Factors affecting mental health of health care workers during coronavirus disease outbreaks: a rapid systematic review

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Abstract

Introduction: The novel Coronavirus Disease (COVID-19) outbreak currently puts health care workers at high risk of both infection and mental health problems. Considering their pivotal role in tackling this pandemic crisis, providing adequate mental health care for health care workers is imperative. This study aimed to identify the risk and protective factors for mental health outcomes in health care workers during coronavirus epidemics.

Methods: A rapid systematic review was performed in three databases and current COVID-19 resources (search date March 24, 2020). Following study selection, study characteristics and effect measures were tabulated, and data were synthesized by using vote counting based on direction of effect. Risk of bias of each study was assessed and the certainty of evidence was appraised according to the GRADE methodology.

Results: Out of 2605 references, 28 observational studies were selected and the identified risk and protective factors were categorized in ten thematic categories. The level of disease exposure, being quarantined as health care worker, and health fear were significantly associated with worse mental health outcomes. There was evidence that clear communication and support from the organization, social support and personal sense of control and coping ability are effective protective factors. No specific mental health interventions for assisting health care workers in mental distress during infectious disease outbreaks were identified. The evidence was of very low certainty, because of risk of bias and imprecise results.

Conclusion: Safeguarding mental health of health care workers during infectious disease outbreaks should not be treated as a separate mental health intervention strategy, but requires a protective approach. This study therefore suggests that embedding mental health support in a safe and efficient working environment which promotes collegial social support and personal sense of control can help to maximize resilience of health care workers during the COVID-19 global health crisis.

Keywords: Health care worker, post-traumatic stress, anxiety, depression, resilience, COVID-19, acute respiratory syndrome

Introduction

The novel Coronavirus Disease (COVID-19) outbreak, triggered by infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has rapidly evolved into a global pandemic [1]. Similar yet less widespread coronavirus epidemics have occurred in the past, notably the severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) outbreak [2,3]. A common feature of emerging infectious diseases is their rapid increase in incidence, which pressures and potentially exceeds the limits of health care service capacities [4,5].

The current public health emergency exerts significant physical and mental burden on patients, and also health care workers (HCWs) represent a group at specific risk [6]. Typically, they account for a large percentage of patients in infectious disease outbreaks since they provide care for confirmed or suspected cases and/or generally maintain close contacts while social distancing is warranted [7,8]. High rates of mental health problems such as affective disturbances or sleep problems have been frequently described [9]. Current Covid-19 reports similarly indicate high pressure on the mental health of physicians, nurses and hospital-based personnel [10-12].

Considering their great personal risk and pivotal role in tackling this global health crisis, adequate mental health care for health workers is imperative [12-14]. Although plenty of psychosocial initiatives are described, the most effective strategies in a pandemic context are currently unclear [15,16]. We performed a rapid systematic review to identify the best possible evidence on risk and protective factors for psychological outcomes in HCWs during coronavirus epidemics. Our results may inform decisions to safeguard HCW's mental health during this and future respiratory infectious disease outbreaks.

Methods

The reporting of the systematic literature reviews was done according to the PRISMA statements (see S1 Table) [17]. No protocol for the systematic literature searches was published beforehand.

We conducted a systematic literature search in three databases (MEDLINE, via the PubMed interface, Embase, via the Embase.com interface and PsycINFO, via the APA PsycNET database) and available lists with COVID-19 research (COVID-19 Evidence Briefings online [18], PubMed Bibliometric analysis [19] and WHO Database of Global research on COVID-19 [20]) to answer the following research question: What are risk factors/protective factors (I) for the mental health (O) of health care workers during a coronavirus disease outbreak, epidemic or pandemic (P)?

Two reviewers independently developed a search strategy based on search terms describing the HCW, the epidemic, and either mental health outcomes or interventions (full search strategies can be found in S2 Text).

Searches were ran on March 24. Retrieved references were imported in Endnote, duplicates were removed, and study selection was performed by one reviewer, and selected studies were critically evaluated by the second reviewer until consensus was reached.

At the population level we included studies with HCWs in the (pre-)hospital setting during an outbreak of a coronavirus infection, causing the following diseases: SARS, MERS, COVID-19. We included studies describing any risk factor or protective factor, which is relevant to take into account when developing either prevention programs or mental health interventions for HCWs; relevant factors were discussed with content experts. At the outcome level we were interested in any mental health outcome or psychological wellbeing. We included experimental or observational studies, but measures should have controlled for confounding factors (e.g. matching, multivariate regression analyses). Only English language studies were included.

