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Research paper

The prevalence of psychiatric comorbidities during the SARS and COVID-19 epidemics: a systematic review and meta-analysis of observational studies

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\textbf{A R T I C L E  I N F O}

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depression
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stress

\textbf{A B S T R A C T}

The coronavirus disease 2019 (COVID-19) and Severe Acute Respiratory Syndrome (SARS) are associated with various psychiatric comorbidities. This is a systematic review and meta-analysis comparing the prevalence of psychiatric comorbidities in all subpopulations during the SARS and COVID-19 epidemics. A systematic literature search was conducted in major international (PubMed, EMBASE, Web of Science, PsycINFO) and Chinese (China National Knowledge Internet [CNKI] and Wanfang) databases to identify studies reporting prevalence of psychiatric comorbidities in all subpopulations during the SARS and COVID-19 epidemics. Data analyses were conducted using the Comprehensive Meta-Analysis Version 2.0 (CMA V2.0). Eighty-two studies involving 96,100 participants were included. The overall prevalence of depressive symptoms (depression hereinafter), anxiety symptoms (anxiety hereinafter), stress, distress, insomnia symptoms, post-traumatic stress symptoms (PTSS) and poor mental health during the COVID-19 epidemic were 23.9% (95% CI: 18.4%-30.3%), 23.4% (95% CI: 19.9%-27.3%), 14.2% (95% CI: 8.4%-22.9%), 16.0% (95% CI: 8.4%-28.5%), 26.5% (95% CI: 19.1%-35.5%), 24.9% (95% CI: 11.0%-46.8%), and 19.9% (95% CI: 11.7%-31.9%), respectively. Prevalence of poor mental health was higher in general populations than in health professionals (29.0% vs. 11.6%; Q=10.99, p=0.001). The prevalence of depression, anxiety, PTSS and poor mental health were similar between SARS and COVID-19 epidemics (all p values>0.05). Psychiatric comorbidities were common in different subpopulations during both the SARS and COVID-19 epidemics. Considering the negative impact of psychiatric comorbidities on health and wellbeing, timely screening and appropriate interventions for psychiatric comorbidities should be conducted for subpopulations affected by such serious epidemics.

\section{1. Introduction}

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first reported in Wuhan, Hubei province, China in December 2019 (\textit{World Health Organization, 2020}). Subsequently, the WHO declared COVID-19 as a Public Health Emergency of International Concern (PHEIC) on 30 January 2020 (\textit{World Health Organization, 2020}, \textit{World Health Organization, 2020}). As of the end of February 2021, approximately 113 million cases had been confirmed and over 2.5

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million deaths were reported worldwide (Johns Hopkins University, 2021). Severe acute respiratory syndrome (SARS) is an infectious disease caused by another coronavirus, severe acute respiratory syndrome coronavirus (SARS-CoV-1) (World Health Organization, 2004). SARS was first reported in southern China in November 2002, and later found in Hong Kong (World Health Organization, 2004) and many other Asian countries and territories. By 31 December 2003, a total of 8,096 SARS cases were confirmed worldwide (World Health Organization, 2003).

Clinical features of SARS and COVID-19 are similar in some aspects, but also different in others. For example, most patients with SARS suffered from a fever above 38.0°C, chills, headache, lethargy, and muscle pain. After 2 to 7 days, they may develop a dry, nonproductive cough with low blood oxygen levels. Most SARS patients developed shortness of breath and pneumonia subsequently, either primary viral pneumonia or secondary bacterial pneumonia (Centers for Disease Control and Prevention, 2017). In contrast, COVID-19 patients usually experienced flu-like symptoms, including fever and/or dry cough. Severe cases may present difficult breathing, chest pain, sudden confusion, and bluish face or lips (Grant et al., 2020; Centers for Disease Control and Prevention, 2020). Some COVID-19 patients eventually developed pneumonia, acute respiratory distress syndrome, sepsis, and kidney failure (World Health Organization, 2020). Further, SARS-CoV-1 and SARS-CoV-2 are different in both transmission characteristics and virulence. Compared to SARS-CoV-1, SARS-CoV-2 is more infectious with the reproduction number (R0) of around 3.3 (Liu et al., 2020, Xie et al., 2020), while the R0 of SARS-CoV-1 is around 2.7 (Riley et al., 2003, Lipsitch et al., 2003). The SARS-CoV-1 is more virulent than SARS-CoV-2. As of the end of 2003, SARS caused 774 deaths, resulting in a mortality rate of 9.2% (World Health Organization, 2003). In contrast, as of 18 October 2020, the mortality rate of COVID-19 was 2.8% (Johns Hopkins, 2020).

In any major catastrophes including bio-disasters, psychiatric comorbidities and related problems, such as depression, anxiety, sleep disturbances, fear, and stigmatization, are common and may act as barriers to accessing appropriate medical and mental health care. In order to prevent or minimize the negative outcomes caused by psychiatric comorbidities, understanding their patterns and associated factors is important. Previous studies on prevalence of psychiatric comorbidities found that confusion symptoms (27.9%), depression (32.6%), memory impairment (34.1%) insomnia (41.9%) and steroid-induced mania and psychosis (0.7%) were common in patients with SARS or Middle East respiratory syndrome (MERS) (Rogers et al., 2020). In addition, psychiatric comorbidities also persisted after the SARS epidemic, such as post-traumatic stress disorder (PTSD) (Hawryluck et al., 2004) and major depressive disorder (MDD) (Ma, 2009) in SARS survivors. Other subpopulations including family members and close contacts of SARS patients, health professionals, and the public (Salari et al., 2020) also suffered from psychiatric problems during the epidemic (Cong et al., 2003), which could be associated with a range of negative consequences, such as decreased quality of life, increased treatment burden, and increased suicidality (Chinese Ministry of Health 2003). Similarly, psychiatric comorbidities, such as depression, anxiety, and sleep disturbance were common in COVID-19 patients (Deng et al., 2020), health professionals, and other subpopulations (Salazar de et al., 2020, Li et al., 2020).

To date, very few studies have compared the psychiatric comorbidities of SARS and COVID-19 epidemics. Understanding their differences would be important to identify high-risk subpopulations, allocate healthcare resources, and provide appropriate treatments. A number of meta-analyses focused on psychiatric comorbidities of coronavirus diseases (Rogers et al., 2020, Kisyel et al., 2020), but only one compared the epidemiological data of psychiatric comorbidities between multiple coronavirus diseases among health professionals (Salazar de et al., 2020). Several meta-analyses on prevalence of psychiatric comorbidities during the COVID-19 pandemic have been conducted, but most only focused on specific subpopulations, such as infected or suspected patients (Deng et al., 2020), health professionals (Pappa et al., 2020), or the public (Salari et al., 2020).

