R E V I E W

The prevalence of mental health conditions in healthcare workers during and after a pandemic: Systematic review and meta-analysis

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Abstract

Aims: This review aims to explore the prevalence and incidence rates of mental health conditions in healthcare workers during and after a pandemic outbreak and which factors influence rates.

Background: Pandemics place considerable burden on care services, impacting on workers' health and their ability to deliver services. We systematically reviewed the prevalence and incidence of mental health conditions in care workers during pandemics.

Design: Systematic review and meta-analysis.

Data sources: Searches of MEDLINE, Embase, Cochrane Library and PsychINFO for cohort, cross-sectional and case–control studies were undertaken on the 31 March 2020 (from inception to 31 March 2020).

Review methods: Only prevalence or incidence rates for mental health conditions from validated tools were included. Study selection, data extraction and quality assessment were carried out by two reviewers. Meta-analyses and subgroup analyses were produced for pandemic period (pre- and post), age, country income, country, clinical setting for major depression disorder (MDD), anxiety disorder and post-traumatic stress disorder (PTSD).

Results: No studies of incidence were found. Prevalence estimates showed that the most common mental health condition was PTSD (21.7%) followed by anxiety disorder (16.1%), MDD (13.4%) and acute stress disorder (7.4%) (low risk of bias). For symptoms of these conditions there was substantial variation in the prevalence estimates for depression (95% confidence interval [CI]:31.8%; 60.5%), anxiety (95% CI:34.2%; 57.7%) and PTSD symptoms (95% CI,21.4%; 65.4%) (moderate risk of bias). Age, level of exposure and type of care professional were identified as important moderating factors.

Conclusion: Mental disorders affect healthcare workers during and after infectious disease pandemics, with higher proportions experiencing symptoms.

Impact: This review provides prevalence estimates of mental health conditions during and after a pandemic which could be used to inform service staffing impact and formulation of preventative strategies, by identifying clinical populations who may be at high risk of developing mental health symptoms and conditions.

KEYWORDS
health and social care workers, mental health, prevalence, incidence, systematic review, nursing, Covid-19, SARS, pandemic

1 | INTRODUCTION

The emergence of the Covid-19 coronavirus during 2019 and its subsequent spread worldwide have, like previous pandemics, placed a considerable burden on healthcare services and the informal care sector (Huang et al., 2020; World Health Organization, 2020c; Xiong & Peng, 2020) The challenges facing people providing care are many and varied (Krubiner et al., 2020). A highly contagious virus, Covid-19 has spread rapidly between and in countries, offering little opportunity for healthcare services to prepare appropriately (Hamid et al., 2020). As the need and demand for healthcare has risen due to the pandemic, the pressures placed on those providing care have grown markedly (Khera et al., 2020; Minder & Peltier, 2020; World Health Organization, 2020c).

2 | BACKGROUND

Healthcare workers have faced: increased workloads and responsibility; redeployment away from their specialisms; a changing work environment associated with infection control (e.g. protective clothing); emotional consequences of caring for those people with, and dying from, Covid-19 and for their families; the likelihood that they are at increased risk of acquiring the infection themselves from close contact with those already infected; and, personal impact of their own family becoming infected or dying (Schoonhoven et al., 2020). It is almost inevitable that the situation faced by healthcare workers puts them at risk of suffering from stress and associated psychological problems, both in the short and long term (Adams & Walls, 2020; Minder & Peltier, 2020; Xiong & Peng, 2020). These may include trauma/emotional events, sleep deprivation, fatigue, anxiety disorders and depression (Schoonhoven et al., 2020). Recognizing the nature and extent of the effects of pandemics on the mental health of healthcare workers is important, not only for the individual themselves, but also for the continued delivery of services (Xiong & Peng, 2020). It allows service providers to develop plans to prevent and/or manage mental health conditions among staff during and following pandemics.

Although systematic and rapid reviews have assessed the prevalence of psychological problems associated with different pandemics (Pappa et al., 2020; Ricci Cabello et al., 2020; Thapa et al., 2020), they have certain shortcomings. Several focus on specific pandemics and exclude more recent evidence (Pappa et al., 2020; Thapa et al., 2020).

Another has used a broad range of criteria for diagnosing mental health conditions, lacking valid and reliable clinical thresholds that may result in inconsistency (Ricci Cabello et al., 2020). Given these limitations, we conducted a systematic review and meta-analysis of the incidence and prevalence of mental health conditions among healthcare workers associated with infectious disease pandemics. In doing so, we focused on studies using recognized diagnostic criteria for the different mental health conditions and considered the important mediating factors that may influence the occurrence of mental health conditions.

3 | THE REVIEW

3.1 | Research question

Our systematic review addressed two questions. First, what is the prevalence and incidence of mental health conditions in healthcare workers during and after pandemic outbreaks? Second, which factors have an influence on prevalence and incidence rates?'

3.2 | Design

Our systematic review adhered to recognized guidance and is reported in accordance with the PRISMA standards (Moher et al., 2015), with its methods outlined in a research protocol registered with PROSPERO (Registration number: CRD42020181947).

3.3 | Search methods

We undertook a multi-database search on MEDLINE, Embase, The Cochrane Library (Cochrane Database of Systematic Reviews) and PsycINFO bibliographic databases on the 31st of March 2020 (from inception to 31 March 2020). The search used terms identified by the review team and a search filter for prevalence studies adapted from Larney et al., 2013 (Larney et al., 2013) (see Appendix 1 for the full MEDLINE search strategy). Additional studies were identified through screening of all included studies reference lists and identified systematic reviews, alongside opportunistic searching of the literature.

3.4 | Study selection

We included cohort studies, cross-sectional studies (prevalence only) and case–control studies which used a target population of health-care workers (i.e. nurses, doctors, allied health workers, GPs, other primary care workers, social workers, pharmacists, midwives, health visitors, mental health workers, psychological professionals, psychiatrists, surgeons, paramedics, students) who had experienced a pandemic outbreak in any clinical setting. A pandemic was defined as 'an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people' (e.g. Severe Acute Respiratory Syndrome (SARS), Coronavirus disease 2019 (Covid-19), Ebola, Middle East Respiratory Syndrome (MERS)) ([Porta, 2014], p.179). Differentiation of the pandemic periods (before and after) was defined using the World Health Organization and Center for Disease Control and Prevention classifications of specific pandemic periods (Center for Disease Control and Prevention, 2019; World Health Organization, 2011, 2016, 2020a, 2020b).

The primary outcome for the review was either the prevalence or incidence of mental health conditions or the reporting of symptoms of mental health conditions during and after the pandemic. Included studies needed to report a prevalence and/or incidence rate of a psychological condition using cut-off points on a diagnostic scale or a clinical diagnosis (undertaken through clinical interview). For the incidence and prevalence of major depression, anxiety disorders, post-traumatic stress disorder (PTSD), acute stress disorder and psychological distress (see Table 1 study characteristics for full list of validated tools), only studies which were judged to use a valid and reliable data collection tool, based on the Hoy assessment of bias criteria, were included in the meta-analysis (Hoy et al., 2012). This was based on the tool used having a cut-off threshold which achieved both a sensitivity and specificity above 0.8, test–retest reliability above 0.6 (i.e. rated good) and the values having external validity in terms of the target population (Fleiss, 1986). In studies which reported multiple cut-off points on a scale, the cut-off point which has been shown to have the greatest diagnostic accuracy was used (Coffey et al., 2006; Dunstan et al., 2017; Foa & Tolin, 2000; Guest et al., 2018; Kim et al., 2019; Kroenke et al., 2001; Lowe et al., 2008; Matza et al., 2010; Mossman et al., 2017; Park, 2012; Spitzer et al., 2006; Yohannes et al., 2019; Zimmerman et al., 2013). For anxiety disorders the cut-off point included both clinically relevant cut-off points and a specific diagnosis of general anxiety disorder made by a clinician (Bergua et al., 2016; Birmaher et al., 1999; Dunstan & Scott, 2020; Spitzer et al., 2006; Tran et al., 2013). In contrast, no specific inclusion criteria were set to judge the reliability and validity of the tools used to assess the prevalence of symptoms of these conditions. Instead, this was defined by the author of the paper. Included studies needed to be published in English.

3.5 | Data extraction and quality appraisal

Using predefined selection criteria, four reviewers in groups of two independently screened titles and abstracts (J.H., C.H., D.C., P.B.).

Full paper screening, data extraction and risk of bias assessment were undertaken by a single reviewer and verified by a second reviewer (J.H., C.H., D.C., P.B.). Any disagreement during screening, data extraction and risk of bias assessment were resolved by discussion; if consensus could not be achieved arbitration was carried out by a third reviewer (A.C.). At each stage, we used pre-piloted processes and forms or tools. The data items which were extracted were pandemic, country, city, staff type, mean age, proportion of females, clinical setting, study type, control group (where applicable), point of observation (day/month/year) and duration of observation (weeks). Countries of study location were coded into high income, upper-middle income, lower-middle income and low-income countries (The World Bank, 2020). Risk of bias assessment used an adapted Hoy quality assessment checklist for prevalence studies (Hoy et al., 2012) and planned to use an adapted Shamliyan checklist for incidence studies (Shamliyan et al., 2011). The adapted Hoy quality assessment checklist provides a total score (total number of criteria achieved) for each study and a mean quality score (number of studies in the analysis divided by total score of all studies included in the analysis) for all included studies or for studies included in specific sub-group analyses. In contrast the adapted Shamliyan checklist provides an assessment of quality for each component considered important (see Table 1 study characteristics for a full list of included studies). No studies were excluded based on their level of bias.