Study characteristics (study type, country, epidemic, population, relevant risk factors for which confounding was taken into account, relevant outcomes with their measurement tool) and study findings [mean difference (MD), adjusted odds ratio (aOR), or regression coefficient (β)] were extracted and tabulated. Outcomes were categorized in 8 categories, based on the measurement scales that were used. Risk and protective factors were categorized in 6 and 4 thematic categories, respectively. A p-value < 0.05 was considered statistically significant.

Since meta-analysis was not possible because of a high variety in factors, outcomes and effect measures (adjusted for different confounding factors), we synthesized the data where possible using vote counting based on direction of effect by comparing the number of comparisons showing harm and benefit, regardless of the statistical significance or size of their results [21]. A binomial test (RStudio) was used to assess the significance of evidence for the existence of an effect in either direction. Since vote counting is a more cautious and conservative approach to research synthesis, a p-value < 0.10 was considered significant.

Limitations in observational study designs were analyzed by assessing the eligibility criteria, methods for exposure and outcome variables, the strategies for controlling for confounding factors, and follow-up, according to the GRADE (Grading of Recommendations Assessment, Development and Evaluation) criteria. This evaluation was followed by a certainty rating of the body of evidence according to the GRADE methodology [22].

Results

Out of 2605 references we selected 28 relevant studies (Fig. 1), of which 27 cross-sectional studies, and one uncontrolled before-and-after study. The majority of these studies dealt with the mental health of HCWs during the SARS epidemic (n=23), three studies surveyed hospital staff during the MERS epidemic, and two studies during the COVID-19 outbreak in Chinese hospitals. The studies reported on a wide range of mental health

outcomes with acute stress/post-traumatic stress symptoms being the most reported outcome. Relevant risk factors and protective factors were clustered in 10 thematic categories, as described below. The study characteristics are summarized in Table 1 and S3 Table. A detailed summary of findings table can be found in S4 Table.

Fig. 1. PRISMA flowchart for the selection of eligible studies.

Table 1. Study characteristics

Author Publication year	Country	Epidemic	Study design	Participants	Outcome measures Measurement tool
Bai 2004 [23]	Taiwan	SARS	Cross-sectional study	338 staff members including HCWs and administrative personnel	- Acute stress disorder, according to DSM-IV
Chan 2004 [24]	Singapore	SARS	Cross-sectional study	661 HCWs	- Posttraumatic stress, Impact of Event Scale - Psychiatric symptoms, 28- item General Health Questionnaire
Chang 2006 [25]	Taiwan	SARS	Cross-sectional study	211 HCWs	- Emotional exhaustion, measured with a questionnaire developed by the researcher
Chen 2005 [26]	Taiwan	SARS	Cross-sectional study	128 nurses	- Post-traumatic stress, Impact of Event Scale - Anxiety, 90-item Symptom Checklist- Revised - Depression, 90-item Symptom Checklist- Revised
Chen 2006 [27]	Taiwan	SARS	Uncontrolled before-and-after study	116 volunteers from the nursing staff	- Anxiety, Zung's self-rating anxiety scale - Depression, Zung's self- rating depression scale - Sleep quality, Pittsburgh sleep quality index
Chen 2007 [28]	Taiwan	SARS	Cross-sectional study	90 HCWs and 82 subjects without contact with SARS patients (e.g. hospital administrators)	- Mental health, part of the general health status, as measured by the Medical Outcome Study Short- Form 36 Survey
Chong 2004 [9]	Taiwan	SARS	Cross-sectional study	1257 staff members including HCWs and administrative workers	- Psychiatric morbidity, 12 item Chinese Health Questionnaire (use of cut- off score)
Ho 2005 [29]	Hong Kong	SARS	Cross-sectional study	97 HCWs who had been infected	- Post-traumatic stress symptoms, The Chinese Impact of Event Scale - Revised
Kim 2016 [30]	South Korea	MERS	Cross-sectional study	215 nurses	- MERS-related burn-out, Oldenburg Burnout Inventory

