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Review article

PTSD symptoms in healthcare workers facing the three coronavirus outbreaks: What can we expect after the COVID-19 pandemic



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ABSTRACT

The CoronaVirus Disease-19 (COVID-19) pandemic has highlighted the critical need to focus on its impact on the mental health of Healthcare Workers (HCWs) involved in the response to this emergency. It has been consistently shown that a high proportion of HCWs is at greater risk for developing Posttraumatic Stress Disorder (PTSD) and Posttraumatic Stress Symptoms (PTSS). The present study systematic reviewed studies conducted in the context of the three major Coronavirus outbreaks of the last two decades to investigate risk and resilience factors for PTSD and PTSS in HCWs. Nineteen studies on the SARS 2003 outbreak, two on the MERS 2012 outbreak and three on the COVID-19 ongoing outbreak were included. Some variables were found to be of particular relevance as risk factors as well as resilience factors, including exposure level, working role, years of work experience, social and work support, job organization, quarantine, age, gender, marital status, and coping styles. It will be critical to account for these factors when planning effective intervention strategies, to enhance the resilience and reduce the risk of adverse mental health outcomes among HCWs facing the current COVID-19 pandemic.

1. Introduction

The outbreak of Corona Virus Disease-19 (COVID) that emerged in December 2019 in Wuhan (China), quickly spread outside of China, leading the World Health Organization (WHO) Emergency Committee to declare a Public Health Emergency of International Concern (PHEIC) on January 30th 2020 (Nishiura, 2020), and a pandemic on March 11, 2020. The SARS-CoV2 – the virus responsible for COVID-19 – was isolated by 7th January 2020, and belongs to the same viral family as the coronavirus syndrome (SARS-CoV) and the Middle East respiratory coronavirus syndrome (MERS-CoV). Both of these coronavirus-based respiratory syndromes infected over 10,000 cases in the past two decades, with overall mortality rates as high as 11% and 35%, respectively (Peeri et al., 2020; de Wit et al., 2016; Leung et al., 2004; WHO, 2004). Compared to the Severe Acute Respiratory Syndrome (SARS) and the Middle East Respiratory Syndrome (MERS), the Corona Virus Disease-19 (COVID-19) has a greater transmission rate but a lower, though still significant, fatality rate (Peeri et al., 2020; Huang et al., 2020). To date, with more than 14 million infected worldwide and a spread that is far from being contained, investigating

the psychological impact of this pandemic on healthcare workers (HCWs) including physicians and nurses, has become increasingly important.

In the last two decades, first responders' mental health outcomes has been the focus of increasing attention, particularly in the aftermath of September 11 2001, terrorist attacks that shed light on the risks they are exposed to when operating in emergency settings, as they may be affected by physical and mental disorders, such as burnout and post-traumatic stress disorder (PTSD) (Perlman et al., 2011; Carmassi et al., 2016, 2018; Martin et al., 2017). The DSM-5 (APA, 2013) indicates that "experiencing repeated or extreme exposure to aversive details of the traumatic event(s)" can be considered as potentially traumatic events (criterion A4: e.g. first responders collecting human remains, police officers repeatedly exposed to details of child abuse).

Healthcare Workers (HCWs) in emergency care settings are particularly at risk for PTSD because of the highly stressful work-related situations they are exposed to, that include: management of critical medical situations, caring for severely traumatized people, frequent witnessing of death and trauma, operating in crowded settings, interrupted circadian rhythms due to shift work (Figley, 1995; Crabbe et al.,

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2004; Cieslak et al., 2014; Berger et al., 2012; Hegg-Deloye et al., 2013; Garbern et al., 2016). PTSD rates have been reported to range from 10 to about 20% (Grevin, 1996; Clohessy and Ehlers, 1999; Robertson and Perry, 2010; DeLucia et al., 2019), with even higher PTSD rates (8% to 30%) among Intensive Care Unit (ICU) staff, (Mealer et al., 2009; Karanikola et al., 2015; Machado et al., 2018).

Although most individuals prove to be resilient after being exposed to a traumatic event (Bonanno et al., 2007), several risk factors may compromise the effectiveness of adaptation, including prior psychiatric history, female sex, lack of social support (Brewin et al., 1999; Ozer et al., 2003; Carmassi et al., 2020a, 2020b), having young children (Yehuda et al., 2015; Bryant 2019); experiencing feelings of helplessness during the trauma or intensity of emotions when exposed (i.e., anger, peritraumatic distress) (Vance et al., 2018; Carmassi et al., 2017). On the other hand, resilience, defined as the capacity to react to stress in a healthy way through which goals are achieved at a minimal psychological and physical cost (Epstein and Krasner, 2013), plays a key role in mitigating the impact of traumatic events and hence reducing PTSS, enhancing at the same time the quality of care (Wrenn et al., 2011; Ager et al., 2012; Haber et al., 2013; McGarry et al., 2013; Craun and Bourke, 2014; Hamid and Musa, 2017; Colville et al., 2017; Cleary et al., 2018; Winkel et al., 2019).

This interplay of risk and resilience factors becomes even more complex and challenging when applied in the context of an infectious epidemic. This statement is first supported by the fact that, as previous studies outlined, during epidemics a high percentage of HCWs, (up to 1 in 6 of those providing care to affected patients), develops significant stress symptoms (Lu et al., 2006; McAlonan et al., 2007). It is worth considering that in epidemic contexts HCWs are first in line facing the clinical challenges intrinsically linked to the course of the disease while under the constant personal threat of being infected or representing a source of infection.