3.6 | Synthesis

We meta-analysed the prevalence of the different mental health conditions for both our research questions, presenting overall estimates and 95% confidence intervals. Random effects models were estimated (DerSimonian-Laird) due to the likelihood of substantial heterogeneity (DerSimonian & Laird, 1986). In subgroup analyses where there were only two studies assessing the factors affecting prevalence, we used fixed-effect models, as the number of parameters to be estimated exceeded the number of observations. All studies reported mental health conditions and symptoms as a dichotomous variable (presence/absence). The heterogeneity of pooled estimates collected from the studies was assessed using the I-squared statistic (I^2) (Higgins, 2021). To pool data, we used the jamovi software, employing the Project R Metafor package (R Core Team, 2018; The jamovi project, 2019; Viechtbauer, 2010). A descriptive analysis was undertaken of possible statistically significant ($p < .05$) moderators/confounding factors reported in two or more studies on the prevalence or incidence of mental health conditions or symptoms.

The subgroup analyses pre-identified in our registered protocol were performed to address our second research question, which assessed the factors that may influence prevalence rates. These factors, which were identified from previous systematic reviews, were: pandemic period (pre- and post-); age; country income; country; and, clinical setting for major depression disorder (MDD), anxiety disorders and PTSD (Pappa et al., 2020; Ricci Cabello et al., 2020; Thapa et al., 2020). We did not carry out a subgroup analysis for

TABLE 1 Study characteristics

Author name	Pandemic	Country	Country income	Types of staff	Age (ran-ge)	Female (%)	Setting	Study type	During/after pande-mic	Assessment tools	Response rate
Al-Rabiaah et al. (2020) (48)	MERS	Saudi Arabia	High	Students	20–29	40%	University	Cross-sectional	During	Generalized Anxiety Disorder Assessment (GAD-7)	174/200 (87%)
Alsahafi and Cheng (2016) (49)	MERS	Saudi Arabia	High	MDT	NR	43%	Primary, secondary	Cross-sectional	After	Author designed questionnaire	1216/1500 (81%)
Bai et al. (2004) (50)	SARS	Taiwan	High	MDT	30–39	51%	Secondary	Cross-sectional	During	Author designed questionnaire	338/557 (61%)
Chan and Huak (2004) (51)	SARS	Singapore	High	MDT	NR	NR	Secondary	Cross-sectional	During	General Health Questionnaire-28 (GHQ-28), Impact of Event scale (IES)	661/993 (67%)
Chen et al. (2005) (52)	SARS	Taiwan	High	Nurses	20–29	100%	Secondary	Cross-sectional	During	Impact of Event Scale (IES), Symptoms Checklist 90-items-Revised (SCL-90-R)	128/184 (70%)
Chong et al. (2004) (53)	SARS	Taiwan	High	MDT	30–39	81%	Tertiary	Cross-sectional	During	Impact of Event Scale (IES), Chinese Health Questionnaire (CHQ)	1310/2500 (52%)
Chua et al. (2004) (54)	SARS	Hong Kong	High	MDT	NR	NR	Secondary	Case control	During	Perceived Stress Scale (PSS)	613/766 (80%)
Goulia et al. (2010) (55)	A/H1N1 influenza	Greece	High	MDT	30–39	68%	Secondary, tertiary	Cross-sectional	During	Author designed questionnaire, General Health Questionnaire-28 (GHQ-28)	469/1000 (47%)
Grace et al. (2005) (56)	SARS	Canada	High	MDT	40–49	32%	Secondary	Cross-sectional	During	Author designed questionnaire	193/554 (35%)
Huang et al. (2020) (57)	Covid-19	China	Upper middle	MDT	NR	NR	Secondary	Cohort	During	Self-rating Anxiety Scale (SAS), Post-Traumatic Stress Disorder Self-rating Scale (PTSD-SS)	230/246 (93%)
Ji et al. (2017) (58)	Ebola	Sierra Leone	Low	MDT and Medical Students	30–39	50%	Secondary	Cross-sectional	During	Symptoms Checklist 90-items-Revised (SCL-90-R)	NR
Jung et al. (2020) (59)	MERS	South Korea	High	Nurses	NR	100%	Secondary	Cross-sectional	During	Impact of Event Scale–Revised Korean version (IES-R-K)	147/300 (49%)
Koh et al. (2005) (60)	SARS	Singapore	High	MDT	30–39	82%	Primary, secondary	Cross-sectional	During	Author designed questionnaire, Impact of Event Scale (IES)	10,511/15025 (70%)
Lai et al. (2020) (61)	Covid-19	China	Upper middle	MDT	30–39	77%	Secondary, tertiary	Cross-sectional	During	9-item Patient Health Questionnaire (PHQ-9) for depression, 7-item Generalized Anxiety Disorder (GAD-7) scale, 7-item Insomnia Severity Index (ISI), 22-item Impact of Event Scale–Revised (IES-R)	1257/1830 (69%)

TABLE 1 Continued

Author name	Pandemic	Country	Country income	Types of staff	Age (ran-ge)	Female (%)	Setting	Study type	During/after pande-mic	Assessment tools	Response rate
Lance et al. (2008) (62)	SARS	Canada	High	MDT	40–49	87%	Secondary	Cross-sectional	After	Clinician-Administered PTSD Scale (CAPS), Structured Clinical Interview for DSM-IV (SCID interview)	139/587 (24%)
Lee et al. (2005) (63)	SARS	Taiwan	High	Nurses	20–29	100%	Tertiary	Cross-sectional	During	Author designed questionnaire	NR
Lee et al. (2018) (64)	MERS	South Korea	High	MDT	30–39	82%	Secondary	Cross-sectional	During	Impact of Event Scale–Revised Korean version (IES-R-K)	359/1800 (20%)
Li and Zhang (2005) (65)	SARS	China	Upper middle	Nurses	20–29	93%	University	Cross-sectional	During	The crisis response questionnaire, Self-rating Anxiety Scale (SAS)	299/305 (98%)
Lin et al. (2007) (66)	SARS	Taiwan	High	MDT	30–39	91%	Secondary	Cross-sectional	After	Davidson Trauma Scale-Chinese version (DTS-C), Chinese Health Questionnaire-12 (CHQ-12)	DTS-C: 83/92 (90%) CHQ-12: 90/92 (98%)
Liu et al. (2012) (67)	SARS	China	Upper middle	MDT	NR	NR	Secondary	Cross-sectional	After	Center for Epidemiologic Studies Depression Scale (CES-D)	549/661 (83%)
Loh et al. (2006) (68)	SARS	Malaysia	Upper middle	Students	20–29	60%	University	Cross-sectional	During	Author designed questionnaire	204/220 (93%)
Lu et al. (2006) (70)	SARS	Taiwan	High	MDT	30–39	58%	Secondary	Cross-sectional	After	Chinese Health Questionnaire (CHQ)	127/135 (94%)
Lu et al. (2020) (69)	Covid-19	China	Upper middle	MDT	30–39	78%	Secondary	Cross-sectional	During	Hamilton Anxiety Scale (HAMA), Hamilton Depression Scale (HAMD)	2299/2423 (95%)
Lung et al. (2009) (10)	SARS	Taiwan	High	MDT	30–39	58%	Secondary	Cross-sectional	After	Chinese Health Questionnaire (CHQ)	123/127 (97%)
Maunder et al. (2006) (71)	SARS	Canada	High	MDT	NR	87%	Secondary	Case control	After	Impact of Event Scale (IES), Kessler Psychological Distress Scale, Maslach Burnout Inventory	769/1984 (39%) survey A, 187/1984 (9%) survey B
Nickell et al. (2004) (72)	SARS	Canada	High	MDT	40–49	79%	Secondary	Cross-sectional	During	General Health Questionnaire-12 (GHQ-12)	2001/4283 (47%) (510 respondents for the GHQ-12)
Phua et al. (2005) (73, 89)	SARS	Singapore	High	MDT	30–39	76%	Secondary	Cross-sectional	After	Coping Orientation to Problems Experienced (COPE) Impact of Events Scale (IES), General Health Questionnaire (GHQ 28)	96/124 (77%)
Reynolds et al. (2008) (74)	SARS	Canada	High	MDT	NR	84%	NR	Case control	During	Impact of Event Scale–Revised Korean version (IES-R-K)	1057/1912 (55%)

