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# Factors associated with depression among healthcare workers during the COVID-19 pandemic: a systematic review and meta-analysis

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**Review Article**

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## Abstract

The COVID-19 pandemic has had a profound impact on the mental health of healthcare workers (HCWs). We aimed to identify the factors associated with depression among HCWs during the pandemic. We conducted literature search using eight electronic databases up to July 27 2022. Observational studies with more than 200 participants investigating correlates of depression in HCWs after COVID-19 outbreak were included. We used fixed- and random-effects models to pool odds ratios (ORs) across studies, and Cochran's chi-squared test and $I^2$ statistics to assess study heterogeneity. Publication bias was evaluated by funnel plots. Thirty-five studies involving 44,362 HCWs met the inclusion criteria. Female (OR=1.50, 95% CI [1.23,1.84]), single (OR=1.36, 95% CI [1.21,1.54]), nurse (OR=1.69, 95% CI [1.28,2.25]), history of mental diseases (OR=2.53, 95% CI [1.78,3.58]), frontline (OR=1.79, 95% CI [1.38,2.32]), health anxiety due to COVID-19 (OR=1.88, 95% CI [1.29,2.76]), working in isolation wards (OR=1.98, 95% CI [1.38,2.84]), and insufficient personal protective equipment (OR=1.49, 95% CI [1.33,1.67]) were associated with increased risk of depression. Instead, HCWs with a positive professional prospect (OR=0.34, 95% CI [0.24,0.49]) were less likely to be depressed. This meta-analysis provides up-to-date evidence on the factors linked to depression among HCWs during the COVID-19 pandemic. Given the persistent threats posed by COVID-19, early screening is crucial for the intervention and prevention of depression in HCWs.

## Introduction

The World Health Organization declared the COVID-19 outbreak a Public Health Emergency of International Concern on 30 January 2020, and announced the end of global emergency on 5 May 2023, while emphasizing that it continues to pose a global health threat (Wise, 2023). As of 25 June 2023, over 767 million confirmed cases and over 6.9 million deaths have been reported globally (WHO, 2023). The rapid spread of COVID-19 has placed enormous pressure on healthcare systems worldwide, pushing them to the brink of collapse and shutdown. Healthcare workers (HCWs), who serve as the core of healthcare systems, have been exposed to a massive load of stress factors such as excessive workloads, amounts of patients and deaths, and risks of infection (Şahin, Aker, Şahin, & Karabekiroğlu, 2020). A close relationship between chronic stress and psychiatric disorders has been well established (Fava, Cosci, & Sonino, 2017). Thus, during the pandemic, HCWs are recognized to confront with an elevated risk of developing mental disorders, such as depression (Pappa et al., 2020), anxiety (Grandinetti et al., 2021), post-traumatic stress disorder (Grandinetti et al., 2021), and an increased susceptibility to suicide (Awan et al., 2021).

The COVID-19 pandemic has led to a global increase in the prevalence of depression by 27.2% (Lancet, 2021). This rate was even higher among HCWs. A recent meta-analysis of 70 studies conducted in the USA, Asia, and Europe revealed a pooled prevalence of depression among HCWs at 31.1% (Marvaldi, Mallet, Dubertret, Moro, & Guessoum, 2021). In Asia, 34.6% of HCWs exhibited depressive symptoms (Norhayati, Che Yusof, & Azman, 2021), and in China, the aggregated prevalence was 26.2% (Zhang et al., 2021). Depression not only impairs the mental and physical health of HCWs but is also associated with an increased risk of medical errors (Pereira-Lima et al., 2019), ultimately

contributing to a decline in the quality of medical care. Consequently, it is essential to focus on the mental health of HCWs during the COVID-19 pandemic. Furthermore, in the context of a crisis characterized by a heavy healthcare burden, the rapid and accurate identification of high-risk populations is crucial for effectively allocating resources and providing necessary support to HCWs who are most in need.

With the accumulation of data regarding the associations between individual factors and depression among HCWs, several meta-analysis studies have reported potential risk factors such as being female, younger age, working as a nurse or frontline professional, insufficient personal protective equipment, being suspected or confirmed COVID-19 cases, and having an infected family member or friend (Chutiyami et al., 2021; Crocamo et al., 2021; Luo, Guo, Yu, Jiang, & Wang, 2020). However, it should be noted that most of these studies were conducted during the early stages of the COVID-19 outbreak. As a result, there is a need for a current study that takes into account the availability of more observational studies. In addition, recent modifications to COVID-19 policy in certain countries, such as China, have posed new challenges for HCWs and created an urgent need to identify factors associated with depression. Therefore, this systemic review and meta-analysis aims to clarify the correlates of depression among HCWs during the pandemic, by comprehensively investigating observational studies after the COVID-19 outbreak.