In order to better understand the psychiatric comorbidities of SARS and COVID-19, it is necessary to compare the prevalence of psychiatric comorbidities in all subpopulations during the SARS and COVID-19 epidemics. Therefore, we conducted this systematic review and meta-analysis of observational studies to compare the overall prevalence of psychiatric comorbidities (e.g., depressive symptoms [depression hereinafter], anxiety symptoms [anxiety hereinafter], stress, distress, insomnia symptoms [insomnia hereinafter], post-traumatic stress symptoms [PTSS], post-traumatic stress disorder [PTSD], and poor mental health) during the SARS and COVID-19 epidemics across all subpopulations studied. We also explored the moderating effects of sociodemographic characteristics (e.g., sex, education level and marital status) on the results. We hypothesized that the overall prevalence of psychiatric comorbidities during the COVID-19 epidemic would be similar to that during the SARS epidemic; 2) the overall prevalence of psychiatric comorbidities in healthcare professionals would be higher than that in the general population during the COVID-19 epidemic.

2. Methods

2.1. Literature search and selection

This systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009), with the PROSPERO registration number of CRD42020211604. Literature search was systematically and independently conducted by three researchers (WWR, YJ, WL) in PubMed, EMBASE, Web of Science, PsycINFO, China National Knowledge Internet (CNKI) and WanFang databases from their inception to May 25, 2020, using the following search terms: “novel coronavi*”, “alphacoronavirus”, “betacoronavirus”, “COVID”, “COVID-19”, “severe acute respiratory syndrome” and “SARS”. For the psychiatric outcome category, the following search terms were used: “psychiatr*”, “mental”, “psycholog*”, “depress*”, “anxiety”, “posttraumatic stress disorder”, “PTSD”, “insomnia”, “sleep”, “epidemiology” and “prevalence”. The references of retrieved articles were also searched by hand for additional studies.

The same three researchers independently screened titles and abstracts, and then two of the researchers (YJZ and YJ) read the full texts of relevant articles for eligibility. Inclusion criteria were: 1) studies that examined psychiatric comorbidities during the SARS or COVID-19 epidemics in any subpopulations; 2) studies with available data on the prevalence of psychiatric comorbidities or relevant data that could generate the prevalence of psychiatric comorbidities during the SARS or COVID-19 epidemics in any subpopulations, as measured by standardized scales or diagnostic instruments; 3) case-control studies, cross-sectional or cohort studies. Case studies, reviews, systematic reviews, meta-analyses or commentaries were excluded. If more than one article were published using the same dataset, only the one with the most complete information or highest quality assessment score was included. Disagreement was resolved by consensus.

2.2. Data extraction

Relevant data were independently extracted by two researchers (YJZ and YJ) using a pre-designed data extraction sheet, including sex, education level, marital status, the first author, publication year, study design, study location, study period, study population, sample size, sampling method, prevalence of specific psychiatric co-morbidities. Disagreement was resolved by consensus, or a discussion with a senior researcher (YTX).

2.3. Quality assessment

The quality of included studies was evaluated using the Loney’s 8-
item scale (Loney et al., 1998) which has been widely used previously (Boyle, 1998, Yang et al., 2016). This scale assesses the quality of observational studies in eight domains: target population, probability sampling, response rate, non-responders, sample representative of the target population, standardized data collection method, validated criteria for outcomes, and confidence intervals (CI) of the prevalence of target outcomes. The total quality score ranges from 0 to 8, with ‘7-8’ as “high quality”, ‘4-6’ as “moderate quality” and ‘0-3’ as “low quality”. Two researchers (YJZ and YJ) independently evaluated the study quality, and disagreement was resolved by consensus or a discussion with the senior researcher (YTX).

2.4. Data analysis

Data analyses were performed using Comprehensive Meta-Analysis Version 2.0 (CMA V2.0, Biostat Inc., Englewood, New Jersey, USA). $I^2$ test was used to evaluate heterogeneity between studies, with $I^2 > 50\%$ indicating significant heterogeneity. The random-effects model was used in data syntheses due to different demographic characteristics between studies. In SARS related studies, December 31, 2003 was used as the cutoff date to classify acute SARS phase and SARS recovery phase. At least three articles were needed for data synthesis in each phase. If the number of articles in either SARS phase was less than three, the relevant data in the two phases were pooled.

Subgroup and meta-regression analyses were conducted to explore moderating effects of categorical (e.g. study population, sex, education level and marital status) and continuous variables (e.g., female percentage and quality assessment score) respectively, on the prevalence of psychiatric comorbidities in COVID-19 patients. Publication bias was examined by funnel plots, Egger’s test and Duval and Tweedie trim-and-fill method. Two-tailed tests were conducted with the significance level of 0.05.

3. Results

3.1. Study characteristics

A total of 1,793 studies were identified in the literature search, and 82 met the eligibility criteria; of them, 74 studies with available data were included in the meta-analysis. Details of literature search, screening and selection are shown in Figure 1. Study characteristics are presented in Table 1. The included studies were conducted across 10...
Table 1  
Characteristics of studies included in this systematic review and meta-analysis.

