The prevalence of common and stress-related mental health disorders in healthcare workers based in pandemic-affected hospitals: a rapid systematic review and meta-analysis

Sophie M. Allan[1,2], Rebecca Bealey[1,2], Jennifer Birch[1,2], Toby Cushing[1,2], Sheryl Parke[1,2], Georgina Sergi[1,2], Michael Bloomfield[3,4,5,6] and Richard Meiser-Stedman[1]

[1] Department of Clinical Psychology and Psychological Therapies, Norwich Medical School, University of East Anglia
[2] Cambridgeshire & Peterborough NHS Foundation Trust.
[3] Translational Psychiatry Research Group, Research Department of Mental Health Neuroscience, Division of Psychiatry, Faculty of Brain Sciences, University College London
[4] University College Hospital National Institute of Health Research (NIHR) Biomedical Research Centre
[5] Traumatic Stress Clinic, St Pancras Hospital, Camden and Islington NHS Foundation Trust
[6] National Hospital for Neurology and Neurosurgery, University College London Hospitals NHS Foundation Trust.

Corresponding author: Richard Meiser-Stedman, Department of Clinical Psychology and Psychological Therapies, Norwich Medical School, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, UK, email: r.meiser-stedman@uea.ac.uk, tel: +44 1603 593601

Abstract

Background: Healthcare workers (HCWs) are considered at elevated risk of experiencing mental health disorders in working with patients with COVID-19.

Objective: To estimate the prevalence of common mental health disorders in HCWs based in hospitals where pandemic-affected patients were treated.

Method: Databases were searched for studies published before 30th March 2020. Quantitative synthesis was used to obtain estimates of the prevalence of mental health disorders in four time windows, determined a priori (the acute phase, i.e. during and up to 1.5 months post-pandemic; 1.5-5.9 months; 6-11.9 months; 12 months and later).

Results: Nineteen studies met the review criteria. They predominantly addressed the acute phase of the SARS outbreak in Asia. The most studied outcomes were clinically-significant post-traumatic stress symptoms (PTSS) and general psychiatric caseness. For clinically significant PTSS in the acute phase, the prevalence estimate was 23.4% (95% CI 16.3, 31.2; N=4147; I^2=96.2%); in the 12 months plus window, the estimate was 11.9% (8.4, 15.8; N=1136; I^2=74.3%). For general psychiatric caseness, prevalence estimates were: acute phase, 34.1% (18.7, 51.4; N=3971; I^2=99.1%); 6-12 months, 17.9% (13.1, 23.2; N=223; I^2=0.0%); 12 months plus, 29.3% (6.0, 61.0; N=710; I^2=97.8%). No differences between doctors and nurses with respective to PTSS and general psychiatric caseness were apparent in the acute phase.

Conclusions: Mental health disorders are particularly common in HCWs working with pandemic-afflicted patients immediately following a pandemic, but the course of disorders following this period is poorly understood. There was considerable heterogeneity between studies, likely linked to methodological differences. More extended follow up of HCWs is needed.

Introduction

Healthcare workers (HCWs) including nurses, doctors, allied health professionals and all support staff based in hospitals where patients with COVID-19 are treated face considerable challenges and stress. In addition to the clinical challenges associated with treating a large volume of severely unwell patients, HCWs working with this group of infectious patients face threats to their own physical health[1], with a number of highly publicised HCW deaths already reported due to COVID-19. There is increasing recognition of the significant psychological impact of caring for those with COVID-19 given the immense pressure facing HCWs. For example, HCWs may face situations where they are at risk of sustaining moral injury[2], while there are also difficulties in obtaining sufficient personal protective equipment.[3] Health systems are subsequently implementing mental health provision systems and additional psychological support[4].

In order to better plan and develop these support systems, and to assist with education around reactions to working with COVID-19 patients, a rapid systematic review was undertaken to determine the prevalence of mental health disorders in HCWs working with patients infected through a pandemic. The review was focused on common mental health difficulties, such as post-traumatic stress, anxiety and depression, to allow an accurate prevalence of future demand on mental health services and to inform the provision of evidence-based interventions. We broadened our search to include studies relevant to the current COVID-19 crisis, e.g. pertaining to other coronavirus outbreaks (Severe Acute Respiratory Syndrome [SARS], Middle East Respiratory Syndrome [MERS]) and other epidemics that represent significant risks to HCWs (e.g. Ebola). In particular we sought to establish the prevalence of different conditions at different phases, i.e. during and immediately after a pandemic, then over the following months.

In summary, the aim of this rapid systematic review was to estimate the prevalence of common mental health disorders (in particular post-traumatic stress, depression, anxiety or general psychopathology) in HCWs working in hospitals with patients infected through a pandemic in the period during or following the pandemic.

Method

Protocol and registration.

The present review was not pre-registered given the perceived need to disseminate a rapid review pertaining to the mental health consequences for HCWs given the exponential rise in hospital admissions and deaths for COVID-19. The review was produced in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) recommendations[5].

Eligibility criteria.

Studies were included in the present review if they measured the prevalence of mental health disorders (in particular clinically significant post-traumatic stress, depression, anxiety or general psychopathology) in healthcare workers that worked in a hospital where care was provided to patients who had acquired an infection because of a pandemic, e.g. SARS, MERS, Ebola, COVID-19. No restrictions were placed on healthcare worker type (e.g. medical and non-medical staff were included) or department worked in.

Studies, or partial study data, were excluded if they: i) focused exclusively on healthcare workers who had also developed the index illness at the centre of the pandemic; ii) the sample included in-patients with the index infection; iii) the study was not published in English; iv) the study reported on stress or occupational wellbeing measures, such as burnout, rather than a diagnosable or clinical significant mental health disorder; v) participants included staff at other non-affected hospitals; vi) only comprised qualitative data; or vii) addressed work with pandemics with different routes of transmission to COVID-19 e.g. sexually transmitted or blood-borne pathogens including human immunodeficiency virus (HIV).