## Methods

The current meta-analysis was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Liberati et al., 2009), and has been registered in PROSPERO (No. CRD42021292824).

### Study eligibility

We included observational studies investigating correlates of depression in HCWs during the pandemic, written in either English or Chinese. The study subjects consisted of HCWs, including doctors, nurses, medical technicians, and other individuals directly or indirectly involved in medical activities. Depression was defined categorically according to professional diagnosis or specific cut-offs from well-validated psychometric scales, such as Patient Health Questionnaire (PHQ-9) $\geq 10$, Self-rating Depression Scale (SDS) $\geq 53$, Depression Anxiety Stress Scale (DASS-21) $\geq 53$, Hospital Anxiety and Depression Scale-Depression (HADS-D) $\geq 8$, or Epidemiologic Studies-Depression Scale (CES-D) $\geq 16$. The eligible studies should provide odds ratios (OR) and 95% confidence intervals (CI) that enabled us to quantify the strength of association. Finally, to minimize publication bias due to small sample sizes, we required studies with more than 200 participants (Crocamo et al., 2021; Pereira-Lima et al., 2019).

We excluded studies (1) not providing information on depression or only using continuous depressive symptoms; (2) not containing specific information on HCWs; (3) conducting prior to the COVID-19 outbreak; (4) not observational studies, including case reports, qualitative studies, literature reviews, and meta-analyses; (5) duplicated publications, (6) full-text non-available; (7) unrefereed preprints and grey literature.

### Search strategy

We performed a literature search using PubMed, Web of Science, Embase, and the Cochrane Library for original studies published until 27 July 2022. Additionally, we retrieved relevant articles in Chinese from four additional Chinese databases, namely China National Knowledge Infrastructure (CNKI), Chinese Biomedical Literature Database (CBD), China Science and Technology Journal Database (VIP), and Wanfang. Initially, three keywords 'COVID-19', 'healthcare workers', and 'depression' were entered into the Medical Subject Headings (MeSH) database from PubMed to identify MeSH terms and free-text words. The search phrases for associated factors were developed in MEDLINE (Wilczynski & Haynes, 2003). Finally, two authors translated the English keywords into Chinese and made necessary adjustments and expansions to align with the linguistic conventions, ensuring the suitability for Chinese databases. In cases where the translated search terms were inappropriate or insufficient, we supplemented them with relevant terms following common English–Chinese usage practices, to ensure consistency and rigor in our search strategy (Schünemann, 2013). Detailed search strategy is illustrated in online Supplementary Table S1.

### Data extraction and quality assessment

Two authors (H. T. and T. Q.) independently extracted relevant information from each study, including the name of the first author, publication year, study design, sample size, study location, type of HCWs, diagnostic criteria used, risk factors, and effect sizes. As all the eligible studies were cross-sectional, the study quality was evaluated using the US Agency for Healthcare Research and Quality (AHRQ). Studies were categorized as low quality with a AHRQ score ranging from 0 to 3, medium quality with a score ranging from 4 to 7, and high quality with a score ranging from 8 to 11 (Zeng et al., 2015). In case of any disagreements, two researchers worked together to resolve them through discussion, and if they were unable to reach a consensus, a third researcher (Y. H.) was involved to make the final decision.

### Statistical analysis

The factors associated with depression among HCWs during the pandemic that were investigated in at least two different studies were included in this meta-analysis. The pooled effect sizes were calculated based on ORs with 95% CIs. Cochran's $\chi^2$ test and $I^2$ statistics were performed to assess study heterogeneity. If there was minimal heterogeneity (i.e. $p > 0.1$ and $I^2 < 50\%$), a fixed-effects model was used. However, a random-effects model was employed if there was high heterogeneity (i.e. $p \leq 0.1$ or $I^2 \geq 50\%$) (Ryan, 2016). Subgroup and meta-regression analyses were conducted to explore potential influences of various factors, including study location, type of HCWs, frontline worker status, and diagnostic criteria of depression. Furthermore, we performed a sensitivity analysis, in which each study was individually excluded to examine the influence of that study on the overall estimates. Publication bias was evaluated using funnel plots.