| Study                      | Language | Disease          | Study design | Survey period | Country/territory | Population | Sampling method | Sample size | Female percentage (%) | Age Mean | SD | Min | Max | Response rate (%) | Quality score | Reference                  |
|----------------------------|----------|------------------|--------------|---------------|-------------------|------------|------------------|-------------|-----------------------|-----------|----|-----|-----|----------------------|---------------|----------------------------|
| Ahmed, M. Z. et al. 2020   | English  | COVID-19         | cross-sectional | 2020/NR       | Mainland China    | general population | NR          | 1074        | 46.83                  | 33.54     | 11.13| 48  | 68  | 14            | 4              | (Ahmed et al., 2020)        |
| Bo, H. X. et al. 2020      | English  | COVID-19         | cross-sectional | 2020.3        | Mainland China    | infected people   | NR          | 714         | 50.90                  | 50.2      | 12.9 | -   | -   | 97.80                | 6              | (Bo et al., 2020)           |
| Cai, W. et al. 2020        | English  | COVID-19         | cross-sectional | 2020/NR       | Mainland China    | health professionals | NR          | 1521       | 75.54                  | -         | 18  | -   | -   | NR                    | 4              | (Cai et al., 2020)          |
| Cao, W. et al. 2020        | English  | acute SARS       | cross-sectional | 2020/NR       | Mainland China    | university students | C           | 7143        | 69.65                  | -         | -   | -   | -   | 100.00               | 7              | (Cao et al., 2020)          |
| Chan, A. O. M. et al. 2004 | Chinese  | COVID-19         | cross-sectional | 2020.1-2020.2 | Mainland China    | health professionals | NR          | 3881       | 63.05                  | 20         | -   | 18  | -   | 91.38                | 5              | (Chan and Huak, 2004)       |
| Chang, J. et al. 2020      | English  | COVID-19         | convenient    | 2020/NR       | Mainland China    | health professionals | NR          | 128         | 100.00                 | 26.5      | 3.1 | -   | -   | 69.57                | 4              | (Chen et al., 2005)         |
| Chen, Y. et al. 2020       | English  | COVID-19         | cross-sectional | 2020/NR       | Mainland China    | health professionals | NR          | 105         | 90.5                   | 32.6      | 6.5 | -   | -   | 84.70                | 5              | (Chen et al., 2020)         |
| Cheng, S. K. et al. 2004   | English  | acute SARS       | cross-sectional | 2003.6        | Hong Kong total sample | NR          | 284         | 62.32                  | -         | -   | -   | -   | 60.17                | 5              | (Cheng et al., 2004)        |
| Chew, N. W. S. et al. 2020 | English  | COVID-19         | cross-sectional | 2020.2-2020.4 | Singapore, India  | health professionals | NR          | 906         | 64.35                  | 29 (median) | -   | -   | -   | 90.60                | 5              | (Chew et al., 2020)         |
| Chong, M. Y. et al. 2004   | English  | acute SARS       | cross-sectional | 2003.5-2003.6 | Taiwan            | health professionals | NR          | 1257       | 81.07                  | 31.8      | 6.4 | 21  | 59  | 50.28                | 5              | (Chong et al., 2004)        |
| Consolo, U. et al. 2020    | English  | COVID-19         | cross-sectional | 2020.4        | Italy              | health professionals | C           | 356         | 39.61                  | -         | -   | -   | -   | 40.73                | 5              | (Consolo et al., 2020)      |
| Fang, Y. et al. 2004       | Chinese  | acute SARS       | cross-sectional | 2003.7-2003.10 | Mainland China    | infected people    | NR          | 286         | 52.80                  | 33.43     | 11.85| 15  | 64  | 100.00               | 6              | (Fang et al., 2004)         |
| Gao, J. et al. 2020        | English  | COVID-19         | cross-sectional | 2020.1-2020.2 | Mainland China    | general population | NR          | 4827       | 67.68                  | 32.3      | 10.0| 10  | 85  | 82.50                | 6              | (Gao et al., 2020)          |
| Harwyruck, L. et al. 2004  | English  | acute SARS       | cross-sectional | 2003.2-2003.6 | Canada             | general population | convenient | 129         | NR                     | -         | -   | 18  | 66+| 0.86                | 4              | (Harwyruck et al., 2004)    |
| Hong, X. et al. 2009       | English  | acute SARS       | cross-sectional | 2003.6-2007.9 | Mainland China    | infected people    | NR          | 68         | 66.18                  | 38.5      | 12.3| -   | -   | 97.14                | 6              | (Hong et al., 2009)         |
| Huang, J. Z. et al. 2020   | Chinese  | COVID-19         | cross-sectional | 2020.2        | Mainland China    | health professionals | NR          | 230        | 81.30                  | 32.6      | 6.2 | 22  | 59  | 93.50                | 5              | (Huang et al., 2020)        |
| Huang, Y. et al. 2020      | English  | COVID-19         | cross-sectional | 2020.3        | Mainland China    | total sample       | NR          | 7236       | 54.62                  | 35.3      | 5.6 | -   | -   | 85.30                | 6              | (Huang and Zhao, 2020)      |
| Ko, C. H. et al. 2006      | English  | SARS             | cross-sectional | 2003.2        | Taiwan            | general population | R           | 1472       | 51.97                  | -         | -   | 15  | 51+| 94.85                | 6              | (Ko et al., 2006)           |
| Kwak, S. K. et al. 2006    | English  | SARS             | cross-sectional | 2003.2-2003.6 | Singapore          | infected people    | NR          | 63         | 79.37                  | 34.83     | 10.49| -   | -   | 43.45                | 5              | (Kwak et al., 2006)         |
| Lai, J. et al. 2020        | English  | COVID-19         | cross-sectional | 2020.1-2020.2 | Mainland China    | health professionals | CMRS        | 1257       | 76.69                  | -         | 18  | 40+| 68.69              | 5              | (Lai et al., 2020)          |
| Lam, M. H. B. et al. 2009  | English  | recovery SARS    | cross-sectional | 2005.12-2007.7 | Hong Kong         | infected people    | NR          | 181        | 68.51                  | 43.3      | 13.7| -   | -   | 49.05                | 5              | (Lam et al., 2009)          |
| Lancee, W. J. et al. 2008  | English  | recovery SARS    | cross-sectional | 2004.10-2005.9 | Canada            | health professionals | NR          | 139        | 87.05                  | 45.0      | 9.6 | -   | -   | 23.68                | 6              | (Lancee et al., 2008)       |
| Lau, J. T. F. et al. 2006  | English  | acute SARS       | cross-sectional | 2003.5-2003.6 | Hong Kong         | general population | R           | 818        | 50.24                  | -         | 18  | 50+| 64.70              | 6              | (Lau et al., 2006)          |
| Lee, A. M. et al. 2007     | English  | recovery SARS    | cross-sectional | 2004.4-2004.5 | Hong Kong         | infected people    | NR          | 96         | 63.54                  | -         | 18  | 61+| 80.00              | 5              | (Lee et al., 2007)          |
| Lei, L. et al. 2020        | English  | COVID-19         | cross-sectional | 2020.2        | Mainland China    | general population | convenient | 1593       | 61.27                  | 32.3      | 9.8 | -   | -   | 80.17                | 5              | (Lei et al., 2020)          |