The current COVID-19 pandemic is characterized by some relevant features that increase the risk for PTSD among HCWs addressing the emergency, such as the unprecedented numbers of critically ill patients, with an often unpredictable course of the disease, high mortality rates and lack of effective treatment, or treatment guidelines (Wang, 2020; Peeri et al., 2020). Thus, the burden of the current outbreak on healthcare providers deserves the closest attention, as it is extremely likely that health care workers involved in the diagnosis, treatment and care of patients with COVID-19 are at risk of developing psychological distress and other mental health symptoms (Bao et al., 2020; Lai et al., 2020; Carmassi et al., 2020c).

The aim of the present paper is therefore to systematically review the studies investigating the potential risk and resilience factors for the development of PTSD symptoms in HCWs who faced the two major Coronavirus outbreaks that occurred worldwide in the last two decades, namely the SARS and the MERS, as well as the ongoing COVID-19 pandemic, in order to outline effective measures to reduce the HCWs' psychiatric burden during the current crisis affecting healthcare systems all over the world.

2. Methods

2.1. Search strategy

We reviewed articles indexed in the electronic database PubMed until 20th April 2020. No time limit was set in regard to the year of publication. The search terms were combined with the Boolean operator as follows: "(Post-traumatic stress OR Post-traumatic stress disorder OR Post-traumatic stress symptoms OR PTSD OR PTSS) AND (Severe Acute Respiratory Syndrome OR SARS OR Middle East Respiratory Syndrome OR MERS OR Corona Virus Disease 19 OR COVID-19 OR Coronavirus)". Furthermore, relevant articles were extracted from the references section of the manuscripts found in the initial search, to complete our search.

2.2. Eligibility criteria

We included articles that met the following inclusion criteria: original studies on humans investigating possible risk and/or resilience factors for PTSD symptoms in HCWs facing the coronavirus outbreaks of SARS, MERS and COVID-19. Articles in print or published ahead of print were accepted. The exclusion criteria were: (a) studies involving general population samples that did not consider a sub-sample of HCWs; (b) studies examining other mental health symptoms but not PTSS; (c) studies assessing PTSS but not considering potential risk and resilience factors; (d) literature reviews; (e) full text not available; (f) not available in English.

2.3. Study selection

The first author screened each study for eligibility by reading the title and abstract. Any uncertainties about eligibility were clarified through discussion among all authors. Decisions for inclusion or exclusion are summarized in a flowchart according to PRISMA recommendations, usually used to conduct meta-analyses and systematic reviews of randomized clinical trials, but that have also been used for other types of systematic reviews such as our present one (Moher et al., 2009).

3. Results

3.1. Process of study selection

The study selection process is outlined in a flow-chart (Fig. 1). The electronic database search returned 263 publications. Following a preliminary screening of the titles and abstracts, 47 articles were considered of potential relevance, their eligibility was assessed by means of a full text examination. Twenty-four of these studies, published between 2004 and 2020, were included in this review. The main reasons for study exclusion were: the absence of a HCW sample or sub-sample, the lack of data regarding PTSS and/or about possible risk or resilience factors related to psychopathology.

3.2. Characteristics of included studies

The key characteristics of the studies included are summarized in Table 1. All retrieved studies were published between January 2004 and April 2020. Nineteen studies were on the SARS 2003 outbreak, two on the MERS 2012 outbreak, and three on the ongoing Covid-19 outbreak. Nine studies were on a mixed population in which HCWs represented a sub-sample (Bai et al., 2004; Chong et al., 2004; Kwek et al., 2006; Reynolds et al., 2007; Lancee et al., 2008; Wu et al., 2009; Mak et al., 2010; Wing and Leung, 2012; Li et al., 2020) while all other studies included HCWs only. Finally, five studies included specifically survivors from the infection (Kwek et al., 2006; Lee et al., 2007; Mak et al., 2010; Wing and Leung, 2012; Ho et al., 2005).

3.3. PTSD and PTSS risk factors in HCWs facing the coronavirus outbreaks

3.3.1. Level of exposure

Ten studies (Chong et al., 2004; Maunder et al., 2004; Lin et al., 2007; Su et al., 2007; Styra et al., 2008; Wu et al., 2009; Lee et al., 2018; Lai et al., 2020; Kang et al., 2020; Jung et al., 2020) highlighted the role of exposure level, such as working in high-risk wards or in front-line settings during the Coronavirus outbreaks, as the major risk factor for developing PTSS and PTSD. Particularly, they pointed out the relevance of perceived threat for health and life and the experienced feelings of vulnerability as mediating factors. Most of these studies reported on the 2003 SARS outbreak. Lin et al. (2007) showed higher rates of PTSD (21,7%) among 66 emergency department staff compared to 26 HCWs of non-emergency departments (i.e., psychiatric ward,