## Results

### Study characteristics

In accordance with the search strategy, a total of 2088 records were identified from eight databases, and an additional 14 articles

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were obtained from a related meta-analysis (Crocamo et al., 2021). After duplication removal and preliminary screening by title and abstract, we were left with 209 full-text papers for further assessment. Finally, 35 eligible studies (Ahn et al., 2021; Akova, Kiliç, & Özdemir, 2022; Al-Humadi et al., 2021; Al Maqbali & Al Khadhuri, 2021; Awano et al., 2020; Azoulay et al., 2020; Chatzittofis, Karanikola, Michailidou, & Constantinidou, 2021; Gu, Zhu, & Xu, 2022; Hennein, Mew, & Lowe, 2021; Hong et al., 2021; Huang et al., 2021; Işik, Kirli, & Özdemir, 2021; Khanal, Devkota, Dahal, Paudel, & Joshi, 2020; Lasalvia et al., 2021; Li et al., 2022, 2020a, 2020b; Mekonen, Shetie, & Muluneh, 2020; Mosheva et al., 2021; Napoli, 2022; Ning et al., 2020; Osório et al., 2021; Pandey et al., 2021; Pazmiño Erazo, Alvear Velásquez, Saltos Chávez, & Pazmiño Pullas, 2021; Pouralizadeh et al., 2020; Quintana-Domeque et al., 2021; Shah et al., 2021; Şahin et al., 2020; Vlah Tomičević & Lang, 2021; Wang et al., 2020, 2021; Xiao et al., 2020; Xing et al., 2021; Zheng et al., 2021; Zhu et al., 2020) (two were in Chinese) were included in the current meta-analysis. The flowchart of the selection process is presented in Fig. 1.

Characteristics of the eligible studies are summarized in Table 1. All studies were cross-sectional. Thirteen studies were conducted in China (Gu et al., 2022; Hong et al., 2021; Huang et al., 2021; Li et al., 2022, 2020a, 2020b; Ning et al., 2020; Wang et al., 2020, 2021; Xiao et al., 2020; Xing et al., 2021; Zheng et al., 2021; Zhu et al., 2020), 10 studies (Ahn et al., 2021; Akova et al., 2022; Al Maqbali & Al Khadhuri, 2021; Awano et al., 2020; Işik et al., 2021; Khanal et al., 2020; Mosheva et al., 2021; Pandey et al., 2021; Pouralizadeh et al., 2020; Şahin et al., 2020) were conducted in other Asian countries such as Nepal and Turkey, five studies (Azoulay et al., 2020; Lasalvia et al., 2021; Napoli, 2022; Quintana-Domeque et al., 2021; Vlah Tomičević & Lang, 2021) in Europe, three studies (Chatzittofis et al., 2021; Osório et al., 2021; Pazmiño Erazo et al., 2021) in South America, two studies (Al-Humadi et al., 2021; Hennein et al., 2021) in North America, and two studies (Mekonen et al., 2020; Shah et al., 2021) in Africa. A total of 44 362 HCWs were included in this meta-analysis, including nurses, doctors, and other HCWs such as pharmacists, laboratory personnel, physiotherapists, administrative staff, and so on. Furthermore, the HCWs could be further categorized into front-line, non-frontline, or mixed groups based on their roles and responsibilities. Eighteen studies (Ahn et al., 2021; Al-Humadi et al., 2021; Chatzittofis et al., 2021; Gu et al., 2022; Hennein et al., 2021; Hong et al., 2021; Huang et al., 2021; Lasalvia et al., 2021; Mosheva et al., 2021; Napoli, 2022; Osório et al., 2021; Pazmiño Erazo et al., 2021; Pouralizadeh et al., 2020; Quintana-Domeque et al., 2021; Shah et al., 2021; Şahin et al.,