TABLE 1 Continued

Author name	Pandemic	Country	Country income	Types of staff	Age (ran-ge)	Female (%)	Setting	Study type	During/after pande-mic	Assessment tools	Response rate
Sim et al. (2004) (75)	SARS	China	Upper middle	MDT	30–39	85%	Primary, secondary	Cross-sectional	After	General Health Questionnaire-28 (GHQ-28)	277/301 (92%)
Styra et al. (2008) (76)	SARS	Canada	High	MDT	30–39	86%	Secondary	Cross-sectional	After	Impact of Event Scale-Revised (IES-R)	248 /604 (41%)
Su et al. (2007) (77)	SARS	China	Upper middle	Nurse	20–29	100%	Secondary	Cohort	During	Beck depression inventory (BDI), Spielberger Trait Anxiety Inventory (STAI), Davidson trauma scale–Chinese version (DTS-C), Pittsburgh Sleep Quality Index (PSQI)	NR
Tam et al. (2004) (78)	SARS	Hong Kong	High	MDT	30–39	79%	Secondary	Cross-sectional	During	Author designed questionnaire, Chinese Health Questionnaire-12 (CHQ-12)	652/1621 (40%)
Tan et al. (2020) (79)	Covid-19	China	Upper middle	MDT	30–39	68%	Tertiary	Case control	During	Depression, Anxiety, and Stress Scales (DASS-21), Impact of Events Scale–Revised (IES-R)	470/500 (94%)
Tang (2005) (80)	SARS	Guangxi Province, China	Upper middle	Students	NR	100%	University	Cross-sectional	During	Self-rating Depression Scale (SDS), Self-rating Anxiety Scale (SAS)	121/128 (95%)
Tolomiczenko et al. (2005) (81)	SARS	Canada	High	MDT	40–49	74%	Secondary	Cross-sectional	During	Author designed questionnaire	300/1100 (27%)
Verma et al. (2004) (82)	SARS	Singapore	High	MDT	40–49	40%	Secondary	Cross-sectional	During	General Health Questionnaire-28 (GHQ-28), Impact of Event Scale-Revised (IES-R), perception of stigma scale adapted from HIV Stigma Scale by authors	GPs 721/2500 (29%), Traditional Chinese Medicine Practitioners 329/1500 (22%)
Vinck et al. (2011) (83)	A/H1N1 influenza	Netherlands	High	MDT	40–49	66%	Secondary	Cross-sectional	During	Author designed scale	166/302 (55%)
Wong et al. (2007) (84)	SARS	Hong Kong and Canada	High	MDT	NR	15%	Primary	Cross-sectional	During	Author designed questionnaire	188/333 (56%)
Wu et al. (2008) (11, 106)	SARS	China	Upper middle	MDT	40–49	76%	Secondary	Cross-sectional	After	Center for Epidemiologic Studies Depression Scale (CES-D)	549/662 (83%)
Xu et al. (2020) (85)	Covid-19	China	Upper middle	MDT	30–39	63%	Secondary	Cross-sectional	During	Anxiety scale, Depression score, Dream anxiety score, Short Form (36) Health Survey (SF-36 scale)	NR

TABLE 1 Continued

Author name	Pandemic	Country	Country income	Types of staff	Age (range)	Female (%)	Setting	Study type	During/after pandemic	Assessment tools	Response rate
Xuehua et al. (2003) (86)	SARS	China	Upper middle	Nurses	NR	NR	Secondary	Case control	During	Beck Depression Scale (BDI), State and Trait Anxiety Inventory (STAI), Symptoms Checklist 90-items (SCL-90)	NR
Zhang et al. (2005) (88)	SARS	China	Upper middle	MDT	NR	NR	Secondary	Case control	After	Author designed questionnaire, Impact of Event Scale-Revised (IES-R), Perceived Social Support Scale (PSSS), Simple Coping Style Questionnaire (SCSQ), Self-Esteem Scale (SES), Eysenck Personality Questionnaire (EPQ)	NR
Zhang et al. (2020) (87)	Covid-19	China	Upper middle	MDT	30–39	83%	Secondary	Cross-sectional	During	Insomnia Severity Index (ISI), Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder scale (GAD), Impact of Events Scale-Revised (IES-R)	NR

Abbreviations: A/H1N1, influenza A virus subtype H1N1; Covid-19, Coronavirus disease 2019; GPs, general practitioners; MDT, multidisciplinary team; MERS, Middle East respiratory syndrome coronavirus; NR, not reported; SARS, severe acute respiratory syndrome.

psychological distress due to the low number of studies and the wide variation in moderating factors. Differences between groups were identified by visual inspection of the 95% confidence intervals estimated for each sub-group. Meta-analyses of symptom prevalence only included studies that reported different levels of severity for the mental health conditions. Where the study used a specific tool (e.g. Beck depression inventory) and did not report any other measurement except the clinical cut-off point for diagnosis, the studies were not included in the meta-analyses of symptom prevalence. As by including a higher clinical cut-off point for diagnosis of prevalence rates only, would result in underrepresentation of healthcare professionals presenting with symptoms.

4 | RESULTS

4.1 | Search outcomes

The initial systematic search found 2007 citations after removal of duplicates. Abstract and title screening identified 65 papers for which manuscripts were retrieved. Through screening of reference lists and opportunistic searching an additional 20 papers were identified and manuscripts obtained, giving a total of 85 papers for full paper screening. Overall a total of 43 studies reported in 45 papers were eligible to be included in this review. No studies reported 'incidence rates' for any mental health condition or symptom.

See Figure 1 for PRISMA flow diagram.

4.2 | Study characteristics

The number of participants in the included studies varied, ranging from 26 to 10,511. Across the included studies five different pandemics were studied with the most studies examining SARS ($n = 30$); Covid-19 ($n = 6$); Influenza A subtype H1N1 (H1N1) ($n = 2$) and Ebola ($n = 1$). The majority of these studies ($n = 27$) took place in high-income countries, specifically Taiwan ($n = 7$), Canada ($n = 7$), Singapore ($n = 4$), Hong Kong ($n = 2$), both Hong Kong and Canada ($n = 1$), Saudi Arabia ($n = 2$), South Korea ($n = 2$), Greece ($n = 1$) and the Netherlands ($n = 1$). The remaining 16 studies took place in low to upper-middle income countries. These were China ($n = 14$), Sierra Leone ($n = 1$) and Malaysia ($n = 1$).

The majority of studies used a cross-sectional design ($n = 35$) and the remaining eight used either a case–control ($n = 6$) or cohort study ($n = 2$) design (see Table 1 for characteristics full of included studies).

4.3 | Risk of bias

Using the Hoy quality assessment checklist (Hoy et al., 2012), the overall risk of bias of the included studies was judged to be of moderate risk (mean score 3.5), in that the studies were
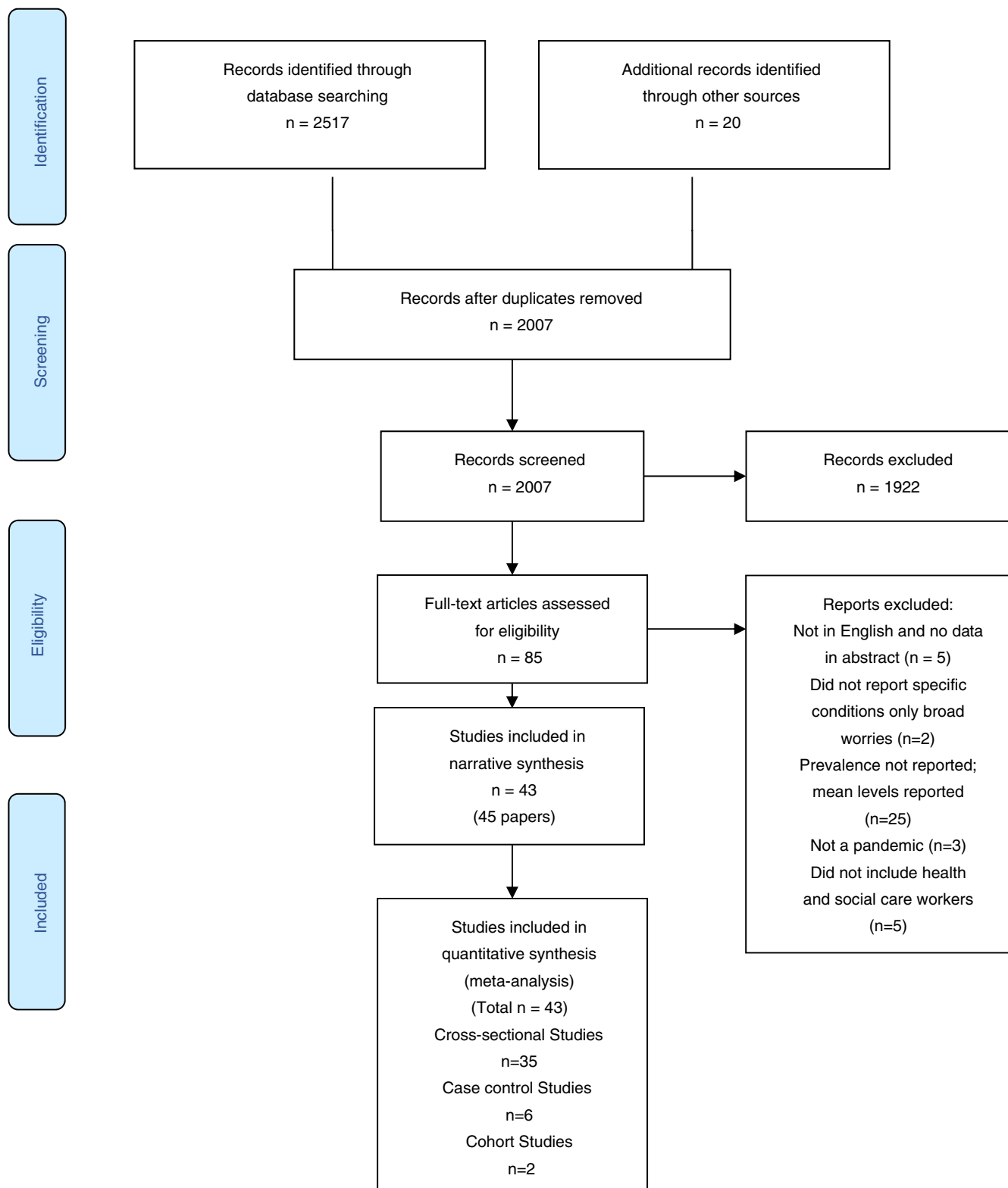
FIGURE 1 PRISMA flow diagram

susceptible to some bias but not enough to invalidate the results (see Table 2 for full list of assessment of bias criteria and corresponding studies Table 3). The most common risk of bias was that the target population was not representative of the national population in relation to relevant variables (*n* = 40). In the majority

of cases this was due to the target population being poorly reported, with 21 studies deemed not to have a true or close representation of the target population. The other two main areas for risk of bias were the lack of random sampling (*n* = 37) and/or response rate of <75% (*n* = 24).