(continued on next page)
| Study | Language | Disease | Study design | Survey period | Country/territory | Population | Sampling method | Sample size | Female percentage (%) | Age Mean | SD | Min | Max | Response rate (%) | Quality score | Reference |
|-------|----------|---------|--------------|---------------|------------------|------------|----------------|-------------|------------------------|-----------|----|-----|-----|-------------------|--------------|-----------|
| Li, X. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | health professionals | NR | 948 | 76.79 | - | 20 | 60+ | NR | 4 (Li et al., 2020) |
| Li, Y. et al. 2020 | English | COVID-19 | prospective cohort | 2020.2 | Mainland China | university students | NR | 1442 | 61.79 | - | - | - | 71.20 | 4 (Li et al., 2020) |
| Liang, L. L. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1 | Mainland China | general population | convenient | 584 | 61.82 | - | - | 14 | 35 | 95.70 | 5 (Li et al., 2020) |
| Liu, C. Y. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | health professionals | NR | 512 | 84.57 | - | - | 18 | 60+ | 85.33 | 5 (Liu et al., 2020) |
| Liu, N. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | general population | NR | 285 | 54.39 | - | - | - | 95.00 | 5 (Liu et al., 2020) |
| Liu, X. et al. 2012 | English | COVID-19 | prospective cohort | 2006 | Mainland China | health professionals | SR | 549 | 76.50 | - | - | - | 83.00 | 6 (Liu et al., 2012) |
| Liu, Z. R. et al. 2004 | Chinese | acute SARS | cross-sectional retrospective | 2003.5 | Mainland China | university students | CS | 6280 | 38.74 | 20.3 | 2.0 | - | - | 92.35 | 6 (Liu et al., 2004) |
| Lü, S. H. et al. 2010 | Chinese | acute SARS | cross-sectional | 2003.3-2003.6 | Mainland China | general population | MS | 2379 | 45.61 | 39.12 | 13.67 | 18 | 69 | 93.96 | 6 (Lü et al., 2010) |
| Lu, W. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | health professionals | NR | 2299 | 77.64 | - | - | - | 94.88 | 5 (Lu et al., 2020) |
| Lu, Y. C. et al. 2006 | English | acute SARS | cross-sectional | 2004.7-2005.3 | Taiwan | health professionals | NR | 123 | NR | - | - | - | 96.85 | 5 (Lu et al., 2006) |
| Mak, I. W. C. et al. 2009 | English | recovery SARS | cohort | 2005.9-2006.3 | Hong Kong | infected people | NR | 90 | 62.22 | 41.1 | 12.1 | - | - | 96.77 | 6 (Mak et al., 2009) |
| Maunder, R. G. et al. 2006 | English | acute SARS | cross-sectional | 2004.10-2005.9 | Canada | health professionals | NR | 769 | 86.87 | - | - | - | 38.76 | 4 (Maunder et al., 2006) |
| Mazza, C. et al. 2020 | English | COVID-19 | cross-sectional | 2020.3 | Italy | general population | NR | 2766 | 71.66 | 32.94 | 13.2 | 18 | 90 | 98.36 | 5 (Mazza et al., 2020) |
| Mihashi, M. et al. 2009 | English | COVID-19 | cross-sectional | 2004.2-2004.3 | Mainland China | general population | NR | 187 | 36.90 | 26.3 | 8.0 | - | - | 62.33 | 3 (Mihashi et al., 2009) |
| Ni, M. Y. et al. 2020 | English | COVID-19 | cross-sectional | 2020/NR | Mainland China | total sample | NR | 1791 | 61.75 | - | - | - | NR | 5 (Ni et al., 2020) |
| Nickell, L. A. et al. 2004 | English | acute SARS | cross-sectional | 2003.4 | Canada | health professionals | NR | 510 | 80.59 | - | - | - | 11.91 | 4 (Nickell et al., 2004) |
| Ozamiz Eztebarria, N. et al. 2020 | Spanish | COVID-19 | cross-sectional | 2020.3 | Spain | general population | NR | 976 | 81.15 | - | - | 18 | 78 | 40.67 | 4 (Ozamiz Eztebarria et al., 2020) |
| Peng, E. Y. C. et al. 2010 | English | acute SARS | cross-sectional | 2003.11 | Taiwan | general population | SR | 1278 | 49.69 | 41.6 | 16.6 | 18 | 89 | 68.31 | 5 (Peng et al., 2010) |
| Reynolds, D. L. et al. 2008 | English | acute SARS | cross-sectional | 2003.3-2003.6 | Canada | total sample | NR | 1057 | 61.12 | - | - | - | 55.28 | 6 (Reynolds et al., 2008) |
| Shacham, M. et al. 2019 | English | COVID-19 | cross-sectional | 2020.3-2020.4 | Israel | health professionals | NR | 338 | 58.58 | 46.39 | 11.18 | 24 | 74 | NR | 4 (Shacham et al., 2020) |
| Sim, K. et al. 2004 | English | acute SARS | cross-sectional | 2003.7 | Singapore | health professionals | NR | 277 | 85.20 | 38.0 | 12.7 | - | - | 92.03 | 5 (Sim et al., 2004) |
| Sim, K. et al. 2010 | English | acute SARS | cross-sectional | 2003.7 | Singapore | general population | consecutive | 415 | 40.72 | 36.6 | 13.9 | - | - | 78.01 | 4 (Sim et al., 2010) |
| Su, T. P. et al. 2007 | English | acute SARS | cross-sectional | 2003.4-2003.6 | Taiwan | health professionals | NR | 102 | 100.00 | 25.4 | 3.7 | - | - | 95.33 | 5 (Su et al., 2007) |
| Tan, W. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | health professionals | NR | 673 | 25.56 | 30.8 | 7.4 | - | - | 50.87 | 4 (Tan et al., 2020) |
| Tang, W. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | university students | convenient | 2485 | 61.37 | 19.81 | 1.55 | 16 | 27 | 68.84 | 4 (Tang et al., 2020) |
| Tham, E. Y. et al. 2004 | English | acute SARS | cross-sectional | 2003.11 | Singapore | health professionals | NR | 96 | 68.75 | - | - | - | 77.42 | 4 (Tham et al., 2004) |