Koh 2005 [31]	Singapore	SARS	Cross-sectional study	10511 staff members from 3 SARS and 6 SARS-free hospitals	- Stress at work, questionnaire developed by researchers
Lai 2020 [32]	China	COVID-19	Cross-sectional study	1257 HCWs	- Depression, 9-item Patient Health Questionnaire - Anxiety, 7-item Generalized Anxiety Disorder - Insomnia symptoms, Insomnia Severity Index - Distress symptoms, 22-item Impact of Event
Lancee 2008 [33]	Canada	SARS	Cross-sectional	587 HCWs	- Psychological disorder, according to DSM-IV
Liu 2012 [34]	China	SARS	Cross-sectional study	549 HCWs	- Depression, Center for Epidemiologic Studies Depression Scale
Marjanovic 2007 [35]	Canada	SARS	Cross-sectional study	333 nurses	- Emotional exhaustion, Maslach Burnout Inventory-General Survey - State anger, State-Trait Anger Expression Inventory
Maunder 2004 [36]	Canada	SARS	Cross-sectional study	1557 HCWs	- Psychological stress, Impact of Event scale
Maunder 2006 [37]	Canada	SARS	Cross-sectional study	769 HCWs	- Acute stress/post-traumatic stress (symptoms): Posttraumatic stress, Impact of Event Scale - General symptoms of psychopathology: Psychological stress, Kessler Psychological Distress Scale - Emotional exhaustion & Burnout: Professional burnout, Emotional Exhaustion Scale of the Maslach Burnout Inventory
McAlonan 2007 [38]	Hong Kong	SARS	Cross-sectional study	106 high-risk HCWs and 71 control subjects including non-respiratory medicine workers	- Perceived stress scale - Depression, subscale of Depression and Anxiety Scale - Anxiety, subscale of Depression and Anxiety Scale - Stress, subscale of Depression and Anxiety Scale - Post-traumatic stress, Impact of Event Scale
Nickell 2004 [39]	Canada	SARS	Cross-sectional study	510 hospital employees	- Emotional distress, 12-item General Health Questionnaire
Park 2018 [40]	South Korea	MERS	Cross-sectional study	187 nurses working in a high risk area	- Mental Health, Mental Component Summary of Short Form-36 instrument - Perceived stress scale-10

Sim 2004 [41]	Singapore	SARS	Cross-sectional study	277 HCWs	<ul style="list-style-type: none"> - Psychiatric morbidity, 28-item General Health Questionnaire (use of cut-off score) - Post-traumatic morbidity, Impact of Event Scale
Son 2019 [42]	South Korea	MERS	Cross-sectional study	280 HCWs and administrative staff	<ul style="list-style-type: none"> - Likelihood of post-traumatic stress symptoms, Korean version of Impact of Event Scale - Negative emotional experience, 9-point Likert scale
Styra 2008 [43]	Canada	SARS	Cross-sectional study	248 HCWs from high-risk units	<ul style="list-style-type: none"> - Posttraumatic stress, Impact of Event Scale
Su 2007 [44]	Taiwan	SARS	Cross-sectional study	70 nurses from SARS units and 32 nurses from non-SARS units	<ul style="list-style-type: none"> - Depression, Beck Depression Inventory - Post-traumatic stress symptoms, Chinese version of Davidson Trauma Scale - Presence of insomnia, DSM-IV
Tam 2004 [45]	Hong Kong	SARS	Cross-sectional study	652 frontline HCWs	<ul style="list-style-type: none"> - Psychiatric morbidity, 12-item Chinese Health Questionnaire (with use of cut-off score)
Wong 2005 [46]	Hong Kong	SARS	Cross-sectional study	466 HCWs	<ul style="list-style-type: none"> - Mental distress, newly designed scale
Wong 2007 [47]	Canada	SARS	Cross-sectional study	137 doctors	<ul style="list-style-type: none"> - Anxiety, Visual Analogue Scale
Wu 2009 [6]	China	SARS	Cross-sectional study	549 HCWs and administrative staff	<ul style="list-style-type: none"> - Post-traumatic Stress, Impact of Event Scale
Xiao 2020 [48]	China	COVID-19	Cross-sectional study	180 HCWs	<ul style="list-style-type: none"> - Anxiety, Self-Rating Anxiety Scale - Self-efficacy, General Self-Efficacy Scale - Stress, Stanford Acute Stress Reaction Questionnaire - Sleep quality, Pittsburgh Sleep Quality Index