4.4 | Prevalence

The prevalence of four main mental health conditions were reported (including clinically diagnosed and reported symptoms) (see Table 4 and Figures 2–9 for prevalence estimates and corresponding forest plots), specifically PTSD (10 studies; n = 2729), anxiety disorders (eight studies; n = 6003), MDD (seven studies; n = 5747) and acute stress disorder (three studies; n = 582). Also, we report on the prevalence of psychological distress (six studies, n = 2662), which provides an indication of possible clinically diagnosed issues related to MDD and anxiety disorders classified through GHQ-28 (De Almeida Vieira Monteiro, 2011; Lobo et al., 1986). In interpreting the results presented, it should be noted that all comparisons and sub-group analyses were affected by substantial heterogeneity (I^2 range: 51.5%–99.6%).

4.5 | Post-traumatic stress disorder

PTSD was the most commonly reported diagnosed psychological health condition with an overall pooled estimate for prevalence of 21.7% (95% CI: 13.3%, 30.0%). A greater proportion reported symptoms that were diagnosed with PTSD, with an estimated prevalence of symptoms of 43.4% (95% CI: 21.4%, 65.4%). Although PTSD was more prevalent during the pandemic (25.8%; 95% CI: 10.6%, 41%) than afterwards (17%; 95% CI: 8.0%, 26.1%), there was substantial overlap of the 95% confidence intervals. There was no strong evidence of a difference between the prevalence during the MERS pandemic (38.9%; 95% CI: 21.5%, 56.3%) than that during SARS (15.9%; 95% CI: 8.1%, 23.7%) or Covid-19 (5.7%; 95% CI: not estimable) pandemics.

Variations were evident in the prevalence of PTSD between countries which may, in part, reflect the effects of the different pandemics. The highest prevalence of PTSD was in South Korea (38.9%), followed by Taiwan (19.3%), Singapore (19%), China (7.7%) and Canada (6.1%). The effects of other factors on prevalence were less clear. All studies were in either high- (n = 7, prevalence 23%) or upper-middle income countries (n = 2, 7.6%). All studies were in the secondary care setting (23.6%), except one in tertiary care (5.7%). PTSD appeared more prevalent in staff aged 20–29 (28.4%) and 30–39 (26.7%) years, although there were limited studies conducted among other age groups or studies did not report age. Only one statistically significant moderating factor of level of exposure was identified in two or more studies, with highly exposed healthcare workers being associated with increased prevalence of PTSD symptoms compared with healthcare workers who were less exposed (defined by geographical location or place of work) (Jung et al., 2020; Reynolds et al., 2008; Wu et al., 2008).

4.6 | Anxiety disorders

The combined prevalence estimate for anxiety disorders among healthcare workers was 16.1% (95% CI: 10.9%, 21.2%), with an estimated prevalence for anxiety symptoms of 45.9% (95% CI: 34.2%, 57.7%). No study examined the prevalence of anxiety after the pandemic period. The pooled prevalence estimate for anxiety disorders was similar for SARS (14.8%; 95% CI: 11.7%, 18.0%) and Covid-19 (18.0%; 95% CI: 12.1%, 23.9%) pandemics, with only one study of MERS reporting a lower prevalence (5.8%; 95% CI: not estimable). All except one of the studies were conducted in China, an upper-middle income country, having an estimated pooled prevalence for SARS and Covid-19 pandemics of 17.7% (95% CI: 12.9%, 22.6%) and one study of MERS in Saudi Arabia reporting a prevalence of 5.8% (95% CI: not estimable). Although there was variation in the prevalence of anxiety disorders by clinical setting and age of population, there were limited studies in the subgroups. Anxiety disorders were most prevalent among those aged 30–39 years (18.2%) and in secondary care settings (20%). The statistically significant moderating factors which were identified in two or more studies were exposure level (healthcare workers working in highly exposed areas of practice or geographical region) (Huang et al., 2020; Lai et al., 2020; Lu et al., 2020; Tan et al., 2020), gender (Huang et al., 2020; Lai et al., 2020) and healthcare worker type (Huang et al., 2020; Lai et al., 2020). Females, nurses and higher exposed healthcare workers (healthcare workers who are more likely to come in contact with patients with the disease) were associated with increased prevalence of anxiety disorders.

4.7 | Major depression disorder (MDD)

Some 13.4% (95% CI: 9.8%, 16.9%) of healthcare workers were reported to have MDD in pooled estimates from studies of SARS and Covid-19 pandemics. Depressive symptoms were more prevalent (46.2%; 95% CI: 31.8, 60.5%). The pooled prevalence of MDD was significantly higher during the pandemic (16.1%; 95% CI: 12.9%, 19.2%) than after (7%; 95% CI: 5.1%, 8.9%). There was limited variation in the estimated prevalence for the different pandemics (SARS 13%; Covid-19 14.6%) or clinical settings (secondary 13.3%; secondary and tertiary 14.8%). Although there were differences in prevalence between age groups and the countries affected, these may reflect the limited evidence available. There were signs that age and country of location may be important moderating factors, but there were limited studies in both comparisons. The other statistically significant moderating factor which was identified in two or more studies was exposure rates, with higher exposed healthcare (defined by geographical location or place of work) workers being associated with increased prevalence of MDD (Lai et al., 2020; Liu et al., 2012; Su et al., 2007).

4.8 | Acute stress disorder and psychological distress

The least common mental health condition was acute stress disorder, where the estimated prevalence was 7.4% (95% CI: 4.3%, 10.6%). No study reported a statistically significant moderator for prevalence of acute stress for healthcare workers. The prevalence of psychological distress (using GHQ-28) was estimated at 25.5% (95% CI: 10.1%, 40.9%).

TABLE 2 Risk of bias—Part 1

		Al-Rabiaah et al. (2020) (48)	Alsahafi and Cheng (2016) (49)	Bai et al. (2004) (50)	Chan and Huak (2004) (51)	Chen et al. (2005) (52)	Chong et al. (2004) (53)	Chua et al. (2004) (54)	Goulia et al. (2010) (55)	Grace et al. (2005) (56)	Huang et al. (2020) (57)
QUALITY ASSESSMENT (further guidance available here: https://ars.els-cdn.com/content/image/1-s2.0-S0895435612000790-mmc1.pdf)											
Was the study's target population a close representation of the national population in relation to relevant variables, e.g. age, sex, occupation?											
Yes	0										
No or NR	1	1	1	1	1	1	1	1	1	1	1
Was the sample a true or close representation of the target population?											
Yes	0	0		0	0	0	0			0	
No or NR	1		1					1	1		1
Was some form of random selection used to select the sample or, was a census undertaken?											
Yes	0	0									
No or NR	1		1	1	1	1	1	1	1	1	1
Was the response rate for the study ≥75% (or a sub-analysis was performed that showed no difference in characteristics between responders and non-responders)											
Yes	0	0	0					0			0
No or NR	1			1	1	1	1		1	1	
Were data collected directly from the subjects (as opposed to a proxy-a representative person)?											
Yes	0	0	0	0	0	0	0	0	0	0	0
No or NR	1										
Was an acceptable case definition used in the study?											
Yes	0	0			0	0			0		0
No or NR	1		1	1			1	1		1	
Was the study instrument that measured prevalence/incidence shown to have reliability and validity (if necessary)?											
Yes	0	0			0	0	0	0	0		0
No or NR	1		1	1						1	
Was the same mode of data collection used for all subjects?											
Yes	0	0	0	0	0	0	0	0	0	0	0
No or NR	1										
Was the length of the shortest prevalence/incidence period appropriate?											
Yes	0	0	0	0			0	0	0		0
No or NR	1				1	1				1	
Were the numerator(s) and denominator(s) for prevalence/incidence appropriate?											
Yes	0	0	0	0	0	0		0	0	0	0
No or NR	1						1				
Summary on the overall risk of study bias											
LOW RISK 0–3	L	1									3
MODERATE RISK 4–7	M		5	5	4	4	5	4	4	6	
HIGH RISK 8–10	H										