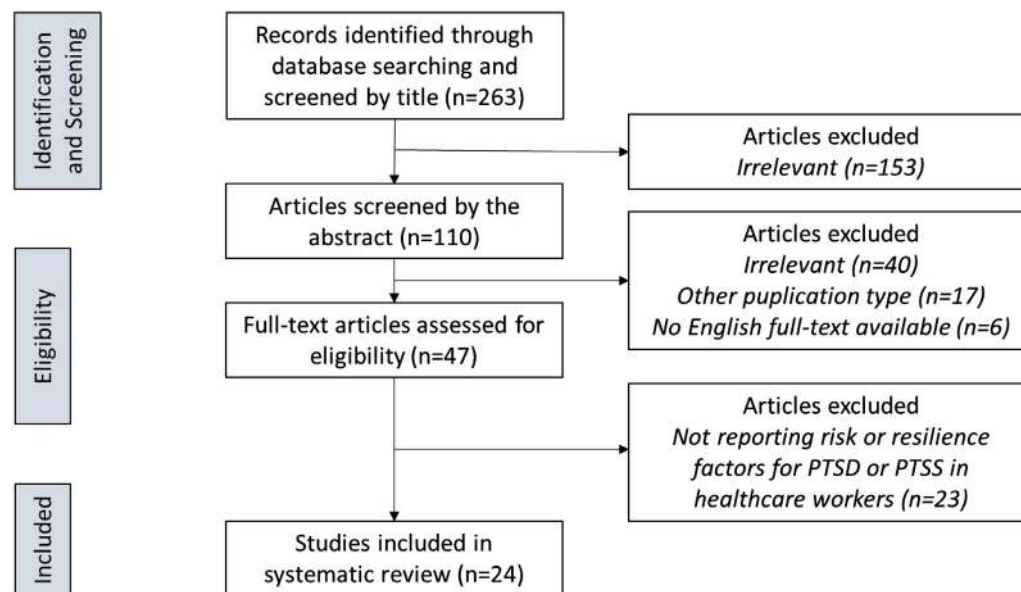


Fig. 1. PRISMA flowchart of studies selection process.

13%). Wu et al. (2009) investigated a sample of 549 HCWs in Beijing (China), including administrative staff, finding 2 to 3 times higher PTSS rates among respondents who worked in high-risk locations and perceived high SARS-related risks, beside an increased risk for subsequent alcohol abuse/dependence. This latter resulted significantly related with hyper-arousal symptoms. A further study in Toronto (Styra et al., 2008) confirmed the impact of operating in a high-risk unit, and first reported that caring for only one SARS patient was related to a higher risk than caring for multiple SARS patients. A recent study on 147 nurses who worked in MERS units during the outbreak found higher PTSD rates among emergency HCWs than among non-emergency ones (Jung et al., 2020). To date, two studies have explored this issue in the COVID-19 pandemic. Li et al. (2020) found among 526 nurses, that those who worked on the frontline appeared to be less prone to developing PTSS compared to second-line ones; conversely Kang et al. (2020) in a large study on 994 HCWs in Wuhan reported the exposure level to infected people, more broadly including colleagues, relatives or friends, to be a risk factor for mental health problems, including PTSS.

3.3.2. Occupational role

Five studies, four on the SARS epidemic and one on the COVID-19 pandemic, highlighted the occupational role as a major risk factor for PTSD or PTSS in Coronavirus outbreaks. Maunder et al. (2004) found on a sample of 1557 HCWs collected in Toronto, higher PTSS rates among nurses and explained this finding by means of the longer contact and higher exposure to patients of the nursing staff. A study on 96 emergency HCWs, assessed six months after the 2003 SARS outbreak, revealed a greater burden of PTSS among nurses than among physicians (Tham et al., 2004). A further study by Phua et al. (2005) confirmed this finding in a sample of 99 HCWs. Finally, a most recent study on 1257 hospital physicians and nurses caring for COVID-19 patients reached the same conclusion (Lai et al., 2020).

3.3.3. Age and gender

Three studies on the SARS outbreak and one on the COVID-19 pandemic reported that younger HCWs had a greater risk of developing PTSS (Sim et al., 2004; Su et al., 2007; Wu et al., 2009). From a wider perspective, further studies pointed out an association between fewer years of work experience and an increased PTSS risk in HCWs, as described in two SARS studies (Chong et al., 2004; Lancee et al., 2008) and in one COVID-19 study (Lai et al., 2020). As far as gender is

concerned, while one recent study on COVID-19 reported a higher risk for the female HCWs, a previous study involving 1257 HCWs in a tertiary hospital affected by SARS found an increased risk of PTSS among males (Chong et al., 2004).

3.3.4. Marital status

Three studies focused on the relevance of marital status, two of which referred to the SARS outbreaks and one to the current COVID-19 pandemic. Chan and Huak (2004) in a study on 661 HCWs in Singapore showed that those who were not married were more adversely affected than married ones. In contrast, a further study in Singapore (Sim et al., 2004) found a positive association between post-traumatic morbidities and being married. Likewise, a recent case control study on HCWs facing the COVID-19 pandemic showed that married, divorced or widowed operators reported higher scores in vicarious traumatization symptoms compared to unmarried HCWs (Li et al., 2020).