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| Study | Language | Disease | Study design | Survey period | Country/territory | Population | Sampling method | Sample size | Female percentage (%) | Age Mean | SD | Min | Max | Response rate (%) | Quality score | Reference |
|-------|-----------|---------|-------------|---------------|-----------------|------------|----------------|-------------|----------------------|----------|----|-----|-----|-------------------|--------------|-----------|
| Tham, K. Y. et al. 2004 | Chinese | acute SARS recovery | cross-sectional | 2006.3-2006.4 | Mainland China | general population | convenient | 2424 | 45.46 | 39.12 | 13.67 | - | - | 101.00 | 5 | (Tian et al., 2007) |
| Tian, B. C. et al. 2007 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | general population | convenient | 1060 | 48.21 | 35.01 | 12.8 | 13 | 76 | 93.64 | 5 | (Tian et al., 2020) |
| Wang, C. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | general population | convenient | 1210 | 67.27 | - | - | 12 | 59 | 92.79 | 5 | (Wang et al., 2020) |
| Wang, S. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | health professionals | NR | 123 | 90.24 | 33.75 | 8.41 | 20 | 50 | 50.00 | 4 | (Wang et al., 2020) |
| Wu, K. et al. 2020 | English | COVID-19 | cross-sectional | 2020/NR | Mainland China | health professionals | NR | 60 | 26.67 | 33.5 | 12.8 | 25 | 59 | NR | 4 | (Wu and Wei, 2020) |
| Yin, Q. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | health professionals | convenient | 371 | 61.46 | 35.30 | 9.48 | 20 | 40 | 98.41 | 5 | (Yin et al., 2020) |
| Zhang, C. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | health professionals | convenient | 1563 | 82.73 | - | - | 18 | 60 | 80.32 | 6 | (Zhang et al., 2020) |
| Zhang, K. R. et al. 2005 | Chinese | acute SARS | cross-sectional | 2003.9-2003.10 | Mainland China | total sample | NR | 296 | 67.57 | 34 | 12 | 8 | 81 | NR | 4 | (Zhang et al., 2005) |
| Zhang, W. R. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | general population | convenient | 263 | 59.70 | 37.7 | 14.0 | 18 | 50 | 65.75 | 5 | (Zhang and Ma, 2020) |
| Zhu, J. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2 | Mainland China | health professionals | NR | 165 | 83.03 | 34.16 | 8.06 | - | - | 100.00 | 6 | (Zhu et al., 2020) |
| Zhu, S. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2-2020.3 | Mainland China | total sample | NR | 2279 | 59.72 | - | - | - | - | NR | 4 | (Zhu et al., 2020) |
| Shi, T. Y. et al. 2005 | Chinese | acute SARS | cross-sectional | 2003.12-2004.1 | Mainland China | total sample | C | 162 | 79.63 | - | - | - | - | 93.1 | 6 | (Shi et al., 2005) |
| Zhang, X. J. et al. 2003 | Chinese | acute SARS | cross-sectional | 2003.4-2003.5 | Mainland China | general population | C | 1031 | 35.89 | 33.17 | - | 16 | 86 | 91.73 | 6 | (Zhang et al., 2003) |
| He, L. P. et al. 2004 | Chinese | acute SARS | cross-sectional | 2003.5 | Mainland China | general population | CR | 1016 | NR | 27.30 | 9.62 | - | - | 94.69 | 6 | (He et al., 2004) |
| Zhao, Q. et al. 2020 | Chinese | COVID-19 | cross-sectional | 2020.2 | Mainland China | infected people | NR | 106 | 56.60 | 35.90 | 11.92 | 21 | 65 | 100.00 | 6 | (Zhao et al., 2020) |
| Gao, H. S. et al. 2006 | Chinese | COVID-19 | longitudinal | 2003.9-2004.6 | Mainland China | infected people | NR | 67 | 68.66 | 25.32 | 8.54 | 15 | 67 | 88.16 | 5 | (Gao et al., 2006) |
| Gao, H. S. et al. 2006 | Chinese | COVID-19 | longitudinal | 2003.6-2004.6 | Mainland China | infected people | NR | 67 | 68.66 | - | - | - | - | NR | 4 | (Gao et al., 2006) |
| Wei, L. P. et al. 2005 | Chinese | SARS | longitudinal | 2003.5-2003.7 | Mainland China | infected people | NR | 180 | 66.67 | 36.9 | 11.1 | 18 | 70 | 42.35 | 5 | (Wei et al., 2005) |
| Cheng, S. K. et al. 2004 | English | acute SARS | cross-sectional | at 1 month and 3 months after discharge from hospital | Hong Kong | infected people | NR | 131 | 56.49 | 41.82 | 14.01 | 18 | 84 | 27.52 | 4 | (Wu et al., 2005) |
| Lee, D. T. S. et al. 2006 | English | acute SARS | case-control | 2003.4-2003.6 | Hong Kong | pregnant women | consecutive | 235 | 100.00 | 29.6 | 5.4 | - | - | 57.6 | 4 | (Lee et al., 2006) |
| Wu, Y. et al. 2020 | English | COVID-19 | cross-sectional | 2020.1-2020.2 | Mainland China | pregnant women | NR | 1285 | 100.00 | - | - | 27 | 32 | NR | 4 | (Wu et al., 2020) |
| Xie, X. et al. 2020 | English | COVID-19 | cross-sectional | 2020.2-2020.3 | Mainland China | children | NR | 1784 | 43.27 | - | - | - | - | 76.57 | 4 | (Xie et al., 2020) |
| Zhou, Y. et al. 2020 | English | COVID-19 | cross-sectional | 2020.3 | Mainland China | adolescents | NR | 8079 | 53.55 | 16 | - | 12 | 18 | 99.25 | 5 | (Zhou et al., 2020) |
countries or areas including Asia, Europe, North America and South America.

### 3.2. Prevalence of psychiatric comorbidities during the COVID-19 epidemic

Of the 36 studies on COVID-19, 21 studies reported prevalence of depression during the COVID-19 epidemic and the pooled prevalence of depression was 23.9% (95% CI: 18.4% - 30.3%; $I^2=99.43$%, $p<0.001$; Supplementary Figure 1). Twenty-four studies reported prevalence of anxiety during the COVID-19 epidemic and the pooled prevalence of anxiety was 23.4% (95% CI: 19.9% - 27.3%; $I^2=98.78$%, $p<0.001$; Supplementary Figure 2). Five studies reported the prevalence of stress during the COVID-19 epidemic and the pooled prevalence was 14.2% (95% CI: 8.4% - 22.9%; $I^2=98.65$%, $p<0.001$; Supplementary Figure 3). Three studies reported prevalence of distress the COVID-19 epidemic and the pooled prevalence of distress was 16.0% (95% CI: 8.4% - 28.5%; $I^2=97.77$%, $p<0.001$; Supplementary Figure 4). Eight studies reported the prevalence of insomnia during the COVID-19 epidemic and the pooled prevalence of insomnia was 26.5% (95% CI: 19.1% - 35.5%; $I^2=98.79$%, $p<0.001$; Supplementary Figure 5). Thirteen studies reported prevalence of PTSS during the COVID-19 epidemic and the pooled prevalence of PTSS was 24.9% (95% CI: 11.0% - 46.8%; $I^2=99.68$%, $p<0.001$; Supplementary Figure 6). Five studies reported the prevalence of poor mental health during the COVID-19 epidemic and the pooled prevalence of poor mental health was 19.9% (95% CI: 11.7% - 31.9%; $I^2=98.92$%, $p<0.001$; Supplementary Figure 7). Details of pooled prevalence of psychiatric comorbidities are presented in Table 2.

### 3.3. Comparisons of prevalence of psychiatric comorbidities between COVID-19 and SARS epidemics

Of the 38 studies on SARS, 6 studies reported prevalence of depression during the acute SARS phase, while 3 studies reported that during the SARS recovery phase, with the pooled prevalence of 27.5% (95% CI: 17.3% - 40.6%; $I^2=94.95$%, $p<0.001$) and 26.0% (95% CI: 15.6% - 40.0%; $I^2=87.59$%, $p<0.001$), respectively. No significant difference in prevalence of depression between SARS and COVID-19 epidemics was found ($Q=0.34$, $p=0.85$). Nine studies reported prevalence of anxiety during the SARS epidemic and the pooled prevalence of anxiety was 17.7% (95% CI: 8.2% - 34.1%; $I^2=97.37$%, $p<0.001$), with no significant difference compared to that during the COVID-19 epidemic ($Q=0.59$, $p=0.44$). Fifteen studies reported the prevalence of PTSS during the SARS epidemic and the pooled prevalence of PTSS was 16.8% (95% CI: 12.9% - 21.5%; $I^2=93.94$%, $p<0.001$), with no significant difference compared to that during the COVID-19 epidemic ($Q=0.89$, $p=0.35$).

Nine studies reported prevalence of poor mental health in acute SARS phase while 3 studies reported that in SARS recovery phase, with the pooled prevalence of 26.6% (95% CI: 11.7% - 49.8%; $I^2=99.61$%, $p<0.001$) and 32.8% (95% CI: 12.4% - 62.8%; $I^2=99.43$%, $p<0.001$), respectively. The pooled prevalence of poor mental health in SARS was similar with that during the COVID-19 epidemic ($Q=1.06$, $p=0.59$). Three studies reported prevalence of PTSD in acute SARS phase while 3 studies reported that in SARS recovery phase, with the pooled prevalence of 29.4% (95% CI: 9.3% - 63.0%; $I^2=96.62$%, $p<0.001$) and 15.3% (95% CI: 6.7% - 31.3%; $I^2=89.83$%, $p<0.001$), respectively. No study on prevalence of PTSD during the COVID-19 epidemic was published by the date of literature search; therefore, comparison between SARS and COVID-19 could not be made. Detailed comparisons of psychiatric comorbidities between COVID-19 and SARS epidemics are shown in Table 3.