5 | DISCUSSION

The occurrence of Covid-19 and the ensuing global pandemic have had a significant effect on societies, placing considerable pressures on healthcare services and their staff (Adams & Walls, 2020; Minder & Peltier, 2020; World Health Organization, 2020c; Xiong & Peng, 2020). Despite advanced planning, healthcare workers have to deal with the realities of managing pandemics where considerable uncertainties remain (Schoonhoven et al., 2020). With healthcare services already overextended, any increase in workload and changes in responsibility places additional demands on staff (Robertson et al., 2017; Watkins et al., 2017). The uncertainties associated with a new virus, the risk of staff being infected, a changing and challenging work environment, possible personal impact of

Ji et al. (2017) (58)	Jung et al. (2020) (59)	Koh et al. (2005) (60)	Lai et al. (2020) (61)	Lancee et al. (2008) (62)	Lee et al. (2005) (63)	Lee et al. (2018) (64)	Li and Zhang (2005) (65)	Lin et al. (2007) (66)	Liu et al. (2012) (67)	Loh et al. (2006) (68)	Lu et al. (2020) (69)
1	1	1	0	1	1	1	1	1	1	1	1
1	0	1	0	0	1	0	1	0	0	1	0
1	1	1	0	1	1	1	1	1	0	1	1
0	1	1	0	1	1	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0
3	3	4	0	4	5	3	3	2	1	4	2

the virus and the concerns associated with caring for patients and their families, all place an additional strain on staff (Ricci-Cabello et al., 2020; Schoonhoven et al., 2020). The reliance placed on healthcare workers necessitates that healthcare services take responsibility for preventing and managing the effects on the physical and mental health of staff (Spoorthy et al., 2020). Understanding the likelihood that staff will experience physical and mental health conditions provides an important initial step in developing and implementing services to manage their short- and long-term effects.

Our systematic review identified and assessed the evidence on the incidence and prevalence of mental health conditions among healthcare workers during and after infectious disease pandemics. Importantly, our estimates are based on studies using only valid and reliable diagnostic criteria to improve accuracy. Although no

TABLE 3 Risk of bias—Part 2

	Lu et al. (2006) (70)	Lung et al. (2009) (10)	Maunder et al. (2006) (71)	Nickell et al. (2004) (72)	Phua et al. (2005) (73)	Reynolds et al. (2008) (74)	Sim et al. (2004) (75)	Styra et al. (2008) (76)	Su et al. (2007) (77)	Tam et al. (2004) (78)
QUALITY ASSESSMENT (further guidance available here: https://ars.els-cdn.com/content/image/1-s2.0-S0895435612000790-mmc1.pdf)										
Was the study's target population a close representation of the national population in relation to relevant variables, e.g. age, sex, occupation?										
Yes	0		0	0						
No or NR		1			1	1	1	1	1	1
Was the sample a true or close representation of the target population?										
Yes	0	0	0	0			0	0		
No or NR					1	1			1	1
Was some form of random selection used to select the sample or, was a census undertaken?										
Yes	0		0							
No or NR		1		1	1	1	1	1	1	1
Was the response rate for the study ≥75% (or a sub-analysis was performed that showed no difference in characteristics between responders and non-responders)										
Yes	0	0	0		0		0	0		
No or NR				1		1			1	1
Were data collected directly from the subjects (as opposed to a proxy-a representative person)?										
Yes		0	0	0	0	0	0	0	0	0
No or NR	1									
Was an acceptable case definition used in the study?										
Yes	0			0	0	0		0	0	0
No or NR		1	1				1			
Was the study instrument that measured prevalence/incidence shown to have reliability and validity (if necessary)?										
Yes	0	0	0	0	0	0			0	
No or NR							1	1		1
Was the same mode of data collection used for all subjects?										
Yes		0	0	0	0	0	0	0	0	0
No or NR	1									
Was the length of the shortest prevalence/incidence period appropriate?										
Yes		0	0	0	0	0	0	0	0	0
No or NR	1									
Were the numerator(s) and denominator(s) for prevalence/incidence appropriate?										
Yes		0	0	0	0	0	0	0	0	0
No or NR	1									
Summary on the overall risk of study bias										
LOW RISK 0–3	L	3	1	2	3			3		
MODERATE RISK 4–7	M 4					4	4		4	5
HIGH RISK 8–10	H									

studies were identified that looked at incidence, 43 studies reported the prevalence of mental health conditions in healthcare workers from infectious disease pandemics. When pooled through meta-analyses, we found that PTSD (21.7%), anxiety disorders (16.1%), MDD (13.4%) and acute stress disorder (7.4%) were frequently reported. These prevalence rates were not unusual. Previous reviews have reported comparable rates for anxiety disorders and MDD among healthcare workers during earlier phases of the current Covid-19 pandemic (Pappa et al., 2020). We identified that prevalence rates for anxiety and MDD during the Covid-19 pandemic were similar to those in the SARS pandemic. The lower prevalence of PTSD during the Covid-19 than the MERS and SARS pandemics

Tan et al. (2020) (79)	Tang (2005) (80)	Tolomiczenko et al. (2005) (81)	Verma et al. (2004) (82)	Vinck et al. (2011) (83)	Wong et al. (2007) (84)	Wu et al. (2008) (11)	Xu et al. (2020) (85)	Xuehua et al. (2003) (86)	Zhang et al. (2005) (87)	Zhang et al. (2020) (88)
1	1	1	1	1	1	1	1	1	1	1
0	1	0	1	0	1	1	1	1	1	0
1	0	1	1	1		0	1	1	1	1
0	0	1	1	0	1	0	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	1	0	0	0
0	0	1	0	1	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	1	0	0
0	0	0	0	0	0	0	0	0	1	0
2	2	4	4	4	6	3	6	5	5	3

may reflect that it is too early in the current pandemic for its effects to be felt. Importantly diagnosis of PTSD should only occur after 1 month of clinically significant symptoms, which may present in different clusters at differing points (National Health Service, 2020). It is evident that the effects on healthcare workers health extends beyond the pandemic itself (Ricci-Cabello et al., 2020), with PTSD

(17%) and MDD (7%) particularly prevalent. Symptoms of depression (95% CI: 31.8%; 60.5%), anxiety (95% CI: 34.2%; 57.7%) and PTSD (95% CI: 21.4%; 65.4%) were more prevalent than the diagnosed condition. Although these differences may reflect the varied nature of the diagnostic tools used and the uncertainty about their reliability and validity, surveys have found similarly high levels of

**TABLE 4** Prevalence of psychological disorder and symptoms

| Psychological condition/symptoms | Participants (n) | Prevalence | | | Heterogeneity statistics | | | |
| | | Estimate | 95% confidence interval | | I^2 | Number of studies | Q test p value | Risk of bias |
			Lower limit	Upper limit				
PTSD (combined after/before pandemic)	2729	21.7%	13.3%	30.0%	97.9%	10	<.001	2.8 (low)
During the pandemic	1565	25.8%	10.6%	41.0%	98.4%	5	<.001	3.4 (moderate)
After the pandemic	1164	17%	8.0%	26.1%	96.1%	5	<.001	2.6 (low)
MERS	583	38.9%	21.5%	56.3%	94.1%	3	<.001	2.7 (low)
SARS	1850	15.9%	8.1%	23.7%	96.4%	6	<.001	3 (moderate)
Covid 19	296	5.7%	N/A	N/A	N/A	1	N/A	2 (low)
20–29	102	28.4%	N/A	N/A	N/A	1	N/A	4 (moderate)
30–39	911	26.7%	5.9%	47.5%	98.4%	5	<.001	2.6 (low)
40–49	139	1.4%	N/A	N/A	N/A	1	N/A	4 (moderate)
Not reported	1577	18.3%	11.9%	24.7%	89.8%	3	<.001	2.3 (low)
Singapore (fixed effects)	757	19.0%	16.2%	21.8%	0.0%	2	0.719	3.7 (moderate)
South Korea	583	38.9%	21.5%	56.3%	94.1%	3	<.001	2.6 (low)
Canada (fixed effects)	908	6.1%	4.5%	7.6%	98.0%	2	<.001	2.5 (low)
Taiwan	83	19.3%	N/A	N/A	N/A	1	N/A	2 (low)
China	398	7.7%	5.1%	10.2%	95.8%	2	<.001	3.0 (moderate)
High-income countries	2331	23.0%	12.6%	33.4%	98.2%	8	<.001	2.8 (low)
Upper middle-income countries	398	7.6%	5.1%	10.2%	95.8%	2	<.001	3.0 (moderate)
Secondary	2433	23.6%	13.8%	33.4%	98.0%	9	<.001	2.9 (low)
Tertiary	296	5.7%	N/A	N/A	N/A	1	N/A	2.0 (low)
Prevalence Post-traumatic (PTSD) symptoms (Combined After/ before pandemic)	3441	43.4%	21.4%	65.4%	99.6%	9	<.001	3.0 (moderate)
Anxiety disorders	6003	16.1%	10.9%	21.2%	96.3%	8	<.001	2.6 (low)
During the pandemic	6003	16.1%	10.9%	21.2%	96.3%	8	<.001	2.6 (low)
After the pandemic (no studies assessed this outcome after the pandemic)	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A
MERS	174	5.8%	N/A	N/A	N/A	1	N/A	1.0 (low)
SARS (fixed effects)	459	14.8%	11.6%	18.0%	79.6%	2	0.027	3.5 (moderate)
Covid 19	5370	18.0%	12.1%	23.9%	96.7%	5	<.001	2.0 (low)
20–29	174	5.8%	N/A	N/A	N/A	1	N/A	1.0 (low)
30–39	5303	18.2%	12.4%	24.0%	96.3%	5	<.001	2.4 (low)
40–49	N/A	N/A	N/A	N/A	N/A	1	N/A	N/a
Not reported	526	14.4%	11.5%	17.4%	92.7%	2	<.001	2.5 (low)
Saudi Arabia	174	5.8%	N/A	N/A	N/A	1	N/A	1.0 (low)
China	5829	17.7%	12.9%	22.6%	95.3%	7	<.001	2.4 (low)
High-income countries	174	5.8%	N/A	N/A	N/A	1	N/A	1.0 (low)
Upper middle-income countries	5829	17.7%	12.9%	22.6%	95.3%	7	<.001	2.4 (low)
Secondary	4155	20.0%	14.5%	25.5%	94.0%	4	<.001	3.3 (moderate)
University (fixed effects)	295	7.3%	4.4%	10.1%	94.6%	2	<.001	1.5 (low)
Secondary and tertiary	1257	12.2%	N/A	N/A	N/A	1	N/A	0.0 (low)
Tertiary	296	10.8%	N/A	N/A	N/A	1	N/A	2.0 (low)
Anxiety symptoms (combined after/ before pandemic)	19,433	45.9%	34.2%	57.7%	99.6%	17	<.001	3.6 (moderate)