We identified six stressors which might be associated with poor mental health in HCW. In first instance, evidence was found that HCWs exposed to coronavirus were at risk of developing mental health problems with 25 of 29 comparisons showing harm (86%, 95%CI [68%;96%], $p<0.001$) (Table 2) [6,9,24,26,28,31,32,34-38,41,43,45]. The risk factors included, amongst others, direct contact with patients, working in high risk units, high risk of exposure, and working on the frontline. Lai et al. [32] reported that HCWs from 34 hospitals in multiple regions of China with direct contact to COVID-19 patients were at significantly higher risk of experiencing symptoms related to post-traumatic stress (aOR: 1.60, 95%CI [1.25;2.04], $p<0.001$), depression (aOR: 1.52, 95%CI [1.11;2.09], $p=0.01$), anxiety (aOR: 1.57, 95%CI [1.22;2.02], $p<0.001$), and insomnia (aOR: 2.97, 95%CI

[1.92;4.60], $p<0.001$). Other studies were conducted during (or after) the SARS epidemic and, when placing a higher value on the largest studies ($n>1000$), indicate that being exposed (daily) to SARS (aOR: 1.62, 95%CI [1.1;2.4], $p=0.017$ and aOR: 1.33, 95%CI [1.19; 1.49], $p<0.05$) was clearly associated with psychiatric morbidity or more stress at work, respectively [9,31]. Of note, a study by Maunder et al. [36] could not demonstrate a significant association between contact with SARS patients and post-traumatic symptomatology (β : 0.002, 95%CI [-0.054;0.059, $p=0.95$).

Table 2. Synthesis of the impact of identified risk and protective factors on the development of mental health problems based on vote counting of the direction of effect. The unknown directions of effect represents the factors which did not significantly contributed to the multivariate regression analyses and of which the direction of effect was not reported.

Variable	Direction of effect			Vote counting		
	Risk (# comparisons)	Protective (# comparisons)	Unknown (# comparisons)	Proportion	95% CI	P value
Risk factors						
Level of disease exposure	25	4	12	86%	[68;96]	<0.001
Being quarantined	5	0	3	100%	[48;100]	0.063
Job stress and dissatisfaction	7	2	1	78%	[40;97]	0.180
Risk perception and fear	11	1	2	92%	[62;100]	0.006
Stigma	4	0	4	100%	[40;100]	0.125
Loss of control and emotional disruption	3	0	0	100%	[29;100]	0.250
Protective factors						
Organizational communication and support	1	10	2	91%	[59;100]	0.012
Physical safety and training	2	6	7	75%	[35;97]	0.289
Social support	2	11	3	85%	[55;98]	0.022
Sense of control and coping ability	0	6	0	100%	[54;100]	0.031

Secondly, four included studies (5 comparisons) indicated that HCWs who were quarantined (100%, 95%CI [48%;100%], $p=0.063$) have worse mental health outcomes (Table 2) [6,23,34,35]. The largest studies ($n>500$) indicate that being quarantined is associated with post-traumatic stress (aOR: 2.09, 95%CI [1.00;4.37], $p<0.05$) or depression (aOR: 5.06, 95%CI [2.12, 12.10], $p<0.05$) [6,34]. Of note, quarantine was not identified as a significant risk factor in the univariate analysis, and thus not entered in the regression models of Maunder et al. [37]. Two smaller studies also reported significant associations between quarantine and development of acute stress disorder [23] and anger [35]. The latter study could not demonstrate a significant impact of time spent in quarantine on emotional exhaustion [35].

Thirdly, the body of evidence on job stress and dissatisfaction could not demonstrate a clear association with mental health problems but only a suggestive trend, with seven of the nine comparisons showing harm (78%, 95%CI [40%;97%], $p=0.180$) (Table 2) [26,30,34,36,39,43,46]. When focusing on the larger studies ($n>500$),

Maunder et al. [36] found a clear association between job stress and post-traumatic stress (β : 0.208, 95%CI [0.162;0.254], $p<0.001$), while Liu et al. [34] could not demonstrate a significant association between job stress and depression (aOR: 0.60, 95%CI [0.16;2.19], $p<0.05$). Three smaller studies found that job stress, impact on work life, and being involuntary conscripted to a high risk unit, were significantly associated with post-traumatic stress, depression, or burn-out [26,30,43]. The latter risk factor was not significantly associated with the presence of symptoms related to anxiety or general mental distress [26,46]. Moreover, job stress related to precautionary measures or hospital procedures was significantly associated with emotional distress (aOR: 2.9, 95% [1.9;4.6], $p<0.05$) in a study of Nickell et al. [39], while Maunder et al. [36] found no association between dissatisfaction with procedures and post-traumatic stress.