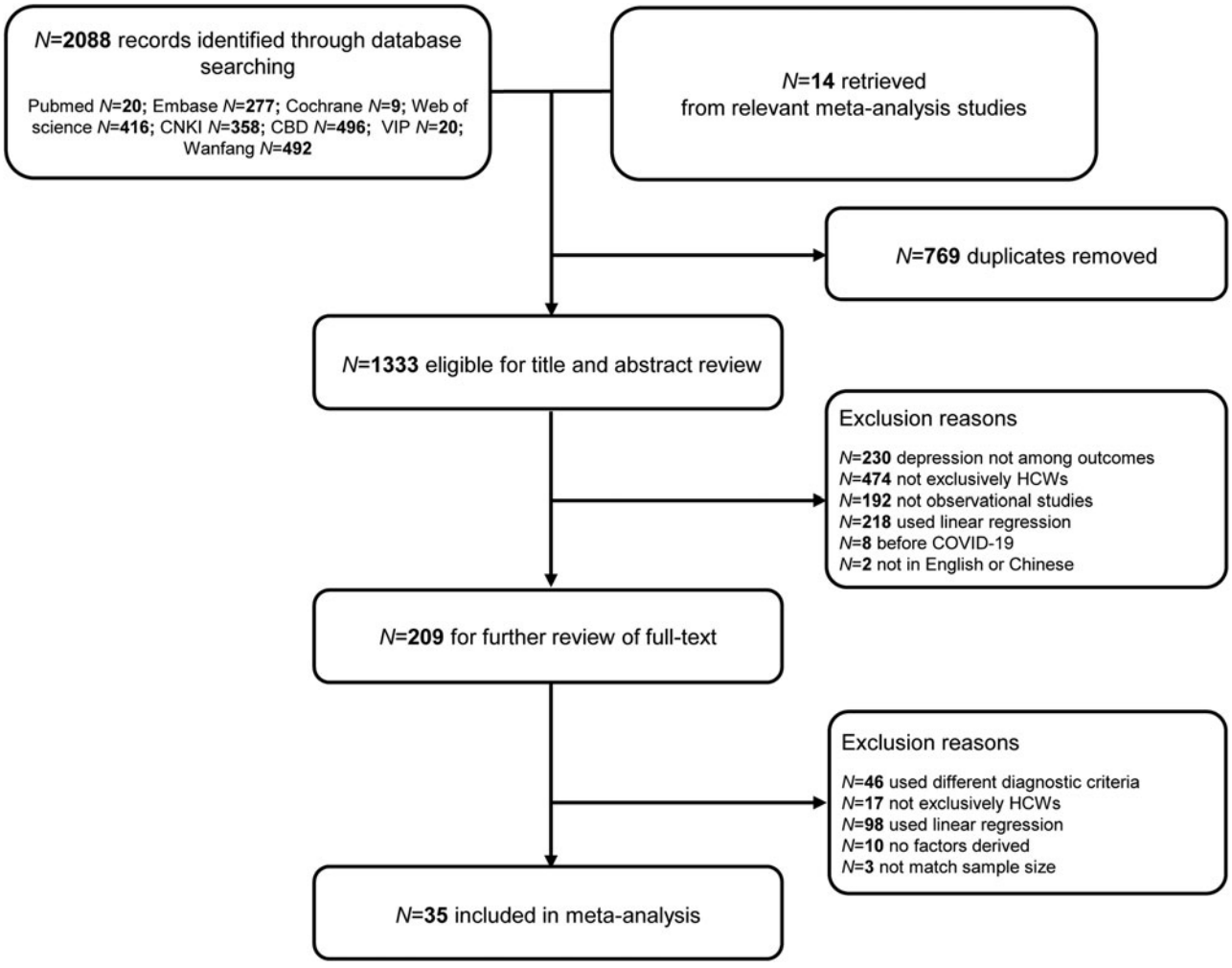


**Figure 1.** PRISMA flow diagram of search strategy and study selection.

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**Table 1.** Characteristics of studies included in the meta-analysis