TABLE 3 (Continued)

Psychological condition/symptoms	Participants (n)	Prevalence			Heterogeneity statistics			
		Estimate	95% confidence interval		I^2	Number of studies	Q test p value	Risk of bias
			Lower limit	Upper limit				
Depression MDD (combined after/before pandemic)	5747	13.4%	9.8%	16.9%	92.5%	7	<.001	2.8 (low)
During the pandemic	5065	16.1%	12.9%	19.2%	86.0%	5	<.001	2.8 (low)
After the pandemic (fixed effects)	682	7.0%	5.1%	8.9%	83.2%	2	0.015	2.5 (low)
SARS	885	13.0%	6.0%	20.1%	90.5%	4	<.001	3.5 (moderate)
Covid 19	4862	14.6%	11.5%	17.7%	89.6%	3	<.001	1.6 (low)
20–29	102	27.5%	N/A	N/A	N/A	1	N/A	4.0 (moderate)
30–39	4862	14.6%	11.5%	17.7%	89.6%	3	<.001	1.7 (low)
40–49	133	4.0%	N/A	N/A	N/A	1	N/A	4.0 (Moderate)
Not reported (fixed effects)	650	14.9%	13.0%	16.8%	0%	2	0.598	3.0 (low)
China	5614	14.8%	11.6%	18.0%	89.4%	6	<.001	2.5 (low)
Canada	133	4%	N/A	N/A	N/A	1	N/A	4.0 (moderate)
High-income countries	133	4%	N/A	N/A	N/A	1	N/A	4.0 (moderate)
Upper middle-income countries	5614	14.8%	11.6%	18.0%	89.4%	6	<.001	2.5 (low)
Secondary	4490	13.3%	8.9%	17.6%	93.4%	6	<.001	3.1 (moderate)
Secondary and tertiary	1257	14.8%	N/A	N/A	N/A	1	N/A	0.0 (low)
Excluding abstracts	5646	13.0%	9.2%	16.7%	93.7%	6	<.001	2.3 (low)
Depressive symptoms (combined after/before pandemic)	5409	46.2%	31.8%	60.5%	99.3%	12	<.001	3.5 (moderate)
Acute stress disorder	582	7.4%	4.3%	10.6%	51.5%	3	0.127	3.3 (moderate)
Psychological distress	2662	25.5%	10.1%	40.9%	98.9%	6	<.001	4.2 (moderate)

Abbreviations: Covid-19, coronavirus disease 2019; H1N1, influenza A virus subtype H1N1; MERS, Middle East respiratory syndrome coronavirus; N/A, not appropriate; SARS, severe acute respiratory syndrome.

FIGURE 2 Forest plot PTSD (combined after/before pandemic)
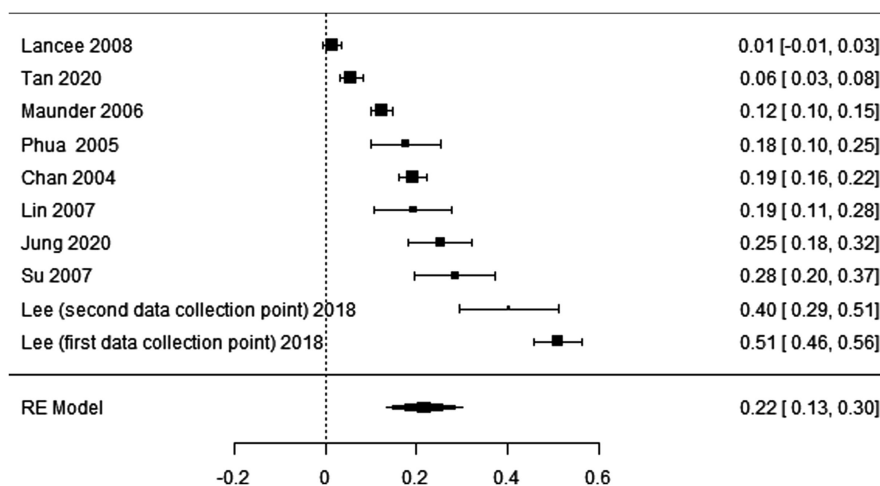
doctors (41%) who report suffering from mental health conditions during the Covid-19 pandemic (British Medical Association, 2020). Importantly, we identified moderating factors that may help to identify specific healthcare workers that are at risk from PTSD, anxiety disorders and MDD. Frontline staff, particularly nurses, who are likely to be highly exposed to the pandemic conditions were found to be at increased risk of having psychological problems than other healthcare workers. Similar findings have been previously reported

for healthcare workers during other infectious disease outbreaks (Brooks et al., 2018; Kisely et al., 2020; Ricci-Cabello et al., 2020). Increasing age of workers was associated with lower prevalence of mental health conditions, although this finding may have been influenced by limited numbers of workers outside the 30–39 year age group.

The risks of infectious disease pandemics for the mental health of healthcare workers are evident, necessitating action from healthcare
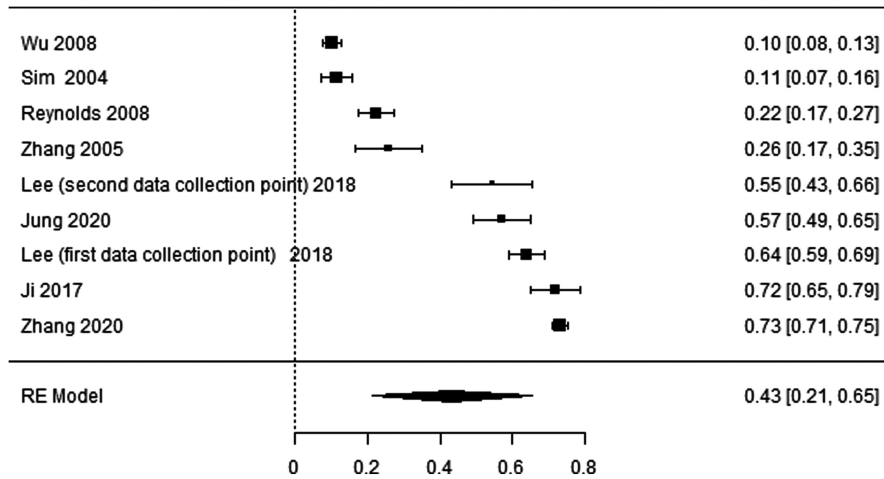
FIGURE 3 Forest plot prevalence post-traumatic (PTSD) symptoms (combined after/before pandemic)
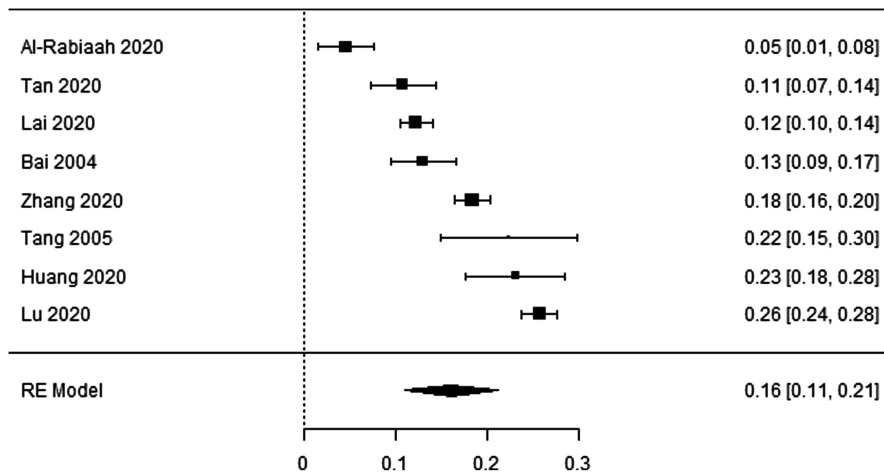
Study	Estimate [95% CI]
Wu 2008	0.10 [0.08, 0.13]
Sim 2004	0.11 [0.07, 0.16]
Reynolds 2008	0.22 [0.17, 0.27]
Zhang 2005	0.26 [0.17, 0.35]
Lee (second data collection point) 2018	0.55 [0.43, 0.66]
Jung 2020	0.57 [0.49, 0.65]
Lee (first data collection point) 2018	0.64 [0.59, 0.69]
Ji 2017	0.72 [0.65, 0.79]
Zhang 2020	0.73 [0.71, 0.75]
RE Model	0.43 [0.21, 0.65]