3.3.5. Quarantine, isolation and stigma

Three SARS studies on Chinese hospital staff members (Bai et al., 2004; Reynolds et al., 2007; Wu et al., 2009) and one on the MERS outbreak (Lee et al., 2018) consistently reported high levels of PTSS among HCWs who had been quarantined. More specifically, Bai et al. (2004) examining 338 HCWs in an East Taiwan hospital found that 5% of them suffered from acute stress disorder, with quarantine being the most frequently associated factor, and a further 20% felt stigmatized and rejected in their neighborhood because of their hospital work, with also 9% reporting reluctance to work and/or considering quitting their job. Similar findings emerged from a Canadian SARS study on 1057 subjects (Reynolds et al., 2007), in which quarantined HCWs reported more PTSS than non-HCWs quarantined individuals. Moreover, in a study on MERS outbreak, Lee et al. (2018) assessed PTSS experienced by 359 university HCWs who cared for infected patients, observing that quarantined HCWs had a higher risk of developing PTSS which persisted over time, particularly sleep and numbness-related symptoms. More in general, social isolation and separation from family was found to be associated with higher rates of PTSS in SARS outbreak, as well as having friends or close relatives with the infection (Maunder et al., 2004; Chong et al., 2004; Wu et al., 2009).

3.3.6. Previous psychiatric disorders

Three studies on SARS have stressed the presence of previous psychiatric disorders as a risk factor for the development of PTSS

Table 1

Main characteristics of included studies.

Study	Outbreak	Type	Sample	PTSS/PTSD measures	Main general findings	Main risk and resilience factors
Bai et al. (2004)	SARS	Cross-sectional study	557 hospital staff members (HCWs $n = 402$; administrative personnel $n = 155$)	SARS-related stress reactions questionnaire	5% acute stress disorder; 20% stigmatized; and 9% reluctance to work or considered resignation	Risk factor: quarantine
Chan and Huak (2004)	SARS	Cross-sectional study	661 HCWs (doctors and nurses)	Impact of Events Scale	20% IES score > 30 ; 27% psychiatric symptoms (35% of doctors and 25% of nurses)	Resilience factors: Support from family/supervisors/colleagues, work organization (clear directives/precautionary measures from management)
Chong et al. (2004)	SARS	naturalistic, observational study	1257 hospital staff members (nurses $n = 676$; doctors $n = 139$; health administrative workers $n = 140$; others $n = 302$)	Impact of Event Scale	IES mean score = 34.8; 75.3% psychiatric symptoms (anxiety and worrying, depression and interpersonal difficulties, somatic problems) in the initial phase of the outbreak	Risk factors: male; technicians; ≤ 2 years work experience; level of exposure
Maunder et al. (2004)	SARS	cross-sectional study	1557 HCWs	Impact of Events Scale	Higher Impact of Event Scale scores are found in nurses and HCWs having contact with SARS patients.	Risk factors: level of exposure; nurses; perceived threat for their health; social isolation
Sim et al. (2004)	SARS	cross-sectional study	277 HCWs (doctors $n = 91$; nurses $n = 186$)	Impact of Events Scale	9.4% PTSS; 20.6% psychiatric morbidity	Risk factors: younger age, being married, psychiatric morbidity, less venting, less humor, and less acceptance.
Tham et al. (2004)	SARS	cross-sectional study	Emergency HCWs (doctors $n = 38$; nurses $n = 58$)	Impact of Events Scale	IES score ≥ 26 in 13.2% doctors and 20.7% nurses; General Health Questionnaire-28 ≥ 5 in 15.8% doctors and 20.7% nurses	Risk factors: nurses
Ho et al. (2005)	SARS	cross-sectional study	82 HCWs not infected and 97 HCWs who recovered from SARS	Impact of Events Scale (Chinese version)	HCWs recovered reported high PTSS intrusion symptoms and more concerns about other health problems and discrimination.	Risk factors: being HCWs survivors
Phua et al. (2005)	SARS	cross-sectional study	99 HCWs (doctors $n = 41$; nurse $n = 58$)	Impact of Events Scale	HCWs not infected had stronger fear related to infection than HCWs recovered; equal concern about infecting others (especially family members) than being self-infected emerged	Risk Factor: nurses
Kwek et al. (2006)	SARS	cross-sectional study	63 HCWs SARS survivors	Impact of Events Scale	41% scored indicative of PTSD; 30% likely anxiety and depression.	Resilience factors: positive coping styles (humor and planning)
Maunder et al. (2006)	SARS	cross-sectional study	769 HCWs (SARS and no-SARS units)	Impact of Events Scale	SARS unit HCWs reported higher PTSS, burnout, and psychological distress rather than no-SARS unit HCWs. SARS unit HCWs more reduced patient contact and work hours.	Risk factor: being HCW survivors
Lee et al. (2007)	SARS	cohort study	SARS survivors (non-HCWs $n = 49$; HCWs $n = 30$)	Impact of Event Scale-Revised	Participants with at least moderate PTSS reported 32.2% intrusion, 20.0% Avoidance, and 22.2% Hyperarousal. HCW SARS survivors were more distressed than non-HCW one year after the outbreak.	Risk factors: maladaptive coping strategies (avoidance, hostile confrontation, and self-blame).
Lin et al. (2007)	SARS	cross-sectional study	66 emergency HCWs and 26 no-emergency HCWs	Davidson Trauma Scale-Chinese version (DTS-C)	Emergency HCWs reported $> DTS-C$ scores than no-emergency HCWs; 21, 7% emergency HCWs and 13% no-emergency HCWs reported DTS-C > 40 (suspected PTSD).	Resilience factors: training, Support from family/supervisors/colleagues, work organization
Reynolds et al. (2007)	SARS	cross-sectional study	1057 quarantined subjects (HCWs $n = 269$)	Impact of Events Scale - Revised	14.6% IES-R ≥ 20 ; quarantined HCWs experienced greater PTSS than quarantined no-HCWs	Risk factors: quarantine
Su et al. (2007)	SARS	prospective and periodic follow-up study	102 HCWs (70 SARS and 32 no-SARS HCWs)	Davidson Trauma Scale-Chinese version (DTS-C)	SARS unit HCWs reported higher Depression (38.5% vs. 3.1%) insomnia (37% vs. 9.7%) and PTSS (33% vs. 18.7%, but not significant).	Risk factors: level of exposure
Lancee et al. (2008)	SARS	cross-sectional study	139 hospital staff (HCWs $n = 103$; clerical staff $n = 13$; Other $n = 21$)	Structured Clinical Interview for DSM-IV; Clinician-Administered PTSD Scale	30% lifetime prevalence of depressive, anxiety, or substance use diagnosis.	Risk factors: previous psychiatric disorder, < 5 years of work experience