Information source.

Databases searched included Medline, PsycINFO, CINAHL, PubMed, OVID and ScienceDirect. Manual searches of relevant review papers and empirical articles were also carried out to identify any studies that had not yet been included in the literature databases.

Search.

Search terms were 1) terms related to identified pandemics (including SARS, MERS, Coronavirus, Ebola and 'pandemic') AND 2) 'acute hospital (including all search engine variants) AND 3) 'mental health' (including post traumatic stress, depression, anxiety and low mood variants) AND 4)'health* professional' (including variants such as doctor and nurse). Searches were conducted on 30th March 2020 with databases searched from inception. See Supplementary Material 1 for full search terms.

Data collection process.

Duplicates were removed from search results. Titles and abstracts were screened for eligibility. The full texts of eligible studies were then accessed and checked against the inclusion and exclusion criteria. Six researchers were split into pairs (SA and RB, JB and SP, and TC and GS), both of whom independently completed initial screening and data extraction. Disagreements were resolved by discussion with the wider team and a decision reached by consensus.

Data items.

Descriptive data was extracted pertaining to key study characteristics (country and year of publication, pandemic, sex and role of participants, method of data collection). Data from comparison control groups (e.g. HCWs at another hospital that did not work with pandemic patients) were not extracted. Following our initial searches, the main outcomes we opted to consider were prevalence of clinically significant PTSS, depression, anxiety and general psychiatric caseness (i.e. scoring above cut-off on a general psychiatric screening questionnaire, such as the General Health Questionnaire). Prevalence data were therefore extracted for post-traumatic stress symptoms (PTSS), depression, anxiety and general psychiatric screening using the number of participants who scored above a defined cut-off on the given outcome measure or met threshold for a diagnosis based on a structured interview. Data were categorised according to four time periods, which were defined *a priori*: during the pandemic up to 1.49 months later (termed the 'acute phase'); 1.5- 5.9 months; 6-11.9 months; and 12 months or later. The end point for each pandemic was defined by the individual studies themselves; studies usually cited the World Health Organisation having declared their region as being removed from the infected areas.

Risk of bias.

The quality of the included papers was assessed using an adapted version of the National Heart, Lung and Blood Institute Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools; see Supplementary Material 2 for full rating scheme). The assessment criteria included: study population defined; participation rate of over 50%; if follow-up, was the attrition rate described; and validity and reliability of measures for post traumatic stress, anxiety, depression and general psychiatric screen. Individual studies were scored for quality (0= not present/poor description, 1= some description but some missing information, 2= all desired information included) for each area of quality. Studies were given a percentage according to the degree of criteria being met. The percentage was used to indicate the study quality (>70% high, 50-69% medium, <50% low).
Quality assessment and extraction were double rated; there were no disagreements on quality rating.

Given how few studies were included in each meta-analysis (less than the 10 suggested for funnel plot asymmetry)[6], formal tests of publication bias are not reported.

Summary measures.

The summary measure of interest was prevalence of a mental health difficulty, based on number scoring above cut-off on a self-report questionnaire measure (i.e. clinically significant levels of symptoms) or the number meeting diagnostic threshold based on a structured interview. Absolute prevalence was selected to be our outcome as we sought to determine the mental health burden for HCWs of working with patients infected through a pandemic, to inform the planning of support services. Comparison between pandemic-affected and non-pandemic-affected hospitals was not possible as we did not find any studies that reported prevalence rates in any control hospitals.

Synthesis of results.

Prevalence outcomes were synthesised using a random-effects meta-analysis. Arcsine transformations was used to account for issues with study weightings when estimating prevalence[7], with back-transformed values presented in all results. The metafor package[8] in R 3.4.2[9] was used to conduct the meta-analysis.

Additional analyses.

Given significant heterogeneity in the literature, the post-hoc decision was undertaken to conduct sensitivity analyses. These involved restricting our quantitative syntheses to SARS-only literature and particular measures, and where possible reporting results by HCW profession groups.

Results

Study selection.

The numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, are presented in a PRISMA flowchart (see Figure 1). Nineteen studies provided usable data. Two articles related to the same cohort but at different time intervals[10 11]; these are therefore reported as a single study.

One group reported two articles on the same hospital but the sampling frame for the follow up study was so different to the first that these articles are reported separately[12 13]. The same Canadian study group also reported follow up data on a smaller sub-set of participants but using structured interviews rather than self-report questionnaire screening[14]; a separate note on this additional study is provided below. References for all articles included in the review are provided in Supplementary Material 3.

Study characteristics.

Nineteen studies met inclusion criteria for this review, comprising 8550 HCWs. Study characteristics are reported Table 1. The majority of included studies related to the SARS pandemic in Asian hospitals. SARS is a condition associated with coronavirus infection (SARS-CoV), characterised by a high transmission rate to HCW's and with similar presenting symptoms to COVID-19 (e.g. dry cough, shortness of breath). The main transmission route and the progression for patients with severe disease are similar in both COVID-19 infection and SARS. One study reported findings from the COVID-19 pandemic. One set of studies pertained to the SARS outbreak in Canada, and a further study pertained to the H1N1 pandemic in Greece. All but two studies involved mixed healthcare worker samples; the remaining two focused exclusively on nurses. Reported outcomes were classified as being related to PTSS, depression, anxiety or a general psychiatric screen. Three studies reported that mental health interventions were offered to HCWs in response to the pandemic.

Risk of bias within studies.

