public (Ni et al., 2020); however, three other studies from China showed that healthcare workers had higher prevalence of anxiety and depression (Zhang et al., 2020; Huang and Zhao, 2020; Huang and Zhao, 2020). Among healthcare professionals working in the hospital, one study showed that medical workers had higher psychological distress compared to administrative staff (Lu et al., 2020), while another study showed that the psychological distress was higher among non-medical workers in hospitals (Tan et al., 2020). Our findings suggested that patients with pre-existing conditions and COVID-19 infection are at the highest risk of psychological distress and should be targeted for psychological assessment and appropriate intervention.

The current review found that women and nurses had higher psychological distress compared to men and doctors, respectively, which were consistent with previous findings that women and nurses were more vulnerable to stress (Qiu et al., 2020, Sareen et al., 2013; Chou et al., 2014). In addition, the current review also found that social isolation, financial security, and being more susceptible to COVID-19 infections (have complications, older age) are associated with higher levels of psychological distress. A recent review published on the *Lancet Psychiatry* corroborated with our findings by showing that social isolation and loneliness are strongly associated with anxiety and depression, and populations with worse health or social inequality are more vulnerable to the psychological distress of COVID-19 (Holmes et al., 2020). These findings highlighted the importance to design interventions to target women, nurses, people with complications or older age, and those with unstable income, whom may have higher psychological burden (Zhou et al., 2020). Furthermore, we found that some factors, such as having sufficient medical resources, having up-to-date and accurate health information, and taking precautionary measures could help decrease the psychological impact among the general public. This highlighted the importance to ensure an effective public health system at the governmental level and taking precautionary measures at the personal level to decrease the mental impact.

The current study had important clinical and public health

implications. First, we identified high-risk population and risk factors of higher psychological distress that could be used for risk stratification and the design of effective psychological interventions at both clinical and community levels. Second, heavy psychological distress has been observed in the general public in various countries that suffered from COVID-19 pandemic. Therefore, this finding underscored the importance to implement and roll out psychological services and intervention programs across all countries that have experienced COVID-19 pandemic. After the outbreak, China implemented rapid psychological crisis intervention including releasing free self-help manual online (Bao et al., 2020), and initiating 24-hour psychological hotlines and online consultations for the general public (Bao et al., 2020) and healthcare workers (Zhou, 2020; Jiang et al., 2020; Zhang et al., 2020). In other countries that suffered from COVID-19 pandemic at a later stage such as Korea, Singapore and Italy, psychological support and interventions have also been prepared and rolled out to take care of high-risk populations during the COVID-19 pandemic (D'Agostino et al., 2020; Jung et al., 2020; Ho et al., 2020). Third, since most countries around the world are currently prioritizing their medical resources for the containment of COVID-19 and the treatment of patients with COVID-19, there may be limited resources available for psychological services and interventions. Therefore, improving knowledge, awareness, and self-coping strategies are critical in the current situation. A prior study has found that 50.4% of study participants had accessed psychological resources through books or media, and 17.5% had sought counseling or psychotherapy (Kang et al., 2020). In addition, the study also found that people with mild or lower disturbances preferred to obtain such services from media sources, while those with heavier burdens expressed their needs to seek services directly from professionals (e.g. psychologists, psychiatrists) (Kang et al., 2020). This finding suggested that psychological screening could be conducted among people, and triaged therapies could be delivered to people with different levels of psychological impacts. Future studies are warranted to evaluate the effectiveness of these interventions and the feasibility to scale up to a larger population.

4.3. Strengths and limitations

Compared to the last systematic review and meta-analysis that comprised 13 studies from Asian countries ($n = 33,062$) (Pappa et al., 2020), the current meta-analysis included more studies (62 studies from 17 countries) with a much bigger sample size ($n = 162,639$). In addition, we conducted comprehensive literature search in multiple important databases, and the results of the current study had important clinical and public health implication globally. However, several limitations merit consideration. First, the current review included studies using different instruments to measure psychological impacts (anxiety, depression, and others). However, since no study utilized standardized clinical interviews for diagnosis, it is not known whether the presence of an actual disorder exist. In addition, the outbreak of COVID-19 was observed in China first and then subsequently in other countries; therefore, the majority of the included studies were conducted in China (65%). Although we included studies from 17 countries, the sampling bias may still exist as papers from many other countries may not have been published yet. Moreover, we only included publications in English language, which may have brought publication bias. However, the limitation in language could also ensure the quality of the included articles. Furthermore, all quantitative studies were cross-sectional surveys or cohort studies with short follow-up duration; therefore, long-term mental health implications and how these base rates of mental health symptoms compare to other time periods cannot be inferred from these studies.

In conclusion, the COVID-19 pandemic has caused heavy psychological impact among medical workers and the general public. Psychological interventions identifying and targeting people with heavy psychological burdens are in urgent need. Future studies are

warranted to design and evaluate the effectiveness of psychological interventions.

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Declaration of Competing Interest

None.

Supplementary materials

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