FIGURE 4 Forest plot prevalence anxiety disorders

Study	Estimate [95% CI]
Al-Rabiaah 2020	0.05 [0.01, 0.08]
Tan 2020	0.11 [0.07, 0.14]
Lai 2020	0.12 [0.10, 0.14]
Bai 2004	0.13 [0.09, 0.17]
Zhang 2020	0.18 [0.16, 0.20]
Tang 2005	0.22 [0.15, 0.30]
Huang 2020	0.23 [0.18, 0.28]
Lu 2020	0.26 [0.24, 0.28]
RE Model	0.16 [0.11, 0.21]
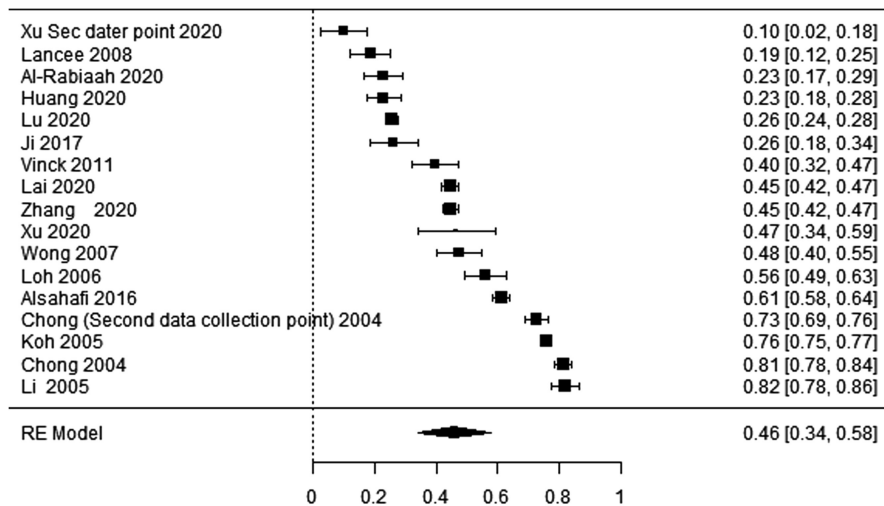
FIGURE 5 Forest plot anxiety symptoms (combined after/before pandemic)

Study	Estimate [95% CI]
Xu Sec dater point 2020	0.10 [0.02, 0.18]
Lancee 2008	0.19 [0.12, 0.25]
Al-Rabiaah 2020	0.23 [0.17, 0.29]
Huang 2020	0.23 [0.18, 0.28]
Lu 2020	0.26 [0.24, 0.28]
Ji 2017	0.26 [0.18, 0.34]
Vinck 2011	0.40 [0.32, 0.47]
Lai 2020	0.45 [0.42, 0.47]
Zhang 2020	0.45 [0.42, 0.47]
Xu 2020	0.47 [0.34, 0.59]
Wong 2007	0.48 [0.40, 0.55]
Loh 2006	0.56 [0.49, 0.63]
Alsahafi 2016	0.61 [0.58, 0.64]
Chong (Second data collection point) 2004	0.73 [0.69, 0.76]
Koh 2005	0.76 [0.75, 0.77]
Chong 2004	0.81 [0.78, 0.84]
Li 2005	0.82 [0.78, 0.86]
RE Model	0.46 [0.34, 0.58]

providers before, during and after the pandemics (Kisely et al., 2020; Pappa et al., 2020; Ricci-Cabello et al., 2020; Schoonhoven et al., 2020). This should be a priority given the importance of healthcare workers in tackling pandemics and their effects, the daily hazards that they face and the possible consequences for the health service and its patients if staff experience psychological problems (e.g. medical errors, patient safety). As pandemics can spread rapidly, consideration should be given to ongoing education and training of workers to ensure an

understanding of the conditions and actions required to identify, protect themselves and others, and to control infectious spread. Staff should be aware and understand the possible psychological challenges that a pandemic can present in terms of a changing work environment and work patterns, the burden of an increasing workload, the effects of managing patients with distressing conditions and their own increased risks (Schoonhoven et al., 2020). Although healthcare providers should have sufficient staff and resources to limit the impact

FIGURE 6 Forest plot depression MDD (combined after/before pandemic)

Lancee 2008	0.04 [0.01, 0.07]
Liu 2012	0.09 [0.06, 0.11]
Lu 2020	0.12 [0.11, 0.13]
Lai 2020	0.15 [0.13, 0.17]
Xuehua 2003	0.17 [0.10, 0.24]
Zhang 2020	0.17 [0.15, 0.19]
Su 2007	0.27 [0.19, 0.36]
RE Model	0.13 [0.10, 0.17]
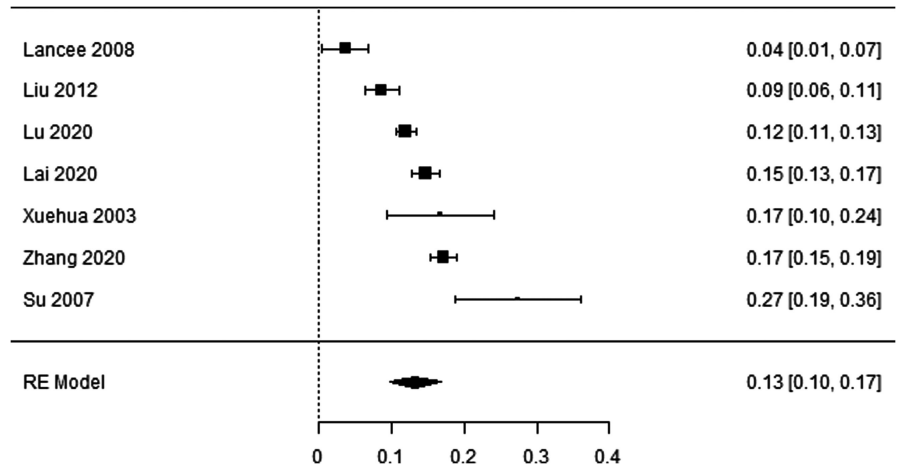
FIGURE 7 Forest plot depressive symptoms (combined after/before pandemic)

Bai 2004	0.11 [0.08, 0.15]
Xu Sec dater point 2020	0.12 [0.04, 0.20]
Ji 2017	0.28 [0.20, 0.36]
Tang (Abstract only) 2005	0.34 [0.25, 0.42]
Xu 2020	0.40 [0.28, 0.52]
Lai 2020	0.50 [0.48, 0.53]
Zhang 2020	0.51 [0.48, 0.53]
Xuehua 2003	0.52 [0.43, 0.62]
Chong 2004	0.68 [0.65, 0.71]
Liu 2012	0.77 [0.74, 0.81]
Chong (Second data collection point) 2004	0.83 [0.79, 0.86]
RE Model	0.46 [0.32, 0.60]
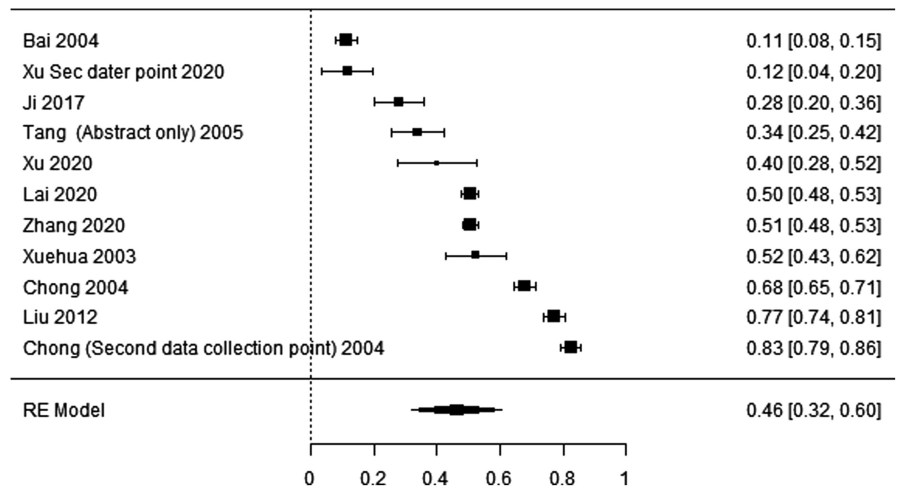
FIGURE 8 Forest plot acute stress disorder