| Study | Language | Location | Age years (mean ± s.d.) | Female proportion | *N* doctor | *N* nurse | *N* other | Frontline | Measure | Explored factors | Quality[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ahn et al. (2021) | English | Korea | NA | 76.10% | 292 | 967 | 524 | Portion | PHQ-9 ≥ 10 | 2, 8, 11 | 6 |
| Akova et al. (2022) | English | Turkey | NA | 47.50% | 569 | 252 | 194 | Portion | DASS ≥ 10 | 4, 7, 12 | 7 |
| Al Maqbali and Al Khadhuri (2021) | English | Oman | NA | 91.20% | 0 | 1130 | 0 | Portion | HADS-D ≥ 8 | 2, 4, 5, 11 | 7 |
| Al-Humadi et al. (2021) | English | America | 38.57 ± 11.48 | 57.30% | 225 | 0 | 0 | No | PHQ-9 ≥ 10 | 8 | 7 |
| Awano et al. (2020) | English | Japan | NA | 74.88% | 104 | 461 | 283 | Portion | CES-D ≥ 16 | 1, 2, 3 | 7 |
| Azoulay et al. (2020) | English | France | NA | 71.00% | 721 | 282 | 52 | Yes | HADS-D ≥ 8 | 2, 6 | 6 |
| Chatzittofis et al. (2021) | English | Cyprus | 38.78 ± 11.40 | 58.50% | 178 | 103 | 143 | Portion | PHQ-9 ≥ 10 | 1, 4 | 7 |
| Gu et al. (2022) | English | China | NA | 77.60% | 112 | 410 | 0 | Yes | PHQ-9 ≥ 10 | 1 | 7 |
| Hennein et al. (2021) | English | America | 40.44 ± 11.52 | 72.00% | 340 | 208 | 542 | Portion | PHQ-9 ≥ 10 | 1, 2, 8, 11 | 7 |
| Hong et al. (2021) | English | China | NA | 96.90% | 0 | 4738 | 0 | Yes | PHQ-9 ≥ 10 | 11 | 7 |
| Huang et al. (2021) | Chinese | China | NA | 73.48% | 230 | 291 | 71 | Portion | PHQ-9 ≥ 10 | 6, 7 | 7 |
| Işik et al. (2021) | English | Turkey | NA | 68.17% | 352 | 157 | 0 | Portion | HADS-D ≥ 8 | 1, 2, 8 | 6 |
| Khanal et al. (2020) | English | Nepal | 28.20 ± 5.80 | 52.60% | 161 | 167 | 147 | Yes | HADS-D ≥ 8 | 7, 12 | 7 |
| Lasalvia et al. (2021) | English | Italy | NA | 76.90% | 138 | 379 | 505 | Portion | PHQ-9 ≥ 10 | 1, 2 | 7 |
| Li et al. (2020) | English | China | 33.80 ± 6.93 | 75.55% | 368 | 394 | 145 | Yes | SDS ≥ 53 | 4, 6 | 8 |
| Li et al. (2020) | Chinese | China | 34.3(s.d. missing) | 100.00% | 0 | 1099 | 0 | Portion | DASS ≥ 10 | 3, 4 | 7 |
| Li et al. (2022) | English | China | NA | 59.80% | 4889 | 0 | 0 | Portion | DASS ≥ 10 | 2, 11 | 7 |
| Mekonen et al. (2020) | English | Ethiopia | 29.60 ± 5.10 | 45.40% | 0 | 293 | 0 | Portion | DASS ≥ 10 | 7, 8, 9 | 6 |
| Mosheva et al. (2021) | English | Israel | 41.70 ± 11.10 | 67.20% | 349 | 479 | 0 | Portion | PHQ-9 ≥ 10 | 1, 2, 6, 8 | 8 |
| Napoli (2022) | English | Italy | NA | 69.90% | 0 | 266 | 0 | Portion | PHQ-9 ≥ 10 | 2, 4, 8 | 6 |
| Ning et al. (2020) | English | China | NA | 72.90% | 317 | 295 | 0 | No | SDS ≥ 53 | 1, 2, 11, 12 | 7 |
| Osório et al. (2021) | English | Brazil | 35.20 ± 9.20 | 79.70% | 275 | 376 | 265 | Portion | PHQ-9 ≥ 10 | 2, 3, 6, 13 | 7 |
| Pandey et al. (2021) | English | Nepal | 32.25 ± 8.23 | 63.60% | 154 | 188 | 65 | Yes | DASS ≥ 10 | 1, 2, 7, 9 | 7 |
| Pazmiño Erazo et al. (2021) | English | Ecuador | NA | 68.30% | 557 | 349 | 122 | Portion | PHQ-9 ≥ 10 | 7 | 7 |
| Pouralizadeh et al. (2020) | English | Iran | 36.34 ± 8.74 | 95.20% | 0 | 441 | 0 | Yes | PHQ-9 ≥ 10 | 2, 4, 7, 9, 11 | 7 |
| Quintana-Domeque et al. (2021) | English | Spain Italy UK | NA | NA | 5275 | 0 | 0 | Portion | PHQ-9 ≥ 10 | 2, 7 | 7 |
| Şahin et al. (2020) | English | Turkey | NA | 66.00% | 580 | 254 | 105 | Portion | PHQ-9 ≥ 10 | 2, 3, 8 | 8 |
| Shah et al. (2021) | English | Kenya | NA | 58.40% | 243 | 190 | 0 | Portion | PHQ-9 ≥ 10 | 1, 2, 3 | 7 |
| Vlah Tomičević and Lang (2021) | English | Croatia | NA | 84.50% | 448 | 86 | 0 | Portion | DASS ≥ 10 | 1, 2, 9 | 8 |
| Wang et al. (2021) | English | China | NA | 82.12% | 382 | 563 | 279 | No | SDS ≥ 53 | 1, 5, 10 | 6 |

(*Continued*)