Overall, eight studies were rated as high quality, eight as medium quality and two as low quality (Table 1; see Supplementary Material 4 for full quality ratings). The majority of studies (15 of 18) were judged to have clearly specified their study population. Ten of the studies had a participation rate greater than 50%. All assessment tools were self-report questionnaire measures; one study used a structured interview with a sub-set of HCWs, which will be reported separately. In only two studies was it explicitly stated that a PTSS measure was completed in relation to the relevant pandemic.

Prevalence of psychiatric disorders.

Prevalence of clinically significant post-traumatic stress symptoms (PTSS). Nine studies were used to derive prevalence estimates for PTSS in the acute phase and two in the 12 months onwards window; single studies addressed the 1.5-5.9 and 6-11.9m windows. Forest plots for each time window are displayed in Figure 2. The pooled estimate for clinically significant PTSS in the acute phase (i.e. during the pandemic itself and up to 1.5 months after the end of the pandemic) was 23.4% (95% CI, 16.3, 31.2; k=9; N=4147; Chan et al 2004, Chen et al 2005, Lai et al 2020, Lee et al 2018, Lin et al 2007, Maunder et al 2004,

Sim et al 2004, Sin et al 2004, Su et al 2007). The pooled studies had a large degree of heterogeneity (Q[8] = 190.00, p < .0001; I^2=96.2%). A single study addressed the 1.5-5.9m window (57.1%; 95% CI 49.1, 65.0; N= 147; Jung et al. 2020), and a single study also addressed the 6-11.9m window (17.7%; 95% CI 10.8, 25.9; N=96; Phua et al. 2005).

The pooled estimate for the period 12 months onwards was 11.9% (95% CI 8.4, 15.8; k=2; N=1136; Liu et al 2012, Maunder et al 2006). The pooled studies had a large degree of heterogeneity (Q[1] = 3.89, p<.05; I^2=74.3%). One of these studies[14] also conducted structured clinical interviews for PTSD with a sub-set of HCWs in Toronto (139 of 587; 24%). Two HCWs met criteria for current PTSD, with one identifying the SARS experience as the most severe traumatic event.

Prevalence of anxiety. One study reported the prevalence of clinically significant anxiety in the acute phase, as measured by the GAD-7[15] (12.3%; 95% CI 10.5, 14.1; N=1257; Lai et al. 2020).

Prevalence of depression. Two studies were used to derive the prevalence estimate for depression in the acute phase; one study addressed the 12 months onwards window. Forest plots for each time window are displayed in Supplementary Material 5. The pooled estimate for depression in the acute phase was 20.2% (95% CI 9.5, 33.7; k=2; N=1359). The pooled studies had a large degree of heterogeneity (Q[1] = 9.26, p<0.003; I^2=89.2%). A further study considered the prevalence of depression in the 12 month onwards window (8.7%; 95% CI 6.5, 11.3; N=549; Liu et al. 2012). In their study that utilised structured interviews for psychiatric disorders, Lancee and colleagues[14] found that there was one new case with a major depressive episode, among 93 HCWs who reported no pre-SARS mental health disorders.

Prevalence of general psychiatric screening cases. Eight studies were used to derive the prevalence estimate for general psychiatric caseness within the acute phase, two in the 6-12m window and two in the 12 months onwards window. Forest plots for each time window are displayed in Figure 3. The pooled estimate for the prevalence of positive cases on general psychiatric screening instruments in the acute phase was 34.1% (95% CI 18.7, 51.4; k=8, N=3971; Chan et al 2004, Chong et al 2004, Goulia et al 2010, Lin et al 2007, Nickell et al 2004, Sim et al 2004, Sin et al 2004, Tam et al 2004). The pooled studies had a large degree of heterogeneity (Q[7] = 1199.28, p<0.0001; I^2=99.1%).

For the 6 to 12 month window the pooled estimate was 17.9% (95% CI 13.1, 23.2; k=2; N=223; Lu et al 2009/Lung et al 2009, Phua et al 2005), with no significant heterogeneity (Q[1] = 0.08, p= 0.78; I^2=0.0%). For the 12 months onwards window, the pooled estimate was 29.3% (95% CI 6.0, 61.0; k=2; N=710; Maunder et al 2006, Lu et al 2006/Lung et al 2009). These studies were associated with a large degree of heterogeneity (Q[1]=44.60, p<.0001; I^2=97.8%). Maunder and colleagues (2006) used a relatively low threshold for indicating caseness, possibly inflating the numbers that screened positive (44.9%); when applying the same criteria to a hospital not affected by the SARS epidemic, the authors found a large proportion (30.2%) scored above this threshold.

Prevalence by profession. Further meta-analyses were conducted to consider whether prevalence differed by profession. These were restricted to the acute phase given how little data was available at follow up. The main professions considered were doctors and nurses. Regarding clinically significant PTSS the prevalence estimate for doctors was 18.7% (95% CI=6.0, 36.4; k=3; N=698; Chan et al. 2004, Lai et al. 2020, Sim et al. 2004), while for nurses it was 21.4% (95% CI 13.0, 31.3; k=5; N=1686; Chan et al. 2004, Chen et al. 2005,

Lai et al. 2020, Sim et al. 2004, Su et al. 2007); for the 3 studies that included both doctors and nurses, there was no difference in prevalence (odds ratio = .87 [95% CI .71, 1.08]; Chan et al. 2004, Lai et al. 2020, Sim et al. 2004). Regarding general psychiatric screening cases the estimate for doctors was 31.6% (95% CI 13.8, 52.7; k=5; N=508; Chan et al. 2004, Chong et al. 2004, Goulia ea al. 2010, Nickell et al. 2004, Sim et al. 2004), while for nurses it was 38.2% (95% CI 19.0, 59.4; k=5; 1683; Chan et al. 2004, Chong et al. 2004, Goulia ea al. 2010, Nickell et al. 2004, Sim et al. 2004); there was no significant in prevalence between nurses and doctors (the same five studies; odds ratio = 1.29 [95% CI=0.45, 1.32]).