Bai 2004	0.05 [0.02, 0.08]
Tan 2020	0.08 [0.05, 0.12]
Chen 2005	0.11 [0.06, 0.16]
RE Model	0.07 [0.04, 0.11]
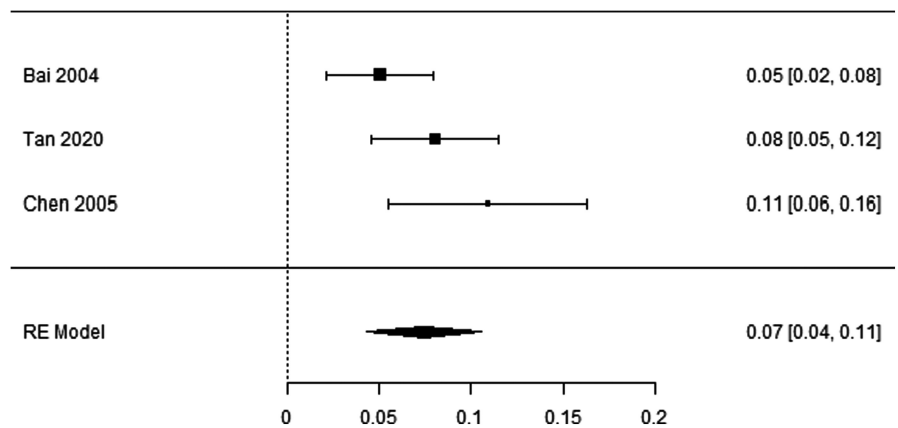
on staff, this is increasingly challenging due to the imbalance between funding and increasing demands on services (Robertson et al., 2017). Despite this, service providers should have plans in place for handling pandemics to limit the consequences for healthcare workers, communicating these effectively throughout (Schoonhoven et al., 2020). These plans should encompass early detection and screening for symptoms of depression, anxiety and PTSD among workers, as this may reduce those developing more severe symptoms (Halfin, 2007; Harvey et al., 2009; Kearns et al., 2012; Ströhle et al., 2018). During

pandemics, effective psychological and psychosocial support should be provided, extending beyond the pandemic period, as it is recognized that psychological symptoms of traumatic stress often emerge sometime after the event (National Health Service, 2020). For some the impact of the pandemic may retrigger previous traumatic symptoms and these longer-term conditions need to be identified and managed appropriately. Consideration should be given to the approaches required to deliver interventions to healthcare workers during pandemics, where face-to-face contact may not be possible for several
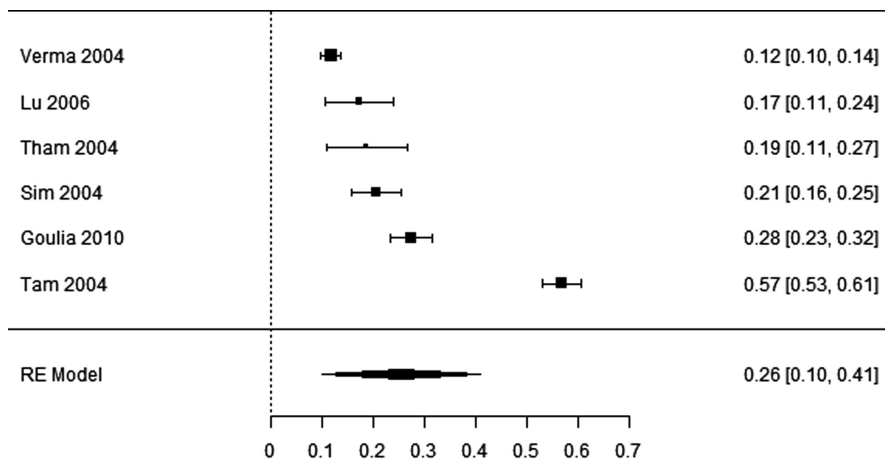
FIGURE 9 Forest plot psychological distress

reasons (e.g. time available, social distancing) and online options may be more beneficial. Planning should also include improving team support and resilience via embedded staff peer support models such as Trauma Risk Management (Greenberg et al., 2008) or similar adapted approaches for healthcare (Hughes et al., 2012).

5.1 | Strengths and limitations

Our systematic review has certain strengths, including: it was produced following a research protocol registered on PROSPERO; used a robust multi-database search with the addition of reference checks; study selection, data extraction and assessment of study quality were undertaken using pre-piloted forms and processes; only studies using valid and reliable data collection tools with recognized threshold levels for diagnosing conditions were included; specific definitions for pandemics and for pre- and post-pandemic periods were used to ensure standardization of comparisons (Coffey et al., 2006; Dunstan et al., 2017; Foa & Tolin, 2000; Guest et al., 2018; Hoy et al., 2012; Kim et al., 2019; Kroenke et al., 2001; Lowe et al., 2008; Matza et al., 2010; Mossman et al., 2017; Park, 2012; Spitzer et al., 2006; Yohannes et al., 2019; Zimmerman et al., 2013); and, a public advisor was involved during the review. However, this systematic review also had certain limitations, such as: the evidence base is rapidly changing as the Covid-19 pandemic progresses, meaning that it is likely that some evidence will have emerged subsequent to our searches; only studies published in English language were included; screening of studies, data extraction and quality assessment were undertaken by a single reviewer, although decisions were checked by a second reviewer; and, where study details were lacking, further evidence was not obtained from study authors. The evidence-base was also affected by certain limitations. Studies tend to diagnose the prevalence of a single condition, when people may fulfil the diagnostic criteria for several conditions. Given that many mental health conditions are characterized by the same symptoms (e.g. symptom of arousal is common to PTSD and anxiety), it is inevitable that the prevalence of some conditions maybe be underestimated. The accuracy of prevalence estimates may be affected by the approach to diagnosing the

condition, specifically whether a cut-off point on a scale or a clinical diagnosis by a physician was used. Importantly, we endeavoured to limit the impact of different diagnostic approaches by using only highly sensitive and specific tools for the prevalence estimates of conditions. As pooled prevalence rates were assessed through a visual inspection of confidence intervals rather than through calculating the difference between the confidence intervals, it is possible that borderline differences were considered statistically significant (i.e. type II error) (Payton et al., 2003). Additionally, due to the multiple comparison there is also the risk of type I error occurring as no adjustments were made (Chen et al., 2017). We were unable to assess the effects of publication bias due to the substantial between-study heterogeneity and limited number of studies (Higgins, 2021).

Despite the evidence presented identifying the risks healthcare workers face in providing care during infectious disease pandemics, further research would be beneficial. Understandably most prevalence studies focus on previous MERS and SARS pandemics. Although those studies of the Covid-19 pandemic appear to have similar results for some conditions, further studies would help to clarify the findings. New evidence continues to emerge on Covid-19 and an update of this review would be beneficial. Any studies that are conducted should ensure that they use only previously validated tools to diagnose the conditions, reporting any thresholds to help interpretation. Studies included in this systematic review had several methodological limitations which should be addressed in future studies, including a lack of random sampling and reporting of target population. As most studies considered the effects on healthcare workers during the pandemic itself, studies reporting at later points following the pandemic should be considered to allow planning for services in the longer term. With limited information on the natural recovery pathway and those factors that may have an influence, longitudinal studies should be considered. There were limited studies undertaken in low to low middle-income countries or in European countries, which should be addressed. Given the increasing reliance on healthcare services working together with the informal care sector, it would be helpful for a systematic review to include all groups involved in care. Although prevalence studies provide an opportunity to estimate the need for mental health services, the proportion of people that will

actually use the services remains uncertain. A consistent approach to stratifying those who may demand mental health services is necessary and remains a challenge for future research.

6 | CONCLUSION

Healthcare workers remain a central part of any strategy responding to the Covid-19 pandemic, with policies focusing on managing the effects of the pandemic on already under pressure healthcare services. Despite their importance, many healthcare workers are experiencing psychological problems during Covid-19 (e.g. PTSD, anxiety disorders and MDD), which are similar to previous pandemics. This places the onus on providers of healthcare to ensure they have adequate plans in place for preventing, diagnosing and managing any mental health conditions arising in the short- and longer term. Although it is evident that certain healthcare workers may be at higher risk, further research would help to clarify who they are, and which interventions should be used to prevent and manage the different mental health conditions.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1111/jan.15175.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

APPENDIX 1

Search strategy—MEDLINE (Ovid)

1	epidemics/ or pandemics/
2	(outbreak$1 or pandemic* or ebola or H1N1 or swine flu or SARS or severe acute respiratory syndrome or Middle East Respiratory Syndrome or MERS or spanish flu or spanish influenza or asian flu or hong kong flu or h2n2 or h3n2 or cholera or typhoid fever or dengue fever or zika virus or covid 19 or covid19 or ([coronavirus or corona virus] adj2 "2019")).tw.
3	1 or 2
4	Depressive Disorder/
5	anxiety disorders/ or panic disorder/
6	exp "trauma and stressor related disorders"/ or stress disorders, post-traumatic/
7	((psychological or mental) adj3 (trauma or problem* or issue* or disorder* or distress or stress or impact* or sequalae)).tw.
8	(traumatic stress or traumatic disorder* or stress disorder* or stress syndrome* or ptsd or posttraumatic or post traumatic or traumati* or stress reaction* or burnout or burn out).tw.
9	(depression or anxiety or depressive disorder*).tw.
10	or/4–9
11	incidence/ or prevalence/
12	(incidence or prevalence or survey or rapid assessment or situational assessment or cohort or cross sectional or surveillance or screening or level or presence or rate).tw.
13	(longitudinal or follow-up or prospective or retrospective or observational or case control or epidemiological stud* or occurrence).tw.
14	11 or 12 or 13
15	3 and 10 and 14
16	(hiv or opioid*).mp. [mp = title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
17	15 not 16
18	exp Animals/ not exp Humans/
19	17 not 18