Fourthly, evidence exists that HCWs experiencing fear or risk of becoming infected or infecting others may suffer from mental health problems with 11 of 12 comparisons showing harm (92%, 95%CI [62%;100%], $p=0.006$) (Table 2). Fear of infection and perception of risk were generally significantly associated with post-traumatic stress, depression, insomnia, and (mental) distress [6,29,34,36,39,42-44,46], while a significant effect of perception of risk to others or family could not be demonstrated [43,46]. Of note, the study by Kim and Choi [30] was not able to demonstrate a significant association between fear for MERS-infection and burnout.

Lastly, although a suggestive trend exists that stigma, including avoidance and social isolation (100%, 95%CI [40%;100%], $p=0.125$) [36,37,39,40,46], and loss of control and emotional disruption (100%, 95%CI [29%;100%], $p=0.250$) [29,42,46] can lead to mental distress, no significant association could be demonstrated due to the low number of events (Table 2).

Furthermore, four factors which may protect HCWs for developing mental health problems during coronavirus disease outbreaks were identified. First, ten out of 11 comparisons (91%, 95%CI [59%;100%], $p=0.012$) indicated that HCWs who receive clear communication and support from the organization were less likely to develop mental health problems (Table 2) [24,27,35,43,45]. The clear communication of directives and precautionary measures has a beneficial impact on psychiatric symptoms (aOR: 0.51, 95% CI [0.29;0.90], $p=0.020$), while a statistical association could not be demonstrated with post-traumatic stress [24]. The provision of support and adequate insurance and compensation by the organization significantly relieved feelings of anger (β : 0.24, 95%CI [0.13;0.35], $p=0.000$) and reduced psychiatric morbidity (aOR: 0.52, 95%CI [0.29;0.93], $p<0.05$), respectively [35,45]. Other factors such as confidence in the information provided and expressing opinions through staff unions or mass media were not statistically significant in multivariate logistic regression analyses [43,45]. More in particular, there is evidence that a implementing a supportive prevention program, including the availability of a

mental health team, training, detailed manpower allocation, and adequate equipment, substantially improved symptoms of anxiety and depression along with sleep quality of the nursing staff [27]. In line with this result, perception of adequate counseling and psychological support from the employer was found to statistically lower the psychiatric morbidity of HCWs (aOR: 0.53, 95%CI [0.31;0.89], $p<0.05$) [45].

Regarding physical safety and training, the body of evidence could not demonstrate a clear association, but only provided a suggestive trend that provision of physical safety and training protects HCWs from developing mental health problems with six of the eight comparisons showing benefit (75%, 95%CI [35%;97%], $p=0.289$) (Table 2) [33,35-37,39,43,45,47]. Evidence exists that perceived adequacy of training and support was negatively associated with post-traumatic stress (β : -0.22, 95%CI [-0.38;-0.06], $p=0.01$), burnout (β : -0.27, 95%CI [-0.44;-0.10], $p=0.002$), [37] and psychological disorder (β : -0.20, $p=0.03$) [33]. Similarly, trust in precautionary measures, equipment and infection control initiatives also protected HCWs from emotional exhaustion (β : -0.15, 95%CI [-0.26;-0.05], $p=0.005$), distress (aOR: 0.4, 95%CI [0.3;0.5], $p<0.05$) or state anger (β : -0.14, 95%CI [-0.25;-0.03], $p=0.011$) [35,39]. On the contrary, Wong et al. [47] found that training in handling infectious diseases increased anxiety amongst HCW (aOR: 5.41, 95%CI [1.02;28.79], $p=0.048$). No statistical associations between doubt about protection, unprotected exposure, infection control measures/guidelines and protective facilities and mental health outcomes could be demonstrated [37,43,45].