Exploratory sub-group analyses in the acute phase.

Given the significant heterogeneity present for most of the meta-analyses conducted, exploratory sub-group analyses were undertaken to see if more consistent findings might be discernible. Such analyses were only possible in relation to the acute phase. Moderator analyses were not undertaken given how few studies were available.

First, meta-analyses were undertaken that included only those studies which addressed the SARS pandemic (the bulk of the retrieved literature). The SARS-only prevalence meta-analysis for acute PTSS yielded a pooled prevalence estimate of 19.7% (95% CI 13.1, 27.4; k=7; N= 2813; Chan et al. 2004, Chen et al. 2005, Lin et al. 2007, Maunder et al. 2004, Sim et al. 2004, Sin et al. 2004, Su et al. 2007), only slightly less than the estimate for all studies. There remained a large degree of heterogeneity (Q[6] = 159.51, p<.0001; I^2 = 93.8%). The SARS-only prevalence meta-analysis for acute general psychiatric screening cases yielded a pooled prevalence estimate of 39.1% (95% CI 23.9, 55.6; k=7; N=3502; Chan et al. 2004, Chong et al. 2004, Lin et al. 2007, Nickell et al. 2004, Sim et al. 2004, Sin et al. 2004, Tam et al. 2004), a slightly higher than figure than that obtained for all studies. Again, this did not improve heterogeneity, which remained large (Q[6])=749.37, p.0001; I^2=99.8%).

Second, meta-analyses that used only the same measure were undertaken. For the IES (PTSS)[16], a point estimate of 21.0% was obtained (95% CI 11.7, 32.0; k=4; N= 2351; Q[3]=87.25, p<.0001; I^2=95.7%; Chan et al. 2004, Chen et al. 2005, Maunder et al. 2004, Sin et al. 2004). For the IES-R[17] a point estimate of 26.6% was obtained (95% CI 9.4, 48.7; k=3; N=1611; Q[2]=97.67, p<.0001; I^2=97.9%; Lai et al. 2020, Lee et al. 2018, Sim et al. 2004). For the GHQ-28[18] a point estimate of 17.7 (95% CI 9.3, 28.1; k=4; N=1462; Q[3]=87.60, p<.0001; I^2=94.9%; Chan et al. 2004, Goulia ea al. 2010, Sim et al. 2004, Sin et al. 2004). For each analysis there remained a large degree of heterogeneity.

It is noteworthy that even when restricting analyses to a single measure (e.g. IES, IES-R, GHQ-28), different cut-off scores were used to denote caseness. For example, if the point estimate GHQ-28 in the acute phase was restricted to studies that used a cut-off score of 5, a point estimate of 23.4% was obtained (95% CI 18.6, 28.5; k=3; N=993; Chan et al. 2004, Sim et al. 2004, Sin et al. 2004) that did not have significant heterogeneity (Q[2]=4.88, p=0.087; I^2=58.7%).

Discussion

The studies identified in this rapid systematic review and meta-analysis predominantly addressed clinically significant PTSS and general psychiatric caseness in HCW in the acute phase, i.e. during and immediately after a pandemic. Fewer studies addressed longer-term follow up. The majority of the studies considered the SARS pandemic. Our findings suggest that a significant minority of HCWs met threshold for clinically significant PTSS and general psychiatric caseness in the acute phase, with no apparent differences between doctors and nurses with respect to either outcome. However, a precise estimate of either PTSS and general psychiatric caseness cannot be derived from the reviewed literature given the large of heterogeneity in study findings.

The limited data from follow up studies suggested that there was a lower rate of PTSS several months after a pandemic (in particular SARS). Only two studies addressed PTSS rates more than 12 months post-pandemic and the results demonstrated significant heterogeneity. Both studies were large (>500 participants) and yielded a reasonably precise estimate of PTSS prevalence (95% CI 8.4-15.8%) that was markedly lower than the (albeit more imprecise) estimate for the acute phase. Whilst this could indicate a reduction in PTSS over time, it is important to stress that the lower number of follow-up studies and the high heterogeneity within the included studies makes comparison between time points very difficult; as such an apparent reduction in PTSS should be considered with caution.

For general psychiatric screening the picture was not clear. While two studies suggested an improvement by the time of the 6-12 month post-pandemic window, there was considerable heterogeneity at the time on the 12 months onwards timeframe. We would highlight the potential contribution to between-study heterogeneity of using different cut-offs in screening instruments. The one study to use structured interview assessments at follow-up found very low rates of psychiatric disorder that might be directly attributable to HCW experiences during a pandemic.

We found that PTSS were elevated during the acute phase and at 12 months, similar to existing populations of at-risk health workers such as rescue workers (10%)[19], paramedics (11%)[20], and HCWs in general (14.8%)[21] who report higher levels of PTSS than the general population (e.g. 3.5%)[22]. Whilst there were very limited data pertaining to the course of clinically-significant PTSS, our findings may be considered broadly consistent with the existing literature that suggests natural recovery is common in trauma-exposed individuals.[23 24]

However, it is likely that the COVID may have a longer, ongoing acute phase than in those studies reviewed such staff may have longer exposure to stress whilst experiencing PTSS. Furthermore, it is possible that COVID-19 represents a degree of threat more serious than that from previous pandemics due to factors including lack of personal protective equipment, impaired systemic resilience factors related to social distancing and uncertainties around the duration of the pandemic. As such, our findings may provide an under-estimate. Comparison with a recent review of HCWs exposed to COVID-19[25] is appropriate. This systematic review and meta-analysis found that 23.3% and 22.8% HCWs working during the first few months of the COVID-19 pandemic experienced symptoms of anxiety and depression respectively, as well as 38.9% experiencing insomnia. Sex and occupational differences were also reported within the sample, with female HCWs reporting increased

symptoms compared to male medical staff. These findings suggest a slight increase in the prevalence of depression compared with the findings of the present review.