**Table 1.** (*Continued.*)

| Study | Language | Location | Age years (mean ± s.d.) | Female proportion | *N* doctor | *N* nurse | *N* other | Frontline | Measure | Explored factors | Quality[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wang et al. (2020) | English | China | NA | 82.50% | 1334 | 563 | 0 | Portion | PHQ-9 ≥ 10 | 1, 2, 3, 6, 7 | 8 |
| Xiao et al. (2020) | English | China | NA | 67.20% | 378 | 359 | 221 | Portion | HADS-D ≥ 8 | 4, 7 | 7 |
| Xing et al. (2021) | English | China | 33.5 ± 9.50 | 97.40% | 274 | 35 | 0 | Yes | SDS ≥ 53 | 1 | 7 |
| Zheng et al. (2021) | English | China | NA | 99.50% | 0 | 617 | 0 | Portion | DASS ≥ 10 | 7, 10 | 8 |
| Zhu et al. (2020) | English | China | NA | 85.00% | 1004 | 3417 | 641 | Portion | PHQ-9 ≥ 10 | 2, 5, 8 | 7 |

Explored factors: (1) type of HCWs; (2) gender; (3) frontline worker status; (4) contacting confirmed or suspected COVID-19 patients; (5) having a relative confirmed or suspected COVID-19; (6) health anxiety due to COVID-19; (7) insufficient personal protective equipment; (8) history of mental diseases; (9) history of chronic diseases; (10) working in isolation wards; (11) marital status; (12) age; (13) professional prospects.
[a]Quality of the eligible studies was evaluated by the AHRQ. Each study was assigned a score on a scale of 0–3, indicating low quality; 4–7, indicating medium quality; and 8–11, indicating high quality.

2020; Wang et al., 2020; Zhu et al., 2020) used the PHQ-9 to define depression, seven (Akova et al., 2022; Li et al., 2022, 2020b; Mekonen et al., 2020; Pandey et al., 2021; Vlah Tomičević & Lang, 2021; Zheng et al., 2021) used the DASS, five (Al Maqbali & Al Khadhuri, 2021; Azoulay et al., 2020; Işik et al., 2021; Khanal et al., 2020; Xiao et al., 2020) used the HADS-D, four (Li et al., 2020a; Ning et al., 2020; Wang et al., 2021; Xing et al., 2021) used the SDS, and one (Awano et al., 2020) used the CES-D. On the basis of the AHRQ grading system, six studies were classified as high quality, and 29 studies were categorized as medium quality.

### Factors associated with depression among HCWs

Thirteen relevant factors had data available from at least two different studies and were included in the meta-analysis. Among them, seven factors were associated with individual characteristics, including gender, age, marital status, history of mental diseases, history of chronic diseases, health anxiety due to COVID-19, and having a relative infected or suspected to be infected with COVID-19. Moreover, six factors were occupational-related, such as type of HCWs, frontline worker status, working in isolation wards, insufficient personal protective equipment, positive professional prospects, and contacting with confirmed or suspected COVID-19 patients.

The forest plot of the considered correlates is reported in Fig. 2. We revealed that female (OR 1.50, 95% CI 1.23–1.84), single (OR 1.36, 95% CI 1.21–1.54), nurse (OR 1.69, 95% CI 1.28–2.25), history of mental diseases (OR 2.53, 95% CI 1.78–3.58), frontline (OR 1.79, 95% CI 1.38–2.32), health anxiety due to COVID-19 (OR 1.88, 95% CI 1.29–2.76), working in isolation wards (OR 1.98, 95% CI 1.38–2.84), and insufficient personal protective equipment (OR 1.49, 95% CI 1.33–1.67) were associated with increased risk of depression. Instead, HCWs with a positive professional prospect (OR 0.34, 95% CI 0.24–0.49) were less likely to be depressed. No significant effect was observed for age over 40 years (OR 0.77, 95% CI 0.30–2.02), history of chronic diseases (OR 1.84, 95% CI 0.75–4.50), contacting with confirmed or suspected COVID-19 patients (OR 1.29, 95% CI 0.92–1.82), having a relative infected or suspected to be infected with COVID-19 (OR 1.36, 95% CI 0.94–1.97) (detail in online Supplementary Figs S1 and S2).