### 3.4. Subgroup analyses in prevalence of psychiatric comorbidities during the COVID-19 epidemic

The pooled prevalence of poor mental health in the general

| Table 1 (continued) |
|---------------------|
| **Study** | Language | Disease | Sample size | Country/territory | Study design | Survey period | Sample method | Population | Country/territory | Data collection | Survey period | Study design | Reference |
|-------|--------|---------|-------------|-----------------|--------------|-------------|-------------|-------------|-----------------|----------------|-------------|--------------|-----------|
| Zhou, S. J. et al. | English | COVID-19 | 2020 | Mainland China | Cross-sectional | 2020 | Survey | Female: 100 | Mainland China | Health professionals | 46.6% | | (Yuan et al., 2020) |
| Yuan, R. et al. | English | COVID-19 | 2020 | Mainland China | Cross-sectional | 2020 | Survey | Female: 100 | Mainland China | Health professionals | 57.00 | | (Yuan et al., 2020) |
| Nguyen, H. C. et al. | English | COVID-19 | 2020 | Mainland China | Cross-sectional | 2020 | Survey | Female: 97 | Mainland China | Health professionals | 87.59 | | (Nguyen et al., 2020) |
| Han, Z. H. et al. | English | COVID-19 | 2020 | Mainland China | Cross-sectional | 2020 | Survey | Female: 72 | Mainland China | Health professionals | 41.67 | | (Han et al., 2020) |
| Wan, I. Y. P. | English | COVID-19 | 2003.4 | Hong Kong | Cross-sectional | 2003.4 | Survey | Female: 17 | Hong Kong | Patients on a waiting list for thoracic surgery | 100 | | (Wan et al., 2004) |

Abbreviations: COVID-19: Coronavirus disease 2019; SARS: Severe acute respiratory syndrome; M: multistage; SD: standard deviation; S: stratified; C: cluster; R: random; NR: not reported.
population and health professionals during the COVID-19 epidemic was 29.0% (95% CI: 18.1% - 43.1%) and 11.6% (95% CI: 9.2% - 14.6%), respectively. Subgroup analyses revealed that compared with health professionals, general populations were more likely to have poorer general mental health (Q = 10.99, p = 0.001). No significant difference was found between health professionals (28.0%, 95% CI: 9.5% - 59.0%) and general populations (19.2%, 95% CI: 4.6% - 54.2%) in prevalence of PTSS (Q = 0.21, p = 0.63). The prevalence estimates of depression and anxiety during the COVID-19 were similar between the general population and health professionals (Q = 0.01, p = 0.91 for depression; Q = 0.23, p = 0.64 for anxiety). Details of the comparisons are presented in Table 4. No significant differences were found in prevalence of depression, anxiety, insomnia and PTSS during the COVID-19 epidemic between different sex, between different education levels and between different marital status (all p values > 0.05, Table 5).

3.5. Meta-regression analyses

Meta-regression analyses revealed that the prevalence estimates of depression (r = 0.31), stress (r = 0.54) and insomnia (r = 0.97) were positively and significantly associated with proportion of female participants. Studies with higher quality scores reported higher prevalence of depression (r = 0.64), anxiety (r = 0.40) and PTSS (r = 0.28). Details of meta-regression analyses are shown in Supplementary Table 2.

3.6. Prevalence of psychiatric comorbidities in special subpopulations

A case-control study in Hong Kong reported that the prevalence of depression in pregnant women during the SARS epidemic was 12.3% (Lee et al., 2004), while another cross-sectional study in mainland China reported that the prevalence of depression in pregnant women during the COVID-19 epidemic was 29.6% (Wu et al., 2020). Two cross-sectional studies conducted in mainland China reported that the prevalence of depression in children and adolescents during the COVID-19 epidemic ranged from 22.6% to 43.7%, and the prevalence of anxiety in children and adolescents during the COVID-19 epidemic ranged from 18.9% to 37.4% (Xie et al., 2020; Zhou et al., 2020). A cross-sectional study conducted in mainland China reported that during the COVID-19 epidemic, parents of children hospitalized for any reason had significantly more severe depression and anxiety than parents of non-hospitalized children (48.0% vs. 8.0% in depression; 42.0% vs. 8.0% in anxiety) (Yuan et al., 2020).

A longitudinal study in mainland China reported that inpatients with COVID-19 had high levels of anxiety (86.1% before psychological intervention vs. 58.3% after psychological intervention; p < 0.05) (Han et al., 2020), while a cross-sectional study in Vietnam reported that outpatients with suspected COVID-19 symptoms had significantly higher prevalence of depression than those without (64.3% vs. 35.7%; p = 0.001) (Nguyen et al., 2020). A cross-sectional study in Hong Kong reported that during the SARS epidemic mental health problems were common in patients on a waiting list for thoracic surgeries, of whom 26.3% had depression, and 42.1% had anxiety (Wan et al., 2004).

3.7. Quality assessment and publication bias

Of the 82 included studies, the mean quality assessment score was 4.9, ranging from 3 to 7. Eighty studies are rated as “moderate quality”, while one study was rated as “low quality” and one study was rated as “high quality” (Supplementary Table 1). Egger’s test found marginal publication bias in studies on PTSS during the COVID-19 epidemic (r = 2.26, p = 0.04; shown in Table 2). Funnel plots are shown in Supplementary Figures 8-15. A sensitivity analysis using thetrim-and-fill method was performed with one imputed study, producing an approximately symmetrical funnel plot (Supplementary Figure 14). Using the trim-and-fill method, the adjusted pooled prevalence of PTSS was 53.1% (95% CI: 30.2% - 74.7%).

4. Discussion

To the best of our knowledge, this was the first systematic review that compared the prevalence of psychiatric comorbidities between the SARS and COVID-19 epidemics in all sub-populations. We found that psychiatric comorbidities were common in different subpopulations in both epidemics, and the prevalence estimates of psychiatric comorbidities were similar between both epidemics.