A recent position paper called for high-quality research on the mental health effects of COVID-19 within vulnerable groups, including HCW[26]. With respect to clinical care for HCWs, these findings underline the need to consider closely the mental health needs of this workforce, particularly given how frequent acute mental health disturbance may be. In themselves, such acute reactions to pandemics may be not be classed as "disorders" given the very real threat that close clinical contact with infected patients may present. Whilst these reactions are considered normal, it is imperative to consider how best to support staff during the ongoing crisis, including how to detect persistent PTSD early. An "active monitoring" approach as proposed by the UK NICE guidelines for PTSD[27] or a screen and treatment approach as used in response to other major incidents[28] may be advisable for HCWs experiencing an acute PTSS reaction. Indeed, the persistence of PTSS, and the emergence of what may be properly classed as disorders, is not well understood in this population and service planning for HCWs may need to draw on estimates drawn from other trauma-exposed populations. Moreover, our findings demonstrate the variety of screening tools and cut-off scores that have been be used to determine "caseness". Clinically, services that use such tools need to careful about the use of screening instruments to identify at-risk staff, and the potential impact of even small differences in cut-offs.

This review highlights the need for urgent research to include more extensive follow up, in particular using prospective longitudinal cohorts of HCWs, and consider disorders other than PTSS; depression in particular has received very limited attention. While screening instruments for outcomes like PTSS and depression have obvious benefits in terms of cost-effectiveness, they may also miss key aspects of HCW experience and may fail to consider the impact of other factors, e.g. prior or non-healthcare traumatic experiences. Other aspects of health and well-being (e.g. substance abuse, functioning) were not considered in detail. Though some longer versions of the GHQ/CHQ do include items relating to social functioning, these were not normally presented separately. More detailed assessment (e.g. using structured interviews), similar to that undertaken by Lancee and colleagues[14] may be warranted. It was beyond the scope of the present rapid review to identify risk factors for mental health disorders. Although we were able to consider differences in prevalence for two professions (doctors and nurses), the needs of other HCWs, and allied professions and hospital staff also need to be addressed in detail.

This study is strengthened by its inclusion of studies addressing clinically similar situations, its detailed coverage of methodological issues and its *a priori* definition of time windows. The study is limited by the limited available data and its heterogeneity, and the relative narrowness of outcomes the literature has addressed (e.g. sex differences could not be considered).

Conclusion

There is evidence that HCWs working in pandemics are at increased risk of a range of adverse mental health outcomes, at least in the acute phase; two studies suggesting elevated rates of clinically significant PTSS at follow up. Research is needed to understand the long-term effects of psychological stress and trauma on HCWs during COVID and how best to support HCWs during and after the pandemic.

Funding.

Author contributions.

Conflict of interest statements.

References

1. Adams JG, Walls RM. Supporting the health care workforce during the COVID-19 global epidemic. JAMA 2020.
2. Greenberg N, Docherty M, Gnanapragasam S, et al. Managing mental health challenges faced by healthcare workers during covid-19 pandemic. BMJ 2020;**368**.
3. Livingston E, Desai A, Berkwits M. Sourcing personal protective equipment during the COVID-19 pandemic. JAMA 2020.
4. BBC News Online. Coronavirus: Mental health hotline for NHS staff. Secondary Coronavirus: Mental health hotline for NHS staff 2020. https://www.bbc.co.uk/news/health-52202570.
5. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Annals of internal medicine 2009;**151**(4):264-69.
6. Sterne JA, Sutton AJ, Ioannidis JP, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. Bmj 2011;**343**:d4002.
7. Barendregt JJ, Doi SA, Lee YY, et al. Meta-analysis of prevalence. J Epidemiol Community Health 2013;**67**(11):974-78.
8. Viechtbauer W. Conducting meta-analyses in R with the metafor package. Journal of statistical software 2010;**36**(3):1-48.
9. R: A language and environment for statistical computing. [program]. Vienna, Austria: R Foundation for Statistical Computing, 2014.
10. Lung FW, Lu YC, Chang YY, et al. Mental symptoms in different health professionals during the SARS attack: A Follow-up study. Psychiatric Quarterly 2009;**80**(2):107-16.
11. Lu YC, Shu BC, Chang YY, et al. The mental health of hospital workers dealing with severe acute respiratory syndrome. Psychother Psychosom 2006;**75**(6):370-5.
12. Maunder R. The experience of the 2003 SARS outbreak as a traumatic stress among frontline healthcare workers in Toronto: lessons learned. Philosophical Transactions B: Biological Sciences 2004;**359**(1447):1117.
13. Maunder RG, Lancee WJ, Balderson KE, et al. Long-term psychological and occupational effects of providing hospital healthcare during SARS outbreak. Emerg Infect Dis 2006;**12**(12):1924-32.
14. Lancee WJ, Maunder RG, Goldbloom DS. Prevalence of psychiatric disorders among Toronto hospital workers one to two years after the SARS outbreak. Psychiatric Services (Washington, DC) 2008;**59**(1):91-95.
15. Spitzer RL, Kroenke K, Williams JBW, et al. A brief measure for assessing generalized anxiety disorder: the GAD-7. Archives of Internal Medicine 2006;**166**(10):1092-97.
16. Horowitz M, Wilner N, Alvarez W. The Impact of Event Scale: A measure of subjective stress. Psychosom Med 1979;**41**:209-18.
17. Weiss D, Marmar C. The Impact of Event Scale—Revised, assessing psychological trauma and PTSD. New York, Guilford 1997:399-411.
18. Goldberg DP, Hillier VF. A scaled version of the General Health Questionnaire. Psychol Med 1979;**9**(1):139-45.
19. Berger W, Coutinho ESF, Figueira I, et al. Rescuers at risk: a systematic review and meta-regression analysis of the worldwide current prevalence and correlates of PTSD in rescue workers. Social psychiatry and psychiatric epidemiology 2012;**47**(6):1001-11.
20. Petrie K, Milligan-Saville J, Gayed A, et al. Prevalence of PTSD and common mental disorders amongst ambulance personnel: a systematic review and meta-analysis. Social psychiatry and psychiatric epidemiology 2018;**53**(9):897-909.
21. Jacob Sendler D, Rutkowska A, Makara-Studzinska M. How the exposure to trauma has hindered physicians' capacity to heal: prevalence of PTSD among healthcare workers. The European Journal of Psychiatry 2016;**30**(4):321-34.
22. Kessler RC, Chiu WT, Demler O, et al. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry 2005;**62**(6):617-27.