### Study heterogeneity and publication bias

We found low heterogeneity for marital status ($I^2 = 0\%$, $p = 0.57$), positive professional prospect ($I^2 = 0\%$, $p = 0.47$), working in isolation wards ($I^2 = 0\%$, $p = 0.60$), and insufficient personal protective equipment ($I^2 = 33\%$, $p = 0.14$). However, studies on other factors exhibited high heterogeneity (i.e. $I^2 = 55$–$88\%$, $p < 0.1$). Sensitivity analyses excluding one study at a time showed a significant reduction in heterogeneity only for frontline work status and type of HCWs (online Supplementary Fig. S3). No heterogeneity was observed if excluding the study by Awano et al. (2020) for frontline work status ($I^2 = 25\%$, $p = 0.25$), and excluding the study by Shah et al. (2021) for type of HCWs significantly reduced the heterogeneity ($I^2 = 51\%$, $p = 0.02$). Subgroup analyses indicated that the observed heterogeneity could not be attributed to study location, type of HCWs, frontline worker status, and diagnostic criteria of depression (online Supplementary Figs S4–S8). Finally, significant publication bias was detected for gender, history of mental diseases, contacting with confirmed or suspected

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| Factors | No. of studies | No. of participants | OR (95%CI) | *P* value | $I^2$ (%) |
|---|---|---|---|---|---|
| Female | 20 | 29,936 | 1.50(1.23−1.84) | <0.001 | 79% |
| Single | 7 | 14,683 | 1.36(1.21−1.54) | <0.001 | 0% |
| History of mental diseases | 9 | 10,992 | 2.53(1.78−3.58) | <0.001 | 75% |
| Frontline | 6 | 6,132 | 1.79(1.38−2.32) | <0.001 | 55% |
| Health anxiety due to COVID-19 | 6 | 6,195 | 1.88(1.29−2.76) | 0.001 | 88% |
| Working in isolation wards | 2 | 1,841 | 1.98(1.38−2.84) | <0.001 | 0% |
| Nurse | 14 | 9,121 | 1.69(1.28−2.25) | <0.001 | 72% |
| Positive professional prospect | 3 | 916 | 0.34(0.24−0.49) | <0.001 | 0% |
| Insufficient personal protective equipment | 11 | 11,101 | 1.49(1.33−1.67) | <0.001 | 33% |
| Contacting confirmed or suspected COVID−19 patient | 8 | 6,240 | 1.29(0.92−1.82) | 0.14 | 86% |
| Having a relative confirmed or suspected COVID−19 | 3 | 7,416 | 1.36(0.94−1.97) | 0.11 | 66% |
| History of chronic diseases | 4 | 1,675 | 1.84(0.75−4.50) | 0.18 | 81% |
| > 40 years | 3 | 2,102 | 0.77(0.30−2.02) | 0.60 | 83% |

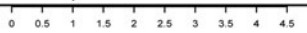


**Figure 2.** Factors associated with depression among HCWs during the COVID-19 pandemic.

COVID-19 patients, and insufficient personal protective equipment (online Supplementary Fig. S9).

## Discussion

Based on a comprehensive systematic review and meta-analysis of 35 cross-sectional studies involving 44 362 nurses, doctors, and other HCWs, the present study revealed nine factors significantly associated with depression among HCWs during the COVID-19 pandemic. The identified factors included four individual variables (i.e. female, single, history of mental diseases, and health anxiety due to COVID-19), and five occupational-related variables (i.e. nurse, frontline position, working in isolation wards, insufficient personal protective equipment, and positive professional prospect). These findings highlight the importance of early screening for HCWs at a high risk of depression and provide valuable insights for targeted prevention and intervention strategies during major crises characterized by overwhelming healthcare burdens.

Based on effect size, the top risk factor associated with depression among HCWs is a history of mental diseases (OR 2.53, 95% CI 1.78–3.58). Consistent with previous studies, individuals with a history of mental illness are susceptible to depression in stressful environments (Burcusa & Iacono, 2007). However, past meta-analyses investigating correlates of depression among HCWs during COVID-19 pandemic were unable to explore this important characteristic due to data constraints (Crocamo et al., 2021). Additionally, our findings indicate that female HCWs were 50% more likely than their male counterparts to experience depression during the COVID-19 pandemic. Epidemiological studies consistently demonstrate that women are more vulnerable to depression and other mood disorders compared to men in general population, potentially due to gender differences in the neural circuits responsible for emotion processing (Bangasser & Cuarenta, 2021). Another significant individual-level factor is marital status. Single HCWs were found to have a 36% higher risk of depression. Family and social support are essential for HCWs to cope with the psychological distress during the severe acute respiratory syndrome outbreak (Chan & Huak, 2004). A systematic review has further emphasized that lack of social support is a crucial risk factor for the development of psychological problems in HCWs during disasters (Naushad et al., 2019).