(continued on next page)

Table 1 (continued)

Study	Outbreak	Type	Sample	PTSS/PTSD measures	Main general findings	Main risk and resilience factors
Styra et al. (2008)	SARS	cross-sectional study	SARS units HCWs ($n = 160$) and no-SARS units HCWs ($n = 88$)	Impact of Event Scale—Revised	HCWs taking care of only one SARS patient had higher PTSS levels than those taking care of none or more than two SARS patients	Resilience factors: training and supervisor/colleagues support. Risk factor: level of exposure
Wu et al. (2009)	SARS	cross-sectional study	549 hospital staff (21% doctors, 38% nurses, 22% technicians; 20% administrative and others)	Impact of Event Scale—Revised	About 10% IES-R ≥ 20 .	Risk factors: level of exposure; younger age; quarantine/isolation (quarantine, having friends or close relatives infected). Resilience factor: coping strategies
Mak et al. (2010)	SARS	retrospective cohort study	90 SARS survivors (30% HCWs)	Structured Clinical Interview for the DSM-IV; Impact of Events Scale—Revised	47.8% PTSD in the aftermath of SARS. 25.6% still suffers PTSD 30-months post-SARS	(altruistic acceptance of work-related risks) Risk factors: being HCWs survivors (but large proportion of the HCWs were female, and this could affect results). Resilience factor: coping strategies
Wing and Leung (2012)	SARS	case-control study	233 SARS survivors	Chinese bilingual version of the Semi-Structured Clinical Interview (SCID-I)	50% SARS survivors a lifetime psychiatric disorder (depression, PTSD, somatoform pain disorder, panic disorder)	Risk factors: being HCWs survivors
Lee et al. (2018)	MERS	cohort study	359 HCWs (MERS and no-MERS unit)	Impact of Event Scale—Revised	51% HCWs reported IES > 25 (MERS units $>$ no-MERS units) in the first month of MERS outbreak. After one month: quarantined MERS units HCWs showed higher sleep and numbness scores; MERS units HCWs showed higher intrusion symptoms	Risk factors: level of exposure, quarantine
Jung et al. (2020)	MERS	cross-sectional study	147 HCWs (nurses of MERS units)	Impact of Event Scale—Revised Korean version	57.1% PTSD (25.1% full PTSD and 32.0% partial PTSD). PTSD was associated with turnover intention	Risk factors: level of exposure (emergency HCWs $>$ no-emergency HCWs), previous psychiatric disorders
Kang et al. (2020)	COVID-19	cross-sectional study	994 Wuhan HCWs (doctors and nurses)	Impact of Event Scale—Revised	Regarding mental health problem (including PTSS), 36.9% had sub-threshold disturbances, 34.4% mild disturbances, 22.4% moderate disturbances, and 6.2% severe disturbance.	Resilience factor: supervisor support Risk factors: level of exposure (to people around them who were infected, including family/colleagues/friends).
Lai et al. (2020)	COVID-19	cross-sectional study	1257 HCWs (doctors $n = 493$, nurses $n = 764$)	Impact of Event Scale—Revised	71.5% reported mild to severe PTSS (36.5% mild, 24.5% moderate, 10.5 severe).	Resilience factors: coping strategies (being motivated to learn the necessary skills to respond to diverse challenges)
Li et al. (2020)	COVID-19	case-control study	214 general public and 526 HCWs (234 front-line nurses, 292 non-front-line nurses)	Vicarious traumatization questionnaire (based on several questionnaires, including IES-R)	Vicarious traumatization was significantly lower in front-line nurses than non-front-line ones and general public (no difference between non-front-line nurses and general public)	Risk factors: level of exposure, nurses, female, fewer years of work experience. Risk factors: level of exposure, marital status.

HCWs: healthcare workers.

(Sim et al., 2004; Su et al., 2007; Lancee et al., 2008). Accordingly, Su et al. (2007) on a sample of 70 nurses from two SARS units and 32 nurses from two non-SARS units found highlighted a previous history of mood disorders as a major risk factor for PTSS. One study on MERS outbreak confirmed this finding (Jung et al., 2020).