23. Hiller RM, Meiser-Stedman R, Fearon P, et al. Research Review: Changes in the prevalence and symptom severity of child posttraumatic stress disorder in the year following trauma - a meta-analytic study. J Child Psychol Psychiatry 2016.
24. Morina N, Wicherts JM, Lobbrecht J, et al. Remission from post-traumatic stress disorder in adults: a systematic review and meta-analysis of long term outcome studies. Clin Psychol Rev 2014;**34**(3):249-55.
25. Pappa S, Ntella V, Giannakas T, et al. Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. Brain Behav Immun 2020.
26. Holmes EA, O'Connor RC, Perry VH, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. The lancet Psychiatry 2020;**7**(6):547-60.
27. National Institute for Health and Care Excellence. Guideline 116: Post-traumatic Stress Disorder. Secondary Guideline 116: Post-traumatic Stress Disorder 2018. https://www.nice.org.uk/guidance/ng116.
28. Gobin M, Rubin GJ, Albert I, et al. Outcomes of Mental Health Screening for United Kingdom Nationals Affected by the 2015-2016 Terrorist Attacks in Tunisia, Paris, and Brussels. J Trauma Stress 2018;**31**(4):471-79.

Table 1. Study characteristics

Study	Epidemic	N	% Female	Country	Staff type	Mental health intervention reported?	PTSD measure	General psychiatric screen	Depression measure	Anxiety measure	Study quality
Chan et al. (2004)	SARS	661	NR	Singapore	Mixed	Existing Peer Support Programme	IES (≥30)	GHQ-28 (≥5)	-	-	Medium
Chen et al. (2005)	SARS	86	100	Taiwan	Nurses	No	IES (≥35)	-	-	-	High
Chong et al. (2004)	SARS	1257	81.1	Taiwan	Mixed	Group debriefing	-	CHQ-12 (≥3)	-	-	Medium
Goulia et al. (2010)	H1N1	469	68.4	Greece	Mixed	No	-	GHQ-28 (≥11)	-	-	Low
Jung et al. (2020)	MERS	147	100	South Korea	Nurses	No	IES-R (Korean) (≥18)	-	-	-	Medium
Lai et al. (2020)	Covid-19	1257	76.7	China	Mixed	Psychological assistance services	IES-R (≥26)	-	PHQ-9 (≥10)	GAD-7 (≥7)	High
Lee et al. (2018)	MERS	77	90	South Korea	Mixed	No	IES-R (≥25)	-	-	-	Low
Lin et al. (2007)	SARS	92	91.3	Taiwan	Mixed	No	DTS (≥40)	CHQ-12 (≥3)	-	-	High
Liu et al. (2012)	SARS	549	75	China	Mixed	No	IES-R (≥20)	-	CES-D (≥25)	-	High
Lu et al. (2006) & Lung et al. (2009)	SARS	127[a]	58	Taiwan	Mixed	No	-	CHQ-12 (≥3)	-	-	High
Maunder et al. (2004)	SARS	1557	NR	Canada	Mixed	No	IES (≥20)	-	-	-	Medium
Maunder et al. (2006)	SARS	587	86	Canada	Mixed	No	IES (≥26)	K-10 (≥16)	-	-	Medium
Nickell et al. (2004)	SARS	510	78.8	Canada	Mixed	No	-	GHQ-12 (≥3)	-	-	Medium
Phua et al. (2005)	SARS	96	69	Singapore	Mixed	Yes (not described)	IES (≥26)	GHQ-28 (≥5)	-	-	High
Sim et al. (2004)	SARS	277	85.2	Singapore	Mixed	No	IES-R (diagnosis)	GHQ-28 (≥5)	-	-	High
Sin et al. (2004)	SARS	47	NR	Singapore	Mixed	No	IES (≥30)	GHQ-28 (≥5)	-	-	Medium
Su et al. (2007)	SARS	102	NR	Taiwan	Nurses	No	DTS (≥23)	-	BDI (≥10)	-	High
Tam et al. (2004)	SARS	652	79	Hong Kong	Mixed	No	-	CHQ-12 (≥3)	-	-	Medium

Notes. Cut-offs for each measure are reported in parentheses. [a]123 at follow up. BDI = Beck Depression Inventory; CES-D = Center for Epidemiological Studies Depression Scale; CHQ = Chinese Health Questionnaire; DTS=Davidson Trauma Scale; GAD-7 = Generalised Anxiety Disorder Assessment; GHQ = General Health Questionnaire; IES = Impact of Events Scale; IES-R = Impact of Events Scale-Revised; K10=Kessler Psychological Distress Scale; NR = not reported.

