



## REVIEW ARTICLE

# The prevalence and risk factors of PTSD symptoms among nurses during the COVID-19 pandemic—A systematic review and meta-analysis

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**Abstract**

Since the first reported outbreak in China, the Coronavirus disease 2019 (COVID-19) has raised serious concerns globally. The COVID-19 pandemic has caused a severe psychological impact on healthcare workers (HCWs), and especially nurses, who are the most numerous and exposed frontline group. This systematic review and meta-analysis aims to summarise extant literature on the effects of the COVID-19 pandemic on the psychological health of nurses, particularly concerning the prevalence and risk factors for post-traumatic stress disorder (PTSD). A systematic search was conducted on *PubMed*, *Embase* and *PsycInfo* from March 2020 to July 2023. Articles were included/excluded on predetermined eligibility criteria. A random-effect meta-analysis was performed using proportions to determine the pooled prevalence for PTSD among nurses. Subgroup analyses were also performed, and heterogeneity across studies was analysed using meta-regression. Relatively high prevalence rates of PTSD were reported among nurse populations during the COVID-19 pandemic in twenty-six different countries, globally. Risk factors associated with PTSD include having prior mental health co-morbidities, being a female, having high exposure/contact with COVID-19 patients, having insufficient protective conditions and having intensive workloads. The overall pooled prevalence was 29.1% (95% C.I. = 23.5%, 35.5%) using a random-effects model in 55 studies. The regression test of funnel plot asymmetry indicated a significant level of publication bias among studies. The COVID-19 pandemic is associated with significant levels of PTSD among frontline nurses globally. A high level of heterogeneity was observed across studies. Psychological, social and administrative interventions should be implemented to mitigate heavy psychological distress in nurses.

**KEYWORDS**

COVID-19, mental health, nursing, occupational health, post-traumatic stress disorder (PTSD)

**BACKGROUND**

Since the first reported outbreak in Wuhan (China), the Coronavirus disease 2019 (COVID-19) and its etiologic agent (Severe Acute Respiratory Syndrome Coronavirus 2-[SARS-CoV-2]) have raised serious concerns worldwide. This novel and extremely contagious virus cause severe respiratory syndrome and is transmitted through respiratory droplets and physical contact (Li et al., 2020). Not surprisingly, the SARS-CoV-2

was transmitted across borders in a short time followed by the declaration of the COVID-19 pandemic on March 11th, 2020 by the World Health Organisation (WHO) (Anand et al., 2020). As of October 12th, 2023, over 771 million cases and 6.9 million deaths have been reported, and the number of cases and deaths continues to increase with time (World Health Organization [WHO], 2023). The emergence of new variants of global health concern represents a constant preoccupation, leading to second and third waves of



disease transmission in many countries/territories worldwide (WHO, 2023).

Much fear and uncertainty related to the viral transmission, the severity of the disease, associated mortality, along with the closure of non-essential businesses and restrictions to mass gatherings has brought unprecedented repercussions to the mental well-being of the world's population, especially frontline workers (De Kock et al., 2021; Wang et al., 2021). Emerging infectious disease outbreaks are known to have an immediate and sustained psychological impact on healthcare workers (HCWs) (McAlonan et al., 2007). Maunder et al. (2006) reported significantly higher levels of burnout, psychological distress and post-traumatic stress disorder (PTSD) in Toronto HCWs after facing the 2003 severe acute respiratory syndrome (SARS) outbreak (Maunder et al., 2006). Similarly, emergency HCWs have reported fear of personal safety and concerns related to the well-being of colleagues and family during the 2014 Middle East Respiratory Syndrome Coronavirus (MERS-CoV) outbreak in Saudi Arabia (Khalid et al., 2016). Wong et al. (2005) reported that the distress level caused by the SARS outbreak in Hong Kong was higher among nurses in emergency departments, followed by doctors and healthcare assistants (Wong et al., 2005).

Nurses constitute a significant proportion of the HCW group among frontline responders worldwide. In an outbreak situation, they play an essential role in preventing the dissemination of the infection, controlling the disease, and supporting patients in isolation (Smith et al., 2020). As a result, nurses involved in COVID-19 clinical management are highly susceptible to psychological distress and negative mental health outcomes. Additionally, they are among the first in the line of duty to have contact with COVID-19 suspected and confirmed cases. In many countries, nurses provide direct medical attention or home visits to older adults and persons with co-morbidities and increased risk of mortality. Therefore, the health status of nurses deserves special attention during this extraordinary public health emergency. During the early stages of the COVID-19 pandemic, the highest prevalence of mental health conditions was reported in China, where the outbreak originated (Ahmed et al., 2020). A cross-sectional study conducted in Hunan Province, China, identified that the prevalence of probable anxiety and depression in nurses was higher than in doctors and that female health workers had a higher proportion of anxiety than males (Ning et al., 2020). Chen et al. (2021) reported that nurses working in intensive care units (ICUs) and other hospital departments involved in the treatment of COVID-19 patients had higher scores in negative mental health outcomes, such as trauma and burnout syndrome (Chen et al., 2021). One of the most common and deteriorating mental health conditions presented by HCWs is post-traumatic stress disorder (PTSD) (Sagherian et al., 2022). This is a mental health condition that develops in individuals who have experienced or witnessed shocking,

scary, or life-threatening events, including global health emergencies (National Institute of Mental Health, 2021). Although most persons overcome the initial symptoms of PTSD over time, in some individuals, these symptoms persist and the traumatic memories can intensify over time, leading to the deterioration of their mental health and quality of life (National Institute of Mental Health, 2021). Many primary studies have evaluated the prevalence and risk factors for PTSD in multiple countries, including African (Asnakew et al., 2021), American (Sagherian et al., 2022), Asian (Gu et al., 2022), and European (Heesakkers et al., 2021) countries. Most of the systematic reviews published have been conducted to explore PTSD among HCWs in general (Al Falasi et al., 2021; d'Ettorre et al., 2021). A meta-analysis conducted by Varghese et al. on the prevalence of anxiety, stress, depression, and insomnia in nurses during the pandemic was published in April 2021 (Varghese et al., 2021). This meta-analysis limited its investigation to pooled prevalences of PTSD from 10 studies, of which only two were based in China (Varghese et al., 2021). This systematic review and meta-analysis aim to summarise and update the extant literature on the effects of the COVID-19 pandemic on the psychological health of nurses, particularly concerning the prevalence and risk factors for PTSD. Our secondary aim is to evaluate the quality of the literature published related to the prevalence and risk factors for PTSD in the nurse subpopulation.

## METHODS

### Systematic review protocol registration

A primary search was conducted at the Joanna Briggs Institute Database of Systematic Reviews and Implementation Reports and the Cochrane Database of Systematic Reviews before the registration of the protocol, to identify systematic reviews focused on the prevalence and risk factors of PTSD among the nurse subpopulation. The protocol for this systematic review and meta-analysis (CRD42022279692) was registered at the International prospective register of systematic reviews (PROSPERO) using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The research question was formulated using the PICO model (Participants, Intervention/Exposure, Comparator, Outcome). This study did not require ethical permission since we used secondary published data, that was already ethically approved by its time of publication.

### Search strategy and eligibility criteria

The search was conducted on *PubMed*, *Embase* (Elsevier) and *APA PsycInfo* (EBSCO) for peer-reviewed



scientific articles. These databases were selected because they contain public health information related to the topic under study (negative mental health outcomes related to the COVID-19 pandemic in HCWs, including nurses). The search strategy used was: COVID-19 OR SARS-CoV-2 AND Post-traumatic stress disorder AND Nurses. The search was related to the current COVID-19 pandemic; therefore, the time limit was March 2020–July 2023. The nurse population was the target of the search (Supplementary material Table S1). Cross-sectional studies published as full-length articles were considered for this literature review. Original quantitative studies examining the psychological impact of the COVID-19 pandemic among nurses were included. Studies were excluded if they: (1) were animal or experimental studies; (2) did not present the relevant association between the COVID-19 pandemic and mental health outcomes (PTSD); (3) did not use validated tools to measure the mental health outcomes; (4) did not present specific prevalence for PTSD in nurses; (5) did not specify the cut-off value for PTSD; (6) did not compare prevalence among HCWs (compared prevalence among non HCW groups: general population, patients, etc.); (7) used patient death as the exposure between groups; (8) did not have full-text available; (9) were not written in the English or Spanish language; (10) were not peer-reviewed; and (11) had a low quality (Score  $\leq 3$  for Loney Criteria Assessment tool) (Supplementary material Table S2). The search strategy followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines as reported in the flow diagram in Figure 1.

## Data extraction

A data extraction form was used to include relevant information from each study: (1) Author and year of publication; (2) Country/Region of the population under study; (3) Sample size; (4) Sample characteristics; (5) Nurse population; (6) Prevalence and/or proportion of PTSD in nurse population; (7) Assessment tools; (8) Cut-off for assessment tool; (9) Associated risk factors in nurse population; and (10) Key findings of the study. If any of this information was not reported literally (e.g. from number to percentage of nurses), the necessary data were calculated manually and confirmed by comparing the extraction form of two investigators.

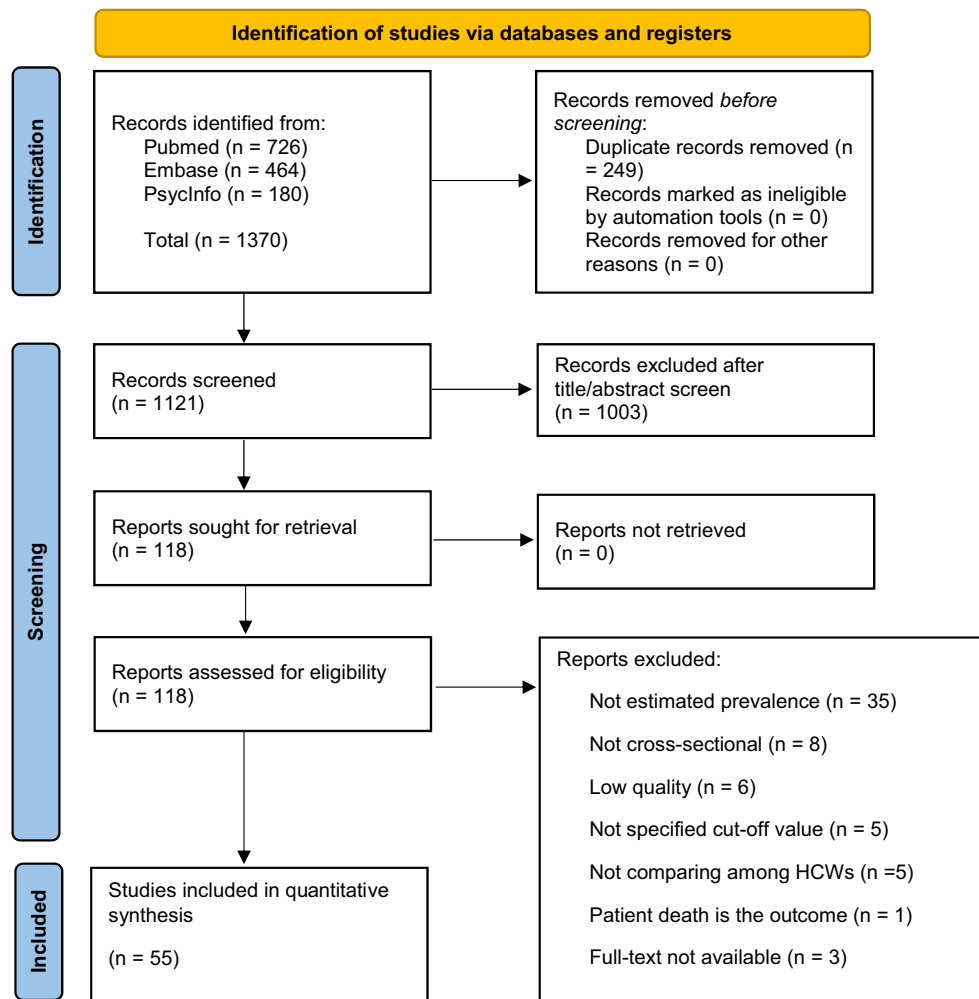
## Quality assessment instrument

Three authors (Author 1, Author 2, Author 3) independently assessed the risk of bias in two different rounds using the Loney criteria, which has been widely used to evaluate the quality of observational studies (Loney et al., 1998; Sanderson et al., 2007). This quality assessment tool

was used because it was originally applied to evaluate the prevalence of mental health conditions in populations (Loney et al., 1998; Sanderson et al., 2007). Eight categories assess the criteria: (1) target population was clearly defined; (2) probability sampling or entire population surveyed; (3) response rate over 80%; (4) non-respondents were clearly described; (5) representativeness of the sample population ( $>300$  subjects); (6) data collection methods were standardized; (7) validated criteria were used to diagnose PTSD; (8) prevalence estimates were given with confidence intervals and detailed by subgroups (if applicable). In the first round of revision, the three authors revised one-third of the studies that passed the secondary exclusion. In the second round, the reviewers rotated the studies so that each reviewer evaluated two-thirds of all studies (Supplementary material-Tables S3 and S4). Potential disagreements in the evaluation of the assessment criteria were resolved by the three reviewers by consensus after the second round of revisions. The total possible score for each study ranges from 0 to 8. Studies with a total score of '0–3' were considered as low quality, '4–6' as moderate quality, and '7–8' as high quality (Qiu et al., 2020).

## Statistical analysis

Prevalence proportions were logit transformed (i.e. log odds) and then pooled with a meta-analytic random-effects logistic regression model (Stijnen et al., 2010) using *rma.glmm* function of the *metafor* package in R (3.0–2; Viechtbauer, 2010). The between-study variance ( $\tau^2$ ) was estimated via maximum-likelihood (ML), and (residual) heterogeneity between studies was statistically assessed using Wald-type  $\chi^2$  (analogous to Cochran's  $Q$  assuming a fixed-effect model) and  $I^2$  statistics (Higgins et al., 2003). Substantial heterogeneity, in terms of proportion of total variability due to  $\tau^2$ , was defined as  $I^2 > 75\%$ . In all statistical analyses,  $n$  is the number of participants,  $k$  is the number of studies, and the significance level was considered at a  $p$ -value  $< 0.05$ . Univariate meta-analyses included the following two-group moderator variables tested with z-statistics as sources of potential heterogeneity: (1) world region (China vs. other countries), (2) sample size (or  $n$ ;  $< 750$  vs.  $\geq 750$ ), (3) study primary target population (nurses vs. all HCWs), (4) assessment tool (IES-R vs. other tools), and a four group moderator of study period (2020 vs. 2021 vs. 2022 vs. 2023) tested with a between-group Q-test. In the text, all pooled outcomes were back-transformed into raw prevalences using the inverse of the logit transformation to aid interpretation. To identify influential and outlying studies, a sensitivity analysis (i.e. leave-one-out) was carried out by subtracting each study and re-calculating the overall pooled effect with the same meta-analytic random-effects logistic regression model. Publication bias among studies was assessed by funnel plot and Egger's linear regression



**FIGURE 1** Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram.

intercept test assuming a fixed-effect meta-analysis and the standard errors of effect sizes as the predictor (Egger et al., 1997).

## RESULTS

### Search results

In total, 1370 publications were identified. Of those, 249 were removed after initial screening due to duplication, and an additional 1003 articles were excluded based on the screening of titles and abstracts. Finally, 118 full-text articles were assessed for eligibility. There were thirty-five studies excluded for not estimating the prevalence and risk factors of PTSD in the nurse subpopulation, eight studies were excluded for not being cross-sectional, five studies were excluded for presenting low-quality scores ( $\leq 3$  Loney criteria), five studies were excluded for not specifying the cut-off value of its assessment tool, five articles were excluded for not comparing among HCWs (nurses), one article was excluded for using patient death

as the outcome, and three studies were excluded for not being available as a full-text article. Fifty-five studies explicitly reported the absolute number of nurses diagnosed with possible PTSD or the prevalence rate of PTSD symptoms. These fifty-five articles were included in the quantitative synthesis through the meta-analysis and the qualitative synthesis which explored the associated risk factors (Figure 1).

### Study characteristics

The characteristics of the studies, their risk factors and key findings are summarised in Table 1. All fifty-five studies followed a cross-sectional design. The sample size of nurses in the 55 studies ranged from 45 to 8863 participants, with a total sample of 40 548 nurses. Female participants made up approximately 76.60% of the total nurse population. The 55 studies were conducted in twenty-six different countries, including China ( $k=14$ ), United States of America ( $k=5$ ), France ( $k=4$ ), Italy ( $k=3$ ), Spain ( $k=3$ ), Canada ( $k=2$ ), Ethiopia ( $k=2$ ), Netherlands ( $k=2$ ),





**TABLE 1** Summary of study sample characteristics, study design, assessment tools used, prevalence rates and risk factors for PTSD among nurses that worked during the COVID-19 pandemic.

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>1</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>2</sup>
Alonso et al. (2021)	Spain	9138	The larger age group was 30–49 years (45.8%). Sex male: 1766 (22.7%)	2746 (30.6%)	689 (25.1%)	PCL-5	≥7	Pre-pandemic lifetime mental disorders	Auxiliary nurses and nurses showed the highest prevalence of current mental disorders (59.5% and 50.4%, respectively).	5
Asnakew et al. (2021)	Ethiopia	396	The larger age group was 25–30 year. Sex male: 69.2%	230 (58.1%)	136 (59.1%)	IES-R-22	≥24	Lack of standardised PPE supply, age >40 years, having a medical illness, perceived stigma, history of mental illness and having poor social support	The prevalence of PTSD in this study was high.	7
Ayalew et al. (2022)	Ethiopia	387	58.7% study participants male. 60.2% in the age group of 26–35 years	197 (50.9%)	139 (70.6%)	IES-R-22	≥24	Being female, married, nurses and working in emergency unit such as inpatient/wards	High levels of PTSD among HCWs	6
Azoulay et al. (2021)	France	845	The median age in years was 29. Sex male: 32.5%	412 (48.7%)	132 (32.0%)	IES-R-22	≥26	Fear of being infected in the first wave, fear of infecting family and friends in the second wave, intention to leave the ICU, inability to rest and having analyst's personality type	The prevalence of mental health disorders in Intensive Care Unit HCW's is high.	5
Bae et al. (2022)	South Korea	365	Mean age was 31.76 years and median was 28. 97.5% were females	365 (100%)	60 (16.4%)	PCL-5	>33	Being married and low abilities, leadership and support of other nurses were the risk factors.	High risk of PTSD seen in 16.5% of the participants and nursing work environment was a huge risk factor	5
Bahadiri and Sagaltici (2021)	Turkey	783	The median age in years was 29. Sex male: 53.4%	377 (48.2%)	57 (15.1%)	PCL-5	≥47	High anxiety levels, being diagnosed with COVID-19, working with 24-h shifts, high depression levels, low work experience, low monthly income and having additional chronic disease	The probable PTSD rate in this study was 19.2%, overall.	5
Bani Issa et al. (2022)	United Arab Emirates	370	84.1% of the population female, 80% married and mean age of 36.1 years	370 (100%)	134 (36.2%)	PDS	≥28	Smoking, lack of recognition by management, exposure to COVID-19 deaths and lack of exercise	PTSD prevalence 36.2% among the participants. Family support and management recognition and motivation factors	7
Blanco-Daza et al. (2022)	Spain	344	88.7% of the participants female and median age of 41 years	226 (65.7%)	91 (57.6%)	DTS-17	≥40	Previous PTSD symptoms, family members or friends deceased from COVID-19, high perception of risk and low resilience	Prevalence of PTSD was high 45.9%	5

(Continues)



TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Cousin Cabrolier et al. (2023)	France	1200	Mean age – 39.4 years, 78.2% females	643 (53.6%)	69 (10.7%)	IES-R-22	≥24	Night shift work, activity to manage COVID-19 patients, fear of contracting COVID-19, inadequate COVID-19 measures	11.7% prevalence of PTSD among study population and 10.7% among nurses.	6
Chatzitrofi et al. (2021)	Cyprus	424	Mean age 38.78 ± 11.40 year. Sex male: 176 (41.5%)	103 (24%)	26 (25%)	IES-R	>33	Personal history of depression. Additionally, an adverse association was noted between years of work experience and PHQ-9 score, IES-R score and PSS scores.	Nurses were more likely than physicians to suffer from PTSD (adjusted prevalence ratio 2.51 (1.49–4.23); <i>p</i> = 0.001).	4
Feingold et al. (2022)	USA	2579	Most of the participants were under 35 years old. Sex male: 681 (26.4%)	1082 (42%)	354 (32.8%)	PCL-4-5	≥8	Past-year burnout. Higher perceived support from hospital leadership was associated with a lower risk of PTSD.	9% of the Frontline HCWs providing care during 2020 in New York City presented symptoms of COVID-19 related PTSD.	4
Flateau et al. (2021)	France	353	Most of the participants were between 36–45 years old (31%). Sex male: 38 (11%)	95 (9%)	19 (33%)	IES-R	>40	Having a relative infected by SARS-CoV-2, feeling at risk during professional practice, increased smoking and treatment with sleeping pills.	The hospital staff presented psychological consequences related to the COVID-19 pandemic, resulting in the use of anxiolytics and sleeping pills.	4
Fournier et al. (2022)	France	4370	Majority were women 81.7% ( <i>n</i> = 3570), married (77%) with 44.6% ( <i>n</i> = 1950) in 30–44 years age group and 41.5% ( <i>n</i> = 1812) in 45–60 years	919 (21%)	228 (25.6%)	IES-R-22	≥33	Workload, lack of PPE, media focus of crisis, possibility of containing the epidemic, and constraints of changing hygiene protocols were the most common factors.	Prevalence of PTSD was 21% and professional working as nurses' aides were most affected	5
Gonzalez Mendez et al. (2022)	China	1263	59.9% of the population < 35 years age and 77.4% were females	573 (45.4%)	66 (11.5%)	PC-PTSD-5	>3	Experience violence during the pandemic, Passive coping, long working hours, more days in isolation during pandemic and close contact with COVID-19 patients were risk factors	The prevalence of PTSD among Nurses was 11.5% and they had highest prevalence compared to other HCWs.	4
Greenberg et al. (2021)	United Kingdom	709	N/A	344 (49%)	168 (49%)	PCL-6	>13	Logistic regression indicated that doctors were more likely than other clinicians, to report good well-being and nurses were more likely to meet the thresholds for depression (moderate and severe), probable PTSD and anxiety.	Nurses reported substantially raised levels of poor mental health and particularly high rates of probable PTSD.	4



TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Gu et al. (2022)	China (Wuhan)	522	238 participants (45.6%) were aged between 26 and 30 years old. Sex male: 117 (22.4%)	410 (78.5%)	118 (28.8%)	IES-R	>33	Participants with senior technical title were more likely to present post-traumatic stress symptoms.	Overall, 25.3% of all participants reported symptoms of post-traumatic stress. Nurses and those with education level of undergraduate or below had higher score for PTSD.	6
Guillen-Burgos et al. (2022)	Colombia	257	Median age was 32 years and 77.43% Women.	114 (44.4%)	19 (16.7%)	PCL-5	>33	Attendance to COVID-19 patients, previous SARS-COV-2 infection and not being a nurse were risk factors	Nurses had lower prevalence of PTSD than other HCWs and were one of the positive factors against PTSD.	4
Guo et al. (2021)	China (Wuhan and Hubei Province)	1091	Most of the participants were between 25–45 years old (72%). Sex male: 356 (33%)	554 (51%)	60 (10.8%)	PCL-C	≥38	Participants with doctoral and master's degrees reported more PTSD. HCWs from Wuhan presented higher risk of PTSD than those living in other cities of Hubei.	Differences in education and working location attributed to the increased risk of anxiety and PTSD in this study.	4
Guttormson et al. (2022)	USA	488	88.1% of the study population Female and 39.3% in age group of 20–30	457 (93.6%)	168 (46.7%)	TSQ-10	>6	Lack of perceived support from administration and shortage of PPE were the risk factors	Higher risk of PTSD than recent veterans or patients with traumatic injury. 47% of the respondents at risk of having PTSD.	4
Havaei et al. (2021)	Canada	3676	N/A	3676 (100%)	1732 (47.1%)	PTSS-14	≥45	Negative ratings of workplace relations, organisational support, organisational preparedness, workplace safety and access to supplies and resources.	'Nurses' workplace conditions are important to their experiences and their ability to deliver effective patient care.'	5
Heesakkers et al. (2021)	Netherlands	726	The mean age in years was 45. 190 (26.2%) participants were men	726 (100%)	164 (22.6%)	IES-6	≥1.75	Working in an academic hospital, being afraid of infecting relatives and experiencing insufficient numbers of colleagues.	Symptoms of at least one outcome, that is anxiety, depression, or PTSD, were present in 256 (35.3%) of the ICU nurses and symptoms or a positive Need for Recovery (NFR) in 378 (52.1%)	5
Heesakkers et al. (2023)	Netherlands	425	Mean age 44 and 76% (n= 320) were Females	367 (87.2%)	72 (16.9%)	IES-R-6	>1.75	No risk factors mentioned separately for PTSD	PTSD prevalence of 16.9% among the nurses in 2021.	5
Hickling and Barnett (2022)	USA	112	40.2% participants in 25–34 years of age, 92% females, 84.8% Caucasians	112 (100%)	17 (15%)	PCL-5	>33	General anxiety, personal well-being, depression positively associated with PTS	Significantly higher percentage of PTSD (15%) in nurses who provided direct care vs those who did not.	4
Jiang et al. (2021)	China	864	Most of the study participants belonged to the 25–39 age group (77.78%). Sex male: 69 (7.99%)	864 (100%)	520 (60.2%)	IES-R	≥26	Nurses who worked in Hubei Province presented lower risk of late-onset PTSD.	Chinese frontline nurses had a high risk to suffer from late-onset PTSD six months after the COVID-19 outbreak.	5

(Continues)



TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Jiang et al. (2022)	China	3419	Mean age – 30.32–30.39 years. Females – 90.2–96.4%	3419 (100%)	1867 (54.6%)	PCL-C	≥38	Average monthly income, length of service, number of children, post-traumatic growth inventory, and nurses perceived professional benefits scale were the risk factors	Nurses working outside Hubei province (55.8%) had greater PTSD than those working inside the Hubei province (48.3%).	5
Jovarauskaite et al. (2022)	Lithuania	206	Mean age of participants was 42.34 years, 97.1% women	206 (100%)	21 (10.2%)	ITQ	≥2	Daily stress, Moral injury and Trauma exposure were risk factors	Daily stress through moral injury had a significant impact on prevalence of PTSD among nurses.	4
Kader et al. (2021)	Qatar	124	Most of participants were between ages 20–34 (71%). Sex male: 57.2%	117 (94.4%)	87 (74.4%)	PDS-5	≥24	Staff with history of mental health concerns.	Participants with previous ICU experience were less likely to have probable PTSD than those without ICU experience.	5
Leng et al. (2021)	China (Wuhan)	90	Young nurses aged 20 to 30 years were the mainstream (71.1%). Sex male: 25 (27.8%)	90 (100%)	5 (4.5%)	PCL-C	≥38	Nurses who came from the emergency department (ED) rated the lowest on PTSD symptoms, followed by internal medicine units, surgical units, ICUs, paediatrics, operating room and obstetrics and gynaecology. As age increases, nurses' stress scores increase.	Major stress sources included working in an isolated environment, concerns about personal protective equipment shortage and usage, physical and emotional exhaustion, intensive workload, fear of being infected and insufficient work experiences with COVID-19.	5
Li et al. (2021)	China	356	The mean age was 31.3. 13.8% of participants were male, 61.5% were never married, 79.5% had bachelor's degree	356 (100%)	220 (62%)	PCL-5	>33	Nurses who had work experience less than 2, nurses who worked in COVID-19 inpatients wards.	Nurses who had PTSD were at younger age, married, had lower education level, had shorter work experience, at lower professional level, not nurse specialists and worked at COVID-19 inpatient ward. Nurses with PTSD had a significantly lower resilience than those without PTSD.	5
Li et al. (2022)	USA	128	Mean age was 43.13 years, 90.55% of participants were female and 83.3% were white.	128 (100%)	24 (19.4%)	PCL-5	>31	Perceived stress, poor life satisfaction, poor general health, and lack of experience were correlated with PTSD symptomatology	The prevalence of PTSD was 19.35%.	3





TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Lopez-Salinas et al. (2023)	Mexico	131	63.4% of the participants were female with 80.9 < 40 years.	48 (36.6%)	30 (22.9%)	IES-R-22	≥33	Female gender significant risk factor for PTSD.	Nurses and Residents/fellow reported more depression and anxiety than other HCWs. Nurses reported non-significant higher likelihood of PTSD than attending physician, residents.	4
Lowry et al. (2023)	Ireland	1898	82% of participants were female, 31% belonging to 31–40 years followed by 27% in 41–50 years.	350 (21%)	159 (35%)	IES-R-22	≥33	Increased levels of frontline exposure, higher pre-pandemic stress	Nurses more likely that other HCWs to endorse PTSD. 35% of nurses vs 22% of medical vs 20% of health and social care professionals vs 30% of other HCWs reported Probable PTSD	5
Machado et al. (2023)	Brazil	941	Median age was 39 years and 76.3% were females, 66.7% White	175 (18.6%)	47 (26.9%)	PCL-5	>36	Age, female, previous diagnosis of mental health disorder, inadequate PPE were the significant risk factors	No significant difference between physicians and nurses in PTSD. 26.9% of nurses had PTSD vs 20.7 Physicians, 37.9 Nurse technicians, 31.9% Physical therapists and 23.4% other HCW	4
Mao et al. (2022)	China	740	Mean age was 30.53 years	740 (100%)	194 (26.2%)	IES-R-22	≥33	Insomnia, marital status were associated risk factors.	26.2% of nurses reported PTSD symptoms.	5
Marcomini et al. (2021)	Italy	173	The larger age group was 41–60 years (52.6%). Sex male: 41 (23.7%)	173 (100%)	69 (39.8%)	IES-R	>26	Women presented higher risk of PTSD than men. The thematic analysis showed that nurses presented distress related to technical aspects (managing ventilation and intubation devices).	Nurses stated that they were overwhelmed by intrusive thoughts associated with COVID-19 as a traumatic event.	4
Martínez-Caballero et al. (2021)	Spain	317	52.7% of the sample were males with 42.9% in the 40–49 years of age group.	78 (24.6%)	22 (6.9%)	DTS-8	≥12	Male gender, change in job duties, prior training on use of PPE, type of SARS-CoV-2 testing, appropriate PPE, use of anxiolytics prior to and during pandemic, anxiety symptoms and psychological support during or before pandemic.	Nurses had higher prevalence of PTSD scores (6.9%) vs physicians (4.7%) and lower prevalence compared to emergency medical technician (19.2%). The more experience the HCWs had (>20 years), the less risk of PTSD they presented.	4
Meena et al. (2022)	India	100	92% of the participants were women, mean age was 29.87 years	45 (45%)	1 (2.2%)	IES-R-22	>24	Marital status was the risk factor associated with PTSD.	Low level of PTSD prevalence among the nurses, that is 2.2%	4
Mehta et al. (2022)	Canada	455	80% were women, 51% 40 years or younger.	279 (61.3%)	75 (32.9%)	IES-R-22	≥33	Female sex, shortage of PPE or inadequate PPE training were associated risk factors	Nurses had higher percentage of PTSD 32.9% than Physicians (4.8%) or other HCW (19%)	6

(Continues)



TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Moon et al. (2021)	South Korea	300	The larger age group was 20–29 years (60.3%). Sex male: 7 (2.3%)	300 (100%)	110 (36.7%)	IES-R	25	The odds ratio (OR) for PTSD was higher for nurses who worked in the NDIU ward, who responded that nurse staffing was poor, and who responded that they experienced COVID-19 symptoms	The mean post-traumatic stress score was 20.68 ± 19.50 points out of a maximum of 88 points.	4
Pazmiño Erazo et al. (2021)	Ecuador	1028	463 (45%) of participants in the 21–40 age group. Sex male: 326 (31.7%)	349 (33.94%)	158 (45.2%)	IES-R	>24	The most relevant associated factors were working in Guayas; being a post-graduate doctor, perception of not having the proper protective equipment and being a woman.	The main associated factors are primarily related to living and working in cities with a higher number of cases and the characteristics of the job, such as being a post-graduate doctor, as well as the perception of security.	5
Qutishat et al. (2021)	Jordan	259	53.3% of the participants were aged 25–34 years and 52.1% of them were males with 80.3% of them being married.	109 (42.1%)	96 (37.1%)	PCL-5	>33	PTSD among participants were significantly different based on age, gender, level of education, working position, years of experience and place of work.	17% of the participants had low level of PTSD, 8.5% had moderate while 10.8% had high level of PTSD. Registered nurse had highest overall significant PTSD experience (Mean = 53.50, SD = 30.65)	4
Ranieri et al. (2021)	Italy	69	49.2% of the participants were married, 55% were working directly with COVID-19 patients, and mean age was 37.3 years ± 10.3. All participants were female	69 (100%)	36 (52.6%)	IES-R	>33	Marital status was a protective factor for PTSD with married nurses having lower levels of PTSD than those single.	Anxiety was a high risk for PTSD	4
Renzi et al. (2023)	Italy	400	Mean age was 34.3 years, 78.5% female	400 (100%)	227 (56.8%)	IES-R-22	≥33	Moderate to severe generalised anxiety disorder, employed in critical area, and being female were predictors of PTSD	High 56.8% prevalence of PTSD among the nurses.	4
Sagherian et al. (2023)	USA	420	Mean age among nurses was 38.44 ± 10.77. 94.06% of the sample were female, 88.78% were white, and 69.36% were married or had a partner.	384 (91.4%)	278 (53.4%)	SPRINT	≥14	Number of working hours per week and skipping 30 min rest breaks were risk factors for PTSD. Participants who worked more or skipped rest breaks had significantly higher PTSD scores.	The mean sprint score was 15.32 ± 7.00	5
Sagherian et al. (2022)	USA	2488	89.71% (n = 2231) were females with mean age of 41.50 with approximately equal distributions between various age groups.	2488 (100%)	1178 (53.8%)	SPRINT	≥14	Frequency care of patients with COVID-19, Work experience, work status, shift length and 30-min breaks associated with PTSD	High prevalence of PTSD among nurses.	5



TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Stafseth et al. (2022)	Norway	484	77.9% were females with mean age of 44.8	392 (81%)	28 (7.4%)	PCL-5	>31	No significant predictors of PTSD.	Registered nurses had significantly higher prevalence of PTSD (7.1%) vs leaders (4.1%) and physicians (2.3%)	6
Tatsuno et al. (2021)	Japan	334	The mean age of participants was 37.4. Sex male: 35.3%	334 (100%)	123 (36.8%)	IES-R-6	≥1.75	Older age and participants with lower educational level presented higher risk for PTSD.	Social support was not associated with PTSD.	6
Vancampfort & Mugisha (2022)	Uganda	108	55.6% were female, mean age = 34.8.	108 (100%)	48 (44.4%)	PCL-5	>31	Lack of physical activity was associated with higher PCL-5 scores. Sleep pattern and harmful drinking pattern not significant risk factors.	High PTSD prevalence among mental health nurses in Uganda	5
Wang et al. (2020)	China (Hubei and other provinces)	1897	Most of the HCWs were aged 25–40 years (61.7%), married (67.5%) and had an educational level of undergraduate or less (84.8%). Sex male: 332 (17.5%)	1334 (70.3%)	146 (10.9%)	IES-R	≥2	Being a nurse, having an intermediate technical title, working