In occupational level, we show that being a nurse is 69% more likely to be depressed during the pandemic, which aligns with previous findings that nurses suffer from depression at almost twice the rate of individuals in other professions (Brandford & Reed, 2016). This could be partly explained by the uneven gender distribution within the nursing profession and the pandemic-induced work-related stress, including heightened job demands, increased workload, and greater job complexity (Galanis, Vraka, Fragkou, Bilali, & Kaitelidou, 2021). Moreover, nurses frequently serve on the frontlines, directly encountering confirmed or suspected cases of COVID-19. Previous meta-analyses examining the association between frontline worker status and depression among HCWs during the pandemic have yielded conflicting results (Crocamo et al., 2021). However, with a larger sample size and increased statistical power, our study confirms that being a frontline HCW increases the likelihood of depression by 79%. Our study also reveals that working in isolation wards and insufficient personal protective equipment are linked to a higher risk of depression. These factors can intensify health anxiety due to COVID-19, which in turn almost doubles the risk of depression among HCWs. Together, insufficient support, experiencing social isolation, and concerns about personal health all contribute to a significant emotional burden on HCWs, which can overwhelm their coping abilities (Holmes et al., 2020). Lastly, we find that a positive professional prospect is associated with a 66% reduced risk of depression among HCWs. This has been reported as a common protective factor against various mental disorders among all types of frontline HCWs during the pandemic (Osório et al., 2021).

HCWs are recognized as the most valuable resource for health, playing a viral role during times of crisis. Depression affects their physical and mental health, as well as the healthcare system and society. Hence, it is imperative for healthcare administrators and governments to prioritize the mental health of HCWs. Relying solely on HCWs to manage their own mental health during the COVID-19 pandemic is insufficient. Addressing this pervasive societal issue requires governmental policy adjustments and healthcare administrators' interventions to ensure the healthcare system's capacity to handle global public health crises (Pollock et al., 2020). Regular screening for depression among HCWs is crucial. Our findings indicate that being female, single, having a history of mental diseases, and working in frontlines or in isolation wards are associated with higher risk of depression. Furthermore, the cumulative burden of multiple risk factors should be considered. For instance, nurses working in high-risk clinical environments like isolation wards have an increased risk of burnout (Galanis et al., 2021). In times of overwhelming healthcare burdens, our findings enable more targeted and cost-effective prevention and intervention strategies for depression among HCWs. Healthcare administrators and governments should provide substantial support to HCWs, including ensuring adequate protective equipment, offering psychological support, and providing timely recognition and rewards. There measures can enhance HCWs' sense of honor, meaning, and confidence in their profession, ultimately bolstering their resilience against depression. Transparent, concise, and thoughtful communication focused on their immediate needs is essential for effective support (Adams & Walls, 2020). Moreover, it is necessary to consider the holistic well-being of HCWs, as depression is not the sole challenge they may face in high-stress environments. Factors such as fatigue and chronic stress can interact with depressive symptoms. Therefore, adopting an integrative care approach that takes into account both biological and psychological factors when treating mental health issues is beneficial in practice (Ee et al., 2020). Managers and policymakers should consider establishing interdisciplinary task forces and fostering collaboration between frontline HCWs and specialized psychiatrists to improve early recognition and referrals for mental health issues. Additionally, the integrative care model emphasizes collaboration among hospitals, families, communities, and other stakeholders, with a focus on the individual HCW, to provide personalized, comprehensive, and holistic approaches that promote the overall well-being of HCWs.

There are several limitations that should be noted. First, we observed a high degree of inconsistency across the studies for specific correlates such as gender and history of mental diseases. Although sensitivity analyses revealed that the heterogeneity for frontline worker status and type of HCWs may be attributed to single specific study, subgroup analyses found that most of the heterogeneity could not be explained by study location, type of HCWs, frontline worker status, and criteria of depression by subgroup analyses. This suggests the presence of methodological

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differences across the studies, including variations in sampling procedures, highlighting the need for further research to explore the impact of these correlates on depressive symptoms among HCWs. Second, it is important to consider cross-cultural comparisons, as healthcare system organizations vary across different countries. In our study, more than a third of eligible studies were conducted in China, which may limit the generalizability of the findings to other settings. However, we did not find significant subgroup differences based on study location. Third, all eligible studies identified in our meta-analysis were cross-sectional. Therefore, no causal inference could be made in our study. It is necessary to incorporate more longitudinal studies in future to understand the temporal effect on the association between individual factors and depression among HCWs.

## Conclusion

The present systematic review and meta-analysis provides up-to-date evidence on nine factors linked to depression among HCWs during the COVID-19 pandemic. Considering the ongoing challenges posed by COVID-19, our findings highlight the significance of early screening and offer valuable insights for targeted prevention and intervention strategies to address depression among HCWs.

**Supplementary material.** The supplementary material for this article can be found at https://doi.org/10.1017/S0033291723002271.

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