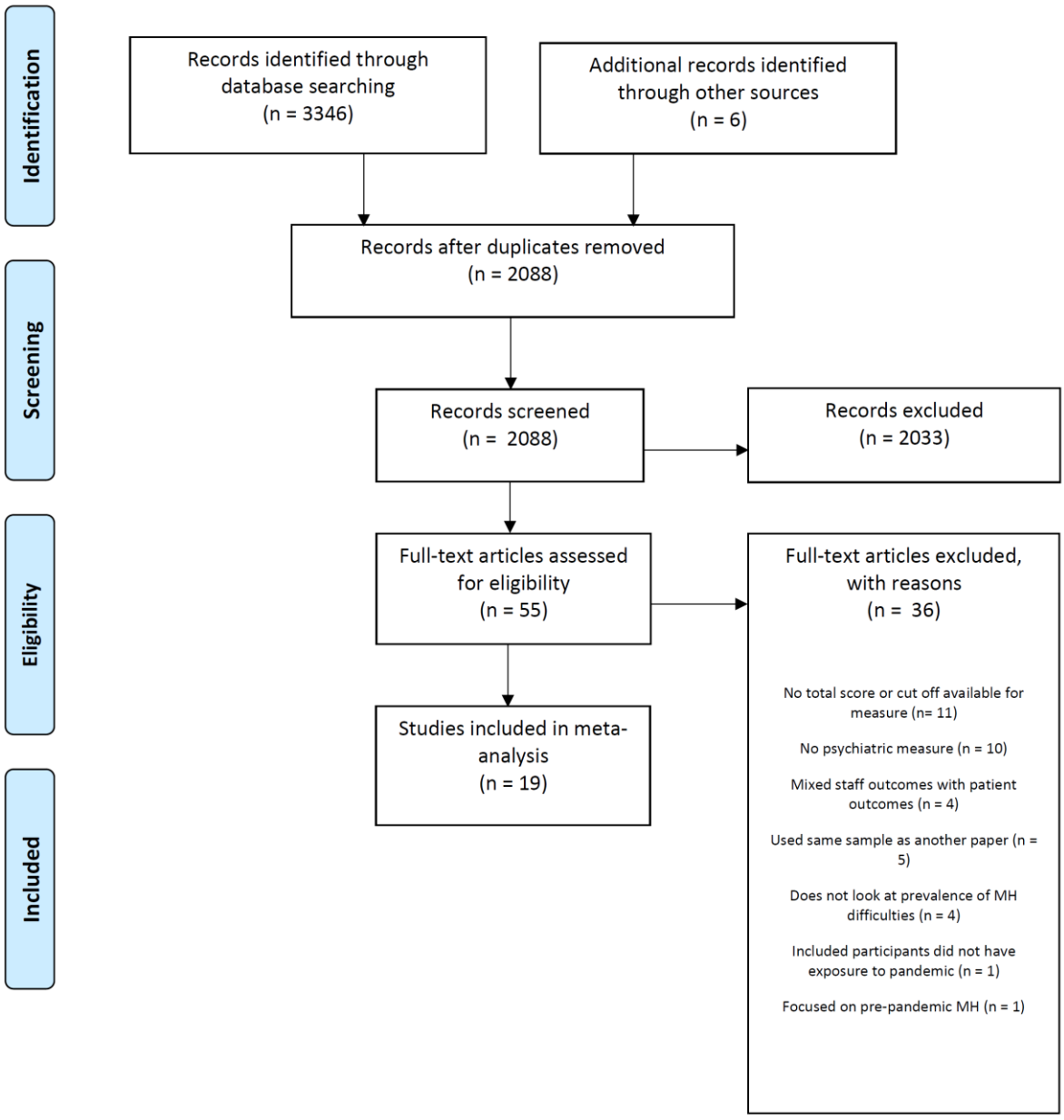

Figure 1. PRISMA flowchart.