The overall prevalence of depression in all subpopulations studied during the COVID-19 epidemic was 23.9% (95% CI: 18.4%-30.3%) in this systematic review, which is similar to the findings of an earlier meta-analysis (18.9%; 95% CI: 13.0% - 26.6%) of depression during the COVID-19 epidemic (Li et al., 2020). We found the overall prevalence of anxiety in all subpopulations studied during the COVID-19 epidemic was 23.4% (95% CI: 19.9% - 27.3%), which is significantly lower than the corresponding figure in an earlier meta-analysis (44.5%; 95% CI: 29.8% - 60.1%) (Li et al., 2020). The reasons might be that the previous meta-analysis included studies published on or before 6 March 2020 (early stage of the COVID-19 epidemic), and conducted specifically on frontline health professionals, confirmed cases and quarantined populations. Another meta-analysis on COVID-19 patients also found higher prevalence of depression (45%; 95% CI 37% - 54%) and anxiety (47%; 95% CI 37% - 57%) (Deng et al., 2020), probably due to uncertainty about the novel virus, lack of specific treatments and fear of transmission to vulnerable populations (Xiang et al., 2020). The pooled prevalence of insomnia in this systematic review was 26.5% (95% CI: 19.1% - 35.5%), which is comparable with the findings of two earlier meta-analyses (49.8%, 95% CI: 18.6% - 81.1% (Li et al., 2020); and 34%, 95% CI: 19% - 50% (Deng et al., 2020)). The overall prevalence of stress and PTSS in this systematic review was 14.2% (95% CI: 8.4% - 22.9%) and 24.9% (95% CI: 11.0% - 46.8%), respectively, both of which are comparable with the corresponding figure in the previous meta-analysis (21.6%; 95% CI: 3.4%-68.1%) conducted in early stage of the COVID-19 epidemic (Li et al., 2020).

We found that the prevalence of depression and anxiety in all subpopulations studied between the SARS and COVID-19 epidemics were similar (Q = 0.34, p = 0.85 for depression; Q = 0.59, p = 0.44 for anxiety), which is also consistent with the findings in health professionals (Q = 1.153, p = 0.283 for depression; Q = 0.557, p = 0.456 for anxiety)
The minimum number of studies to synthesize data. Studies involving anxiety during SARS were not divided into “acute SARS/recovery SARS” because only 2 studies were conducted during recovery phase of SARS and they did not reach the minimum number of studies to synthesize data. Studies involving stress, distress, insomnia were not compared between COVID-19 and SARS due to the similar reason.

Note: Only the first visit of longitudinal studies was included in order to avoid data duplication. Studies involving stress, distress, insomnia were not compared between different populations because their numbers of studies in at least one population did not reach the minimum number of studies to synthesize data. Studies involving anxiety during SARS were not divided into “acute SARS/recovery SARS” because only 2 studies were conducted during recovery phase of SARS and they did not reach the minimum number of studies to synthesize data. Studies involving stress, distress, insomnia were not compared between COVID-19 and SARS due to the similar reason.

Table 3
Comparison of prevalence of psychiatric comorbidities during the COVID-19 and SARS epidemics

| Psychiatric outcomes | Condition       | Number of studies | Events | Sample size | Prevalence (%) | 95% CI (%) | I² (%) | p (within subgroup) | Q (p across subgroups) |
|----------------------|-----------------|-------------------|--------|-------------|----------------|------------|--------|--------------------|------------------------|
| Depression           | COVID-19        | 21                | 10025  | 39542       | 23.9           | 18.4 - 30.3 | 99.43  | < 0.001            | Q = 0.34, p = 0.85     |
|                      | Acute SARS      | 6                 | 348    | 1780        | 27.5           | 17.3 - 40.6 | 94.95  | < 0.001            |                         |
|                      | SARS            | 3                 | 175    | 712         | 26.0           | 15.6 - 40.0 | 87.59  | < 0.001            |                         |
| Anxiety              | COVID-19        | 24                | 11690  | 45253       | 23.4           | 19.9 - 27.3 | 98.78  | < 0.001            | Q = 0.59, p = 0.44     |
|                      | SARS            | 9                 | 275    | 2892        | 17.7           | 8.2 - 34.1  | 97.37  | < 0.001            |                         |
| PTSD                 | COVID-19        | 13                | 4268   | 11983       | 24.9           | 11.0 - 46.8 | 99.68  | < 0.001            | Q = 0.89, p = 0.35     |
|                      | SARS            | 15                | 938    | 5653        | 16.8           | 12.9 - 21.5 | 93.94  | < 0.001            |                         |
| Poor mental health   | COVID-19        | 5                 | 1216   | 6406        | 19.9           | 11.7 - 31.9 | 98.92  | < 0.001            | Q = 1.06, p = 0.59     |
|                      | Acute SARS      | 9                 | 2034   | 9907        | 26.6           | 11.7 - 49.8 | 99.61  | < 0.001            |                         |
|                      | SARS            | 3                 | 129    | 406         | 32.8           | 12.4 - 62.8 | 96.44  | < 0.001            |                         |
|                      | SARS Recovery   | 3                 | 31     | 410         | 15.3           | 6.7 - 31.3  | 89.83  | < 0.001            |                         |

Note: Acute SARS refers to study period before January 1, 2004; Recovery SARS refers to study period after January 1, 2004.

The prevalence of depression and anxiety between the general population and health professionals during the COVID-19 epidemic are comparable, consistent with previous findings (Li et al., 2020).

Table 4
Prevalence of psychiatric comorbidities during the COVID-19 epidemic in all subpopulations

| Psychiatric outcomes | Population          | Number of studies | Events | Sample size | Prevalence (%) | 95% CI (%) | I² (%) | p (within subgroup) | Q (p across subgroups) |
|----------------------|---------------------|-------------------|--------|-------------|----------------|------------|--------|--------------------|------------------------|
| Depression           | General population  | 10                | 6016   | 20644       | 23.2           | 16.6 - 31.4 | 99.38  | < 0.001            | Q = 0.01, p = 0.91     |
|                      | Health professionals| 11                | 2809   | 11922       | 23.9           | 15.0 - 35.9 | 99.32  | < 0.001            |                         |
| Anxiety              | General population  | 10                | 5118   | 20599       | 21.2           | 16.6 - 26.7 | 98.74  | < 0.001            | Q = 0.23, p = 0.64     |
|                      | Health professionals| 14                | 3584   | 13020       | 23.2           | 17.1 - 30.8 | 98.77  | < 0.001            |                         |
| PTSD                 | General population  | 5                 | 1164   | 3015        | 19.2           | 4.6 - 54.2  | 99.57  | < 0.001            | Q = 0.21, p = 0.63     |
|                      | Health professionals| 5                 | 2190   | 4327        | 28.0           | 9.5 - 59.0  | 99.59  | < 0.001            |                         |
| Poor mental health   | General population  | 3                 | 742    | 2575        | 29.0           | 18.1 - 43.1 | 97.93  | < 0.001            | Q = 10.99, p = 0.001   |
|                      | Health professionals| 3                 | 402    | 3327        | 11.6           | 9.2 - 14.6  | 83.06  | < 0.001            |                         |

Note: Only the first visit of longitudinal studies was included in order to avoid data duplication. Studies involving stress, distress, insomnia were not compared between different populations because their numbers of studies in at least one population did not reach the minimum number of studies to synthesize data. Studies involving anxiety during SARS were not divided into “acute SARS/recovery SARS” because only 2 studies were conducted during recovery phase of SARS and they did not reach the minimum number of studies to synthesize data. Studies involving stress, distress, insomnia were not compared between COVID-19 and SARS due to the similar reason.