3.4. PTSD and PTSS resilience factors of in HCWs facing the three coronavirus outbreaks

3.4.1. Family and social support

Two studies on the SARS outbreak highlighted the support of family and friends as having a major role in protecting from PTSS development (Chan and Huak, 2004; Su et al., 2007). In particular, Su et al. (2007) investigating 102 nurses found that strong social and family support protected against acute stress, with a positive impact on their global functioning as a function of time.

3.4.2. Supervisors and colleagues support

Three researches concerning the SARS outbreak (Chan and Huak, 2004; Maunder et al., 2006; Lancee et al., 2008) and one on the MERS (Jung et al., 2020), reported a protective role of the support from supervisors/colleagues. Particularly, Lancee et al. (2008), in 139 HCWs in Canada, showed feeling well supported while working as a resilience factor also in the long-term. Jung et al. (2020) noticed that management strategies based on supervisors' support proved helpful in order to reduce PTSS in 147 nurses in three isolation hospitals in South Korea during the MERS outbreak.

3.4.3. Training

The perception of being adequately trained was identified as a potentially protective factor in two studies on the SARS (Maunder et al., 2006; Lancee et al., 2008). Comparing 769 Canadian HCWs displaced in 9 hospitals that treated SARS patients and 4 hospitals that did not, from 13 to 26 months after the outbreak, Maunder et al. (2006) suggested the importance of supportive interventions in preventing PTSD and PTSS with particular impact on maladaptive coping styles.

3.4.4. Work organization

The same authors reported that working in structured units and the perceived safety of the working environment are further factors which seem to enhance the resilience of HCWs, in line with findings of another study by Su et al. (2007). Moreover, it has also been observed that a clear communication of directives and precautionary measures to be adopted was related to a better outcome with regard to PTSS (Chan and Huak, 2004).

3.4.5. Coping strategies

In five studies on the SARS outbreak (Chan and Huak 2004; Sim et al., 2004; Phua et al., 2005; Su et al., 2007; Wu et al., 2009), positive coping strategies were reported to be a protective factor against the development of PTSD psychopathology. Particularly, in a study carried out in Singapore on 41 physicians and 58 nurses, Phua et al. (2005) reported an association between the use of humor and planning as coping strategies, and lower rates of PTSD. Other protective coping styles included: the altruistic acceptance of work-related risks (Wu et al., 2009), the ability to talk to someone about their experiences, and the presence of religious beliefs (Chan and Huak 2004). Accordingly, Maunder et al. (2006) found that maladaptive coping strategies, such as avoidance, hostile confrontation and self-blame, resulted in worse outcomes in terms of PTSS and Sim et al. (2004) reported that less venting, humor and acceptance were associated to higher levels of PTSS. Consistently, positive coping strategies, such as motivation to learning different skills, have been indicated as resilience factors also in HMWs dealing with the current COVID-19 pandemic (Kang et al., 2020).

3.5. HCWs survivors to coronavirus outbreaks

Five studies focusing on HCWs who survived the SARS infection highlighted this population as particularly "at risk" for PTSD. Kwek et al. (2006) in a sample of SARS survivors at 3 months post-discharge found that HCWs were more affected by PTSS than non-HCWs. Lee et al. (2007) examined a sample of 96 Hong Kong SARS survivors divided into sub-samples of HCWs and non-HCWs, found that while PTSS levels were similar in the two sub-samples at the peak of the outbreak, HCWs compared to non-HCWs, reported significantly higher PTSS one year after discharge, suggesting a lack of recovery as a function of time, among HCW SARS survivors. In line with this, a later study among 233 Chinese SARS survivors also reported a higher risk of PTSD among HCW compared to non-HCW (Wing and Leung, 2012). Furthermore, a study conducted on a sample of 90 Hong Kong SARS survivors at 30 months after the outbreak (Mak et al., 2010) showed that being a HCW was significantly associated with PTSD development, despite the authors hypothesizing that this finding could be gender-biased because the majority of the sample was made up of female HCWs. Finally, Ho et al. (2005) in 97 HCWs in Hong Kong found a positive correlation between the presence of pronounced SARS-related fears and PTSS burden, particularly intrusion symptoms; in addition HCWs who had recovered from SARS appeared to be more concerned about death, discrimination and quarantine than those who had not been infected.

4. Discussion

To the best of our knowledge we conducted the first review addressing PTSD and PTSS risk and resilience factors in HCWs who were involved in the three major recent Coronavirus outbreaks, namely the SARS, the MERS and the current COVID-19, which have affected the worldwide population in the last two decades. Converging data suggest a high risk for PTSD development among emergency HCWs, with studies consistently outlining several risk factors that are enhanced in the case of these highly lethal outbreaks, such as: the frequent unpredictability of daily caseloads, having to frequently manage patients and their families' expectations in unexpected critical cases/situations (Mealer et al., 2009; Czaja et al., 2012; Iranmanesh et al., 2013; Fjeldheim et al., 2014). In the context of an outbreak emergency such as the COVID-19 crisis, difficulties are further heightened by the rapidly increasing flow of critical patients requiring increased medical attention, the decision-making burden and high daily fatality rates, and the constant updates of hospital procedures following advances in knowledge about the disease, that creates another burden for HCWs who need to keep up to date. Further, patients medical management requires tight physical isolation, to protect patients and HCWs because of the extremely high risk of contamination (Petrie et al., 2018; Berger et al., 2012; Brooks et al., 2019). Occupational role, marital status, age and gender, quarantine, stigma, previous psychiatric disorders, isolation and being survivors of the same outbreak also emerged as robust risk factors for PTSS. In parallel, the literature highlighted a number of resilience factors, such as support, training, prompt work organization and good coping strategies.

The majority of studies included in our review focused on the 2003 SARS outbreak; fewer data were available on the MERS, and the studies on COVID-19 are only emerging at the time of writing. All these studies reported a high risk for adverse psychological reactions, particularly PTSS and PTSD among HCWs, suggesting the proximity to "ground zero" as a primary risk factor (Kwek et al., 2006; Lee et al., 2018). HCWs' fear of contagion and infection of their family, friends and colleagues, feelings of uncertainty, stigmatization and rejection in their neighborhood because of their hospital work were also reported. Studies also reported the reluctance to work and/or considering quitting their job, as well as high levels of stress, anxiety and depression symptoms, which could have long-term psychological implications (Maunder et al., 2003;

Bai et al., 2004; Lee et al., 2007; Wu et al., 2009). The self-perceived high risk for contagion might be the most important aspect related to the front-line activities, with for example Su et al. (2007), failing to find any significant difference between HCWs in SARS vs. non-SARS units in PTSD prevalence rate. This suggests that not only HCWs working within the SARS units, but also those working outside them and facing uncertainty because of the displacement, might develop PTSS during the outbreak. In this regard, in the ongoing COVID-19 pandemic, the lack of personal protection devices represents a critical issue.

Interestingly, however, some authors found first-line exposure to have a protective effect. Styra et al. (2008) reported that HCWs working in SARS high risk units, as expected, experienced greater distress than HCWs displaced in other departments such as the psychiatric one, but contrary to expectations HCWs caring for many SARS patients while working in high-risk units emerged as being less distressed. This finding suggests that experience in treating SARS patients may be a mediating factor that could be amenable to intervention in future outbreaks. This is in line with more recent findings from a COVID-19 study, according to which PTSS severity of non-front-line nurses was greater than that of front-line nurses, who showed stronger psychological endurance. The authors argue that this finding may be explained considering that front-line nurses were voluntarily selected and provided with sufficient psychological preparation. Moreover, the selected front-line nurses were mainly middle-level backbone staff with working experience and psychological capacity (Li et al., 2020).

Hence, there is evidence that perceived adequacy of training represents a protective factor against adverse outcomes of traumatic exposure (Mauder et al., 2006; Lancee et al., 2008). Similarly, other factors concerning positive working organization, such as working in structured units, a sense of protection of environment (Mauder et al., 2006; Su et al., 2007) and clear communication of directives and of precautionary measures (Chan and Huak, 2004), have proven to be protective factors against the development of PTSS in HCWs. In particular, Chan and Huak (2004) explored the important role in preventing PTSS of clear and prompt communication of directives and information about the disease, of providing precautionary measures, such as Personal Protective Equipment (PPE), and of the support of a supervisor/head of department, colleagues and family. The support from family and friends as well as that from supervisors and colleagues has been shown to represent an important resilience factor against the development of PTSS, as widely demonstrated in the literature (Chan and Huak, 2004; Mauder et al., 2006; Su et al., 2007; Lancee et al., 2008). Nevertheless, this matter deserves further consideration since in this peculiar clinical setting the implications of the contagion risk often lead to self-isolation, with subsequent decreased social support.

Some important individual risk and resilience factors for PTSS have also been reported among HCWs facing a coronavirus outbreak. First, female gender. Despite the fact that the majority of the studies corroborate the preventive role of professional training as to PTSD onset up to the point of flattening of the gender gap which is commonly observed in PTSD reports, most of the studies on HCWs dealing with Coronavirus outbreaks tend to show a higher incidence of PTSD among women. Females, in fact, were shown to be most affected by PTSS in three SARS studies (Lee et al., 2007; Reynolds et al., 2007; Lai et al., 2020), as well as younger HCWs or HCWs with fewer years of work experience (Reynolds et al., 2007; Lancee et al., 2008). Moreover, nurses proved to be more affected by PTSS than other HCWs (Tham et al., 2004; Mauder et al., 2004). Although this has been explained as related to closer contact with infected patients, we may also argue that often the nurse staff are mostly women. Further studies in this regard are thus warranted. Outbreaks threatening family members' well-being or affecting children's care, in fact, may constitute a burden for women (Carmassi et al., 2019). It is worthy of note that all these factors could be influenced by coping styles adopted by the HCWs to address the psychic burden of the outbreak. Some studies focused on positive coping styles that were associated to a better outcome (Phua et al.,

2005; Wu et al., 2009). Among these, Phua et al. (2005) found that physicians chose humor as a coping strategy more frequently than nurses, and this resulted in lower post-traumatic stress morbidity. Other authors stressed the effect of maladaptive coping styles in predicting PTSS, such as avoidance, hostile confrontation and self-blame (Mauder et al., 2006).

As previously highlighted, the sense of isolation was found to be an important factor related to PTSS. Consequently, HCWs who had been quarantined were shown to be at higher risk (Bai et al., 2004) as well as HCW survivors from the infection. These latter constitute a special population in which the impact of infectious disease, along with related fears for one's health and for the contagion of loved ones and the sense of isolation and the rejection due to the stigma, lead to a greater PTSS burden (Wing and Leung, 2012).

More recently, scientists, clinicians and the general public, in fact, have been increasingly referring to the current COVID-19 emergency and its subsequent impact on health care systems, as the "9/11 of health care systems". First studies reported high levels of psychopathological burden in HCWs dealing with the COVID-19 pandemic in China, including depression, anxiety, insomnia and PTSS (Huang et al., 2020; Kang et al., 2020; Lai et al., 2020). In particular, anxiety and PTSS symptoms resulted higher in females, nurses and in HCWs with fewer years of work experience (Lai et al., 2020; Huang et al., 2020). HCWs are called to confront this new scenario under widespread media coverage and in a context of a persisting imbalance between needs and resources, increasing the decisional burden and the feelings of hopelessness; they are also forced to deal with challenging expectations of the patients and their relatives in a framework characterized by unusual communicative constraints. Moreover, the fear of contagion is amplified by the lack of personal protective equipment (PPE) and the high number of infected or deceased colleagues, and is associated to the concern of representing a threat to family members: this often leads to self-isolation. As a consequence, loneliness, along with the risk of a growing trend towards social stigmatization of HCWs as potential carriers of infection (WHO, 2020) results in deprivation of social support, which is listed among the main factors of resilience.

Despite the slight decrease in the COVID-19 contagion rate, the impact on HCWs mental health may produce enduring effects. Finally, some evidence revealed a significant time-effect on reducing PTSD symptom ratings, as observed in a SARS study by Su et al. (2007), reporting a 50% decrease after one month, no-one meeting the criteria for PTSD. Conversely, a MERS study by Lee et al. (2018) reported that HCWs performing one month before MERS-related tasks were at higher risk for symptoms of PTSD even after time had passed, and the risk was increased in sleep and numbness-related symptoms, in particular if home quarantine was implemented.

For all these reasons, providing a timely response to psychological pressure on HCWs in order to prevent negative mental health outcomes requires the development of specific intervention strategies (Carmassi et al., 2020c). Such strategies cannot but be based on a careful survey of both risk and resilience factors that may be playing a role in this special working population and should take into account what the studies conducted in the aftermath of the previous outbreaks reported.

When discussing our results some limitations should be considered. First, the lack of a quality assessment of the studies. Second, we consulted only one database for our search (PubMed). Third, most of the included articles ($N = 16$) adopted the Impact of Event Scale scores, which is a well-known rating scale that provides a subjective measure of perceived stress (Horowitz et al., 1979; Marziali and Pilkonis, 1986; Weiss et al., 1984), to detect PTSD or PTSS. Fourth, surveys give us a limited glimpse into a complex psychological dynamic that happens with healthcare providers in isolation wards, because they rely on voluntary responses by the subjects, who may choose not to revisit a traumatic experience by participating in the survey, thus leading to under-reporting the incidence of traumatic sequelae (Li et al., 2020).

This is in line with Chen et al. (2020) who reported how the implementation of psychological intervention services in the COVID-19 pandemic proved to be problematic, because medical staff were reluctant to participate in the group or individual psychology interventions provided to them. Fifth, some studies reported that while quarantined HCWs consistently showed more frequent adverse psychological impacts than non-HCWs, their experience was probably influenced by their job-related experiences with SARS and not unique to their HCW status (Reynolds et al., 2007). Finally, no information was available on HCW family members, particularly on the possible impact of the presence of children as a possible PTSS risk factor (Carmassi et al., 2019).

We have examined studies carried out in the context of the three Coronavirus outbreaks in order to outline PTSD and PTSS risk and resilience factors impacting on HCWs and to consistently enhance the effectiveness of intervention strategies. While the COVID-19 pandemic is straining healthcare systems all over the world, awareness of the impact of the emergency on the HCWs' mental health is rising, consistently with evidence of the high risk of them developing psychological distress, such as PTSD and PTSS, under similar circumstances. To date, despite some recommendations released by international organizations (WHO, 2020; Inter-Agency Standing Committee (IASC) 2020; IFRC, 2020) and a variety of action proposals, a systematic approach is not yet in place. Efficacious treatments for PTSD and PTSS exist (Lee and Bowles, 2020; Charney et al., 2018; Dell'Oso et al., 2015), and healthcare systems should also focus on prepare to roll out these treatments among HCWs should prevention strategies fail to prevent the development of these conditions.

CRediT authorship contribution statement

Claudia Carmassi: Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing, Supervision. **Claudia Foghi:** Methodology, Investigation, Writing - original draft, Writing - review & editing. **Valerio Dell'Oste:** Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing. **Annalisa Cordone:** Investigation, Writing - original draft. **Carlo Antonio Bertelloni:** Investigation, Writing - original draft. **Eric Bui:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Supervision. **Liliana Dell'Oso:** Conceptualization, Methodology, Writing - original draft, Supervision.

Declaration of Competing Interest

No conflict of interest. No disclosures to declare of any relationship with a commercial company that has a direct financial interest in subject matter or materials discussed in article or with a company making a competing product.

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Ethical standards

Not applicable.

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Supplementary materials

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