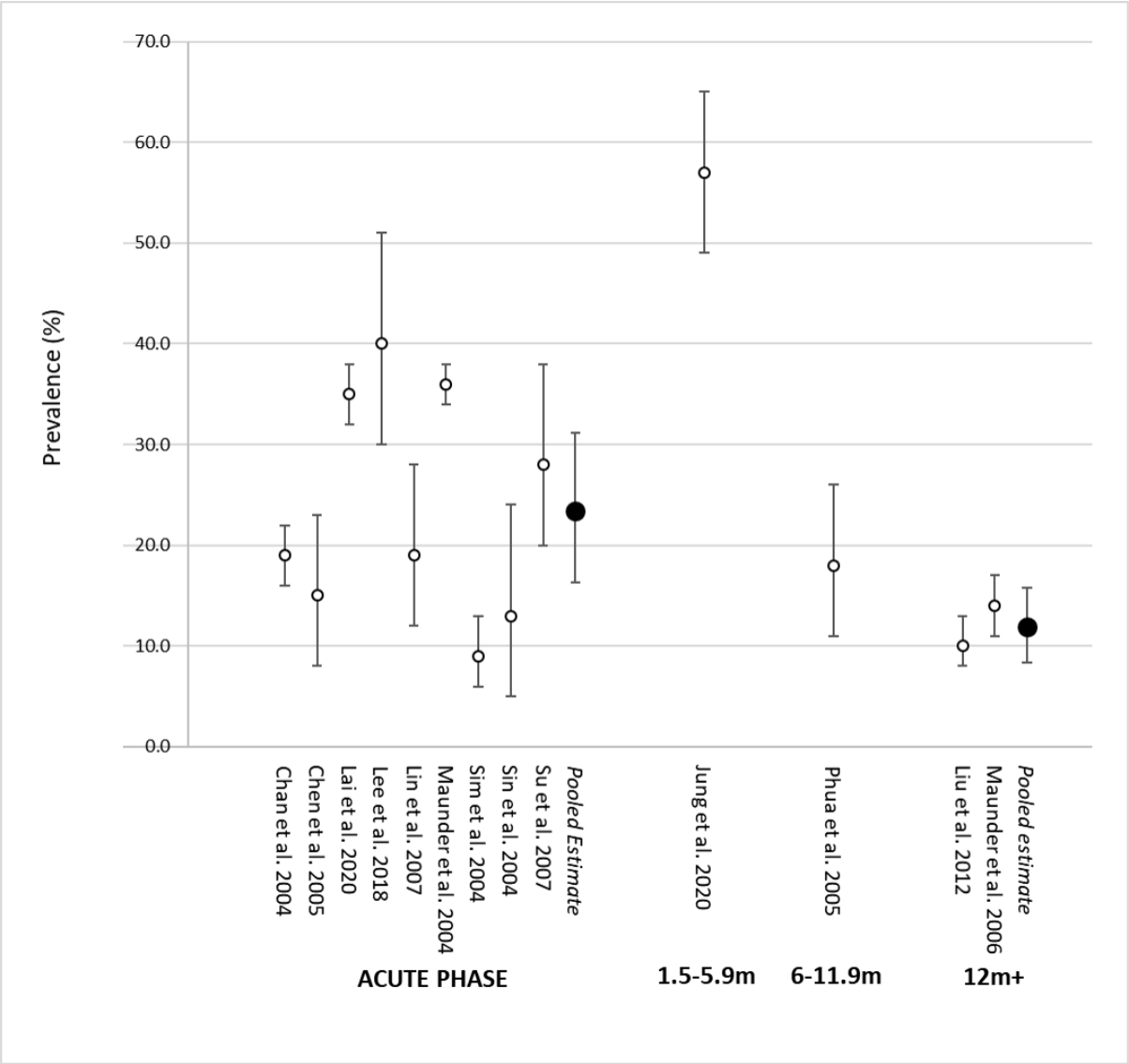

Figure 2. Forest plot showing prevalence of PTSS by time window.

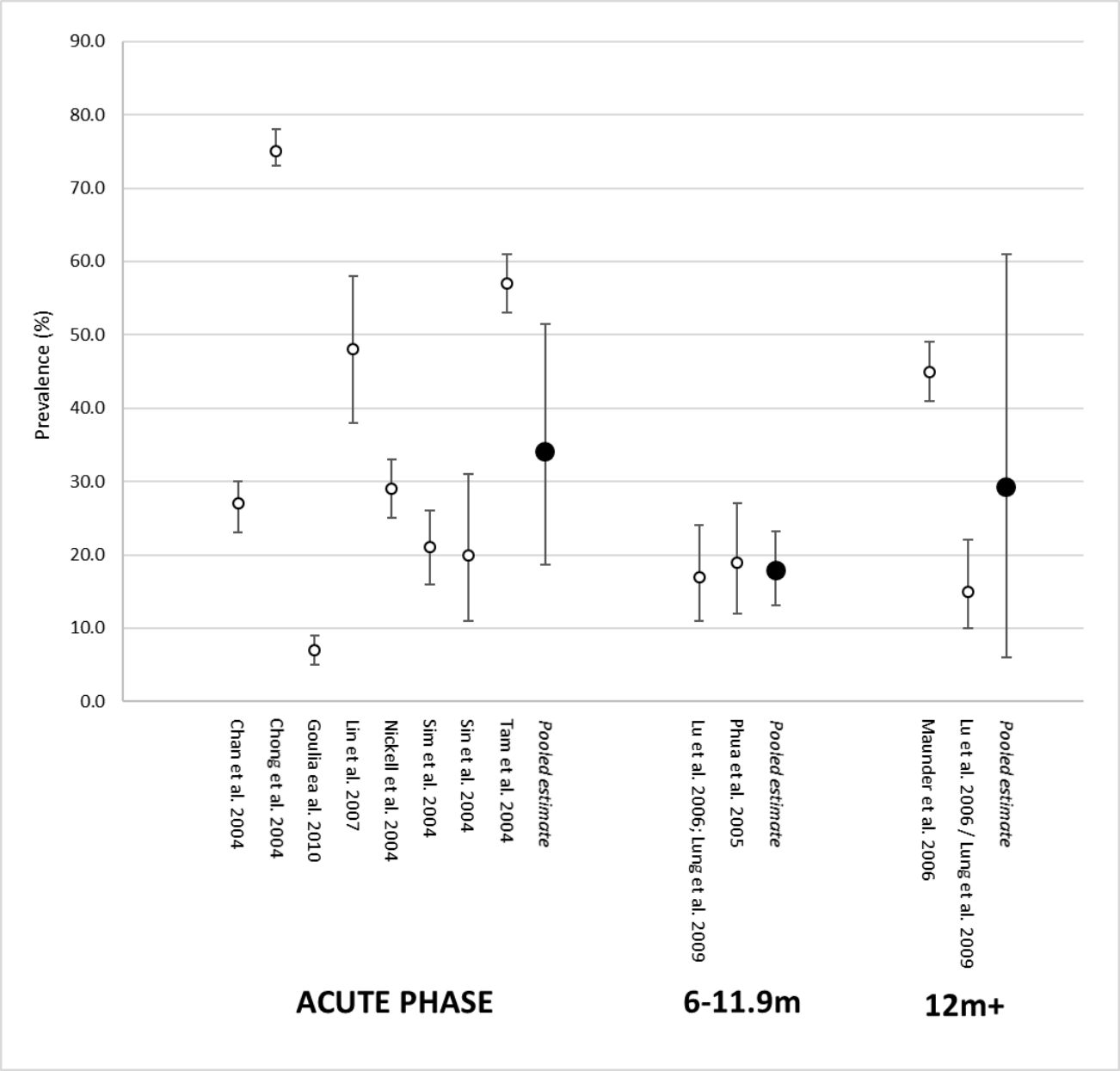

Figure 3. Forest plot showing prevalence of General Psychiatric Screening by time window.