We found that the prevalence of PTSS in all subpopulations studied between the SARS and COVID-19 epidemics were similar (Q=0.89, p=0.35). However, in an earlier meta-analysis the prevalence of PTSD features in health professionals during the SARS, MERS and COVID-19 epidemics were different (16.7% in SARS, 40.7% in MERS, and 7.7% in COVID-19 epidemics; Q=22.74, p<0.001) (Salazar de et al., 2020). This may be because only one COVID-19 study with very low prevalence of PTSD features was included (Salazar de et al., 2020).

Subgroup analyses revealed that compared with health professionals, the general population was more likely to have poor general mental health status during the COVID-19 epidemic. This could be due to several reasons. Widespread misinformation on social mass media may have resulted in panic, fear and other mental health problems at the early phase of COVID-19 epidemic (Apuke and Omar, 2020, Pennycook et al., 2020, Brennen et al., 2020). Compared to health professionals, the general population may have less relevant medical knowledge to appraise the appropriate level of risks (O’Connor and Murphy, 2020), and may be more likely to suffer from mental health problems. In addition, substantial mental health services and psychological assistances were specifically developed for health professionals during the COVID-19 epidemic, which reduced the risk of adverse mental health effects (Liu et al., 2020, Li et al., 2020).

The prevalence of depression and anxiety between the general population and health professionals during the COVID-19 epidemic are comparable, consistent with previous findings (Li et al., 2020) in which...
SARS epidemics were included, while previous meta-analyses focused on comorbidities of all subpopulations studied during the COVID-19 and SARS epidemics (Rao et al., 2020, Xu et al., 2018, Wang et al., 2018). The strengths of this systematic review included first, psychiatric comorbidities of all subpopulations during the COVID-19 and SARS epidemics were included, while previous meta-analyses focused either on COVID-19 or SARS alone (Deng et al., 2020, Li et al., 2020, Salari et al., 2020), and only on certain subpopulations (Rogers et al., 2020, Deng et al., 2020, Salazar de et al., 2020, Kisely et al., 2020). However, several methodological limitations should be noted when interpreting the results. First, only studies published in English and Chinese languages were included. Second, even after subgroup analyses were performed, significant between-study heterogeneity was found. Such heterogeneity is unavoidable in the meta-analyses of epidemiological studies (Rostenstein et al., 2016, Wang et al., 2017). Subgroup analyses revealed that no gender difference was found in the prevalence of depression, anxiety, insomnia and PTSS in all subpopulations studied during the COVID-19 epidemic in this meta-analysis. In the previous study, the prevalence of stress-related symptoms in health professionals (73.4%, 95% CI: 71.1% - 75.5%) was higher than in the general population (2.3%, 95% CI: 0.6% - 8.7%) (Li et al., 2020). However, the previous study only had one survey each on stress-related symptoms in the general population and in health professionals respectively (Li et al., 2020), which could lead to unreliable results.

The strengths of this systematic review included first, psychiatric comorbidities of all subpopulations studied during the COVID-19 and SARS epidemics were included, while previous meta-analyses focused either on COVID-19 or SARS alone (Deng et al., 2020, Li et al., 2020, Salari et al., 2020), and only on certain subpopulations (Rogers et al., 2020, Deng et al., 2020, Salazar de et al., 2020, Kisely et al., 2020). Second, the number of included studies and the total sample size were large, which enabled us to perform sophisticated analyses, such as subgroup and meta-regression analyses and test publication bias. However, several methodological limitations should be noted when interpreting the results. First, only studies published in English and Chinese languages were included. Second, even after subgroup analyses were performed, significant between-study heterogeneity was found. Such heterogeneity is unavoidable in the meta-analyses of epidemiological studies (Rotenstein et al., 2016, Wang et al., 2017). Third, some factors related to psychiatric comorbidities, such as pre-existing psychiatric disorders, social support, and severity and treatments of SARS and COVID-19, were not examined due to insufficient data.

In conclusion, psychiatric comorbidities were common in different subpopulations during both the SARS and COVID-19 epidemics. Although clinical features of both diseases are different, their prevalence of psychiatric comorbidities were almost similar. Considering the negative impact of psychiatric comorbidities on health and wellbeing during serious epidemics, timely screening and appropriate interventions for psychiatric comorbidities should be conducted for vulnerable subpopulations. Further public mental health education and psychological assistance hotlines should also be provided for the affected populations.

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Table 5
Prevalence of psychiatric comorbidities during the COVID-19 epidemic by sex, education level and marital status.

| Psychiatric outcomes | Categories | Number of studies | Events | Sample size | Prevalence (%) | 95% CI (%) | $I^2$ (%) | $p$ (within subgroup) | Q ($p$ across subgroups) |
|----------------------|------------|-------------------|--------|-------------|----------------|------------|----------|----------------------|-------------------------|
| Depression           | Male       | 5                 | 1770   | 5892        | 32.4           | 20.1 - 47.6| 99.00    | < 0.001              | Q = 0.02, $p = 0.90$      |
|                      | Female     | 5                 | 3234   | 9478        | 33.7           | 20.1 - 50.7| 99.53    | < 0.001              | Q = 0.06, $p = 0.42$      |
| Anxiety              | Male       | 8                 | 2748   | 9663        | 25.7           | 21.0 - 31.1| 96.25    | < 0.001              | Q = 0.64, $p = 0.42$      |
|                      | Female     | 8                 | 4928   | 17907       | 28.7           | 23.8 - 34.1| 98.07    | < 0.001              |                         |
| Insomnia             | Male       | 5                 | 848    | 4089        | 25.2           | 19.7 - 31.6| 87.08    | < 0.001              | Q = 1.07, $p = 0.30$      |
|                      | Female     | 5                 | 1818   | 7048        | 31.7           | 21.6 - 43.9| 98.72    | < 0.001              |                         |
| Senior high school or below | Male   | 3                 | 62     | 147         | 43.3           | 28.5 - 59.5| 52.96    | 0.12                 | Q = 1.15, $p = 0.28$      |
| University or above  | Male       | 3                 | 860    | 2486        | 34.6           | 31.4 - 38.1| 56.12    | 0.10                 |                         |
|                      | 3          | 626               | 1775   | 34.6        | 31.0 - 43.8    | 45.5     | 0.15     | Q = 0.17, $p = 0.68$  |                         |
| PTSS                 | Unmarried  | 3                 | 316    | 859         | 35.8           | 31.1 - 40.9| 43.56    | 0.17                 | Q = 0.08, $p = 0.78$      |
|                      | Male       | 4                 | 235    | 993         | 19.1           | 4.2 - 56.3| 98.65    | < 0.001              |                         |
|                      | 4          | 907               | 2199   | 25.4        | 5.1 - 68.3     | 99.56    | < 0.001  |                     |                         |

Note: Only studies reported all categories of sex and education level were included. The minimum number of studies required to synthesize data is 3.
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Supplementary materials
Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2021.03.016.

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