Next, HCWs perceiving social support are more resilient against mental distress with 11 of 13 comparisons showing benefit (85%, 95%CI [55%;98%], $p=0.022$) (Table 2) [24,25,30,45,48]. Of particular interest, Xiao et al. [48] found that levels of social support for HCWs who recently treated patients with COVID-19 infection, were significantly associated with self-efficacy (β : 0.023, 95%CI [0.011;0.035], $p<0.001$), and negatively associated with degree of anxiety (β : -0.781, 95%CI [-0.948;-0.614], $p<0.0001$) and stress (β : -0.704, 95%CI [-1.161;-0.247], $p=0.003$). A clear association with sleep quality could not be demonstrated. There is evidence that especially the support from supervisors and colleagues is beneficially associated with post-traumatic stress (aOR: 0.33, 95% CI [0.16;0.69], $p=0.003$) and psychiatric symptoms (aOR: 0.35, 95% CI [0.17;0.69], $p=0.003$), while a significant effect could not be demonstrated for support from family or the ability to talk about concerns [24,45]. Two other studies reported that social support measures significantly lowered emotional exhaustion or burn-out [25,30]. Four other social support factors such as sense of coherence, interaction and appreciation by the community did not statistically contribute to regression model analyses.

Four included studies (six comparisons) indicated that sense of control and coping ability makes HCWs more resilient against the development of mental health problems (100%, 95%CI [54%;100%], $p=0.031$) (Table 2)

[29,35,40,42]. Especially factors such as levels of vigor and hardiness were negatively associated with perceived stress, emotional exhaustion, mental health, and state anger [35,40]. Significant effects of perceived self-efficacy or coping ability in HCWs could not be demonstrated [29,42]. Specific coping strategies were not included in our data synthesis, but it was shown that venting, humor, and altruistic acceptance were coping strategies resulting in a statistically significant decrease of post-traumatic morbidity [6,41], while for other strategies this association could not be demonstrated [41].

Finally, we assessed the limitations in study design for all included studies individually (S5 Table). The 28 studies included were observational studies, leading to an initial “low” certainty level. The certainty of evidence was downgraded (-1) for limitations in study design. All but one study had a cross-sectional design, and no causal relationships can be inferred. We assessed the studies at high risk of recall and selection bias, with 25% of the studies having a response rate lower than 50%. The response rate varied between 10.5 and 92.9%. The overall certainty of evidence was further downgraded because of imprecision (-1) due to limited sample sizes, large variability of the results and/or lack of data, resulting in “very low”-certainty evidence meaning that any estimate of effect is very uncertain.

Discussion

We identified 27 cross-sectional studies and 1 before-and-after study. A relatively large body of evidence resulted in the following risk factors: level of disease exposure, being quarantined as HCW, and health fear. A limited number of studies also suggested job stress and dissatisfaction, and stigma as risk factors. We also identified factors that are protective for mental health problems, including clear communication and support from the organization, social support, and sense of control and coping ability. Less compelling evidence was found about providing physical safety and training to HCW as protective factors.

We only included two studies on COVID-19 that fulfilled our selection criteria. One of the excluded studies suggests that female nurses with a marriage history are more likely to suffer from psychological disorders due to COVID-19 exposure [49]. Two other Chinese studies reported 73% stress-related symptoms in medical staff workers [11], and 23% anxiety in first-line medical staff [10], but did not measure any risk or protective factors. One qualitative study from China described the difficulties encountered with implementing psychological interventions, including online courses, a psychological assistance hotline team and various group activities to release stress [14].

This systematic review has several limitations. First, because of time pressure, study selection was done by only one reviewer, we only screened a limited number of databases, and did not further check reference lists of included

studies. On the other hand, we used a sensitive search strategy, surveilled relevant grey literature, and two reviewers independently compared the included studies against the selection criteria. Second, the quality of the included studies was very low, as the majority of studies had a cross-sectional design, which made it difficult to infer causal relationships from the results. However, within the available cross-sectional studies, we decided to only focus on those studies that controlled for confounding factors. Third, since there was a high variation in outcome measures, risk factors, and measurement tools, it was difficult to synthesize the findings, and we used vote counting based on direction of effect as synthesis method. To avoid fragmentizing the body of evidence, we combined several mental health outcomes in this analysis, for the different categories of risk/protective factors. Vote counting provides no information on magnitude of effect and takes no account of the differences in relative sizes of each study.

The findings of this systematic review are highly relevant for supporting the HCWs facing the current COVID-19 pandemic and advanced the conclusions of previous systematic evaluations. One review (search date 2009) dealt with the relation of the occurrence of work-related critical incidents and mental health of HCWs, and confirmed that treating victims of terror or disease outbreaks or, more general, treating patients in critical care treatments, had a small to medium impact on post-traumatic stress symptoms, anxiety, and depression in HCWs [50]. However, this review did not identify risk or protective factors determining the mental health status of HCWs, and the population was not limited to disease outbreaks. Another systematic review [51] studied the psychological wellbeing of HCWs involved in the SARS epidemic (search date 2015). The data were synthesized in a thematic narrative analysis. The review concluded that the mental health impact of SARS on HCWs was associated with occupational role, training/preparedness, high-risk work environments, quarantine, role-related stressors, perceived risk, social support, social rejection/isolation and impact of SARS on personal or professional life. In addition to the evidence from the SARS epidemic, the current systematic review now also includes more recent evidence from other coronavirus epidemics, such as MERS and COVID-19. An added value of the current study is the focus on studies that used methods to take into account confounding factors, and the use of quantitative data extraction and synthesis for listing which factors are significantly associated with worse or better mental health outcomes. The body of evidence identified in this study now clearly indicates that especially the provision of support (programs) by hospital organizations, social support (by colleagues) and sense of control and coping ability are primordial to bolster the mental health of HCW. At the same time, the review quantitatively ascertained that high-risk work environments, quarantine and health fear are clear stressors for HCWs. Very recently, Brooks et al. [52] found in the general population that being quarantined is indeed associated with negative psychological

effects. Although the reviewers searched for specific mental health interventions such as debriefing for supporting HCWs during coronavirus disease outbreaks, no such interventions were identified.

Although there is little if any evidence for specific mental health interventions, several risk and protective factors for mental health of HCWs on the organizational, social and personal level were identified. All the available evidence therefore indicates that safeguarding their mental health during infectious disease outbreaks should not be treated as a separate mental health intervention strategy, but requires an integrated protective approach. Embedding mental health support in a safe and efficient working environment which promotes collegial social support and personal sense of control can help to maximize resilience of health workers during the current global health crisis. Our review has several implications for practice and we formulated a number of considerations and recommendations:

- * Sense of support by the organization: Apart from structural support and efficient communication, monitoring of well-being of HCWs is recommended. Awareness by HCWs of internal (e.g. a mental health support team) and external mental health initiatives (e.g., mental health hotlines or websites, contact information of mental health organizations) should be ensured.

- * Provide opportunity to talk, listen to concerns and offer empathic support: these guidelines protect mental health in general and empathic and supportive interactions between colleagues as well as with supervisors should be promoted. Providing specific occasions to share concerns and support could be helpful. Training such supportive skills could provide further benefit.

- * Protect physical safety: providing a safe working environment and adequate and timely information about the required precautionary measures, could help to correct overly strong risk perceptions if applicable. Adequate formal training could further protect both physical and mental health.

- * Reduce the impact of changing job demands (unfamiliar tasks, changing working conditions, work overload, ...): this could include clear definitions and communication of changed duties, and safeguarding sufficient rest is available. Considerations for the COVID-19 outbreak by the World Health Organization (WHO) [53] for example suggest rotating HCWs from higher-stress to lower-stress functions.

- * Maximize sense of control of HCWs: the aforementioned provision of information, clear communication and efficient organization could partially contribute in this respect, as could promoting the idea of challenge instead of threat in light of the outbreak. Paying attention to feelings and cognitions of control could be beneficial in resilience training programs.

* HCWs that are quarantined should receive continuous support from supervisors and colleagues. Quarantine should not last longer than necessary.

* HCWs in high-risk occupations require additional attention and proactive mental health monitoring. The above recommendations might be specifically beneficial for this subgroup, which proves vulnerable to developing mental health problems.

Finally, our review also highlights the need for future research, with a focus on better study designs. These could include more longitudinal studies, with a follow-up measurement after the crisis period. In addition, studies defining a specific exposed and non-exposed group (cohort-type studies) or a case and control group (case-control type studies), where both groups are properly matched based on important confounding variables, would provide useful information. Since we only identified one study that measured the impact of a specific program, including mental health aspects, there is a clear need for studies reporting on the effectiveness of concrete mental health interventions.

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Supporting information captions

S1 Table. PRISMA checklist

S2 Text. Search strategies

S3 Table. Detailed study characteristics

S4 Table. Summary of findings

S5 Table. Risk of bias assessment

421 **Fig. 1. PRISMA flowchart for the selection of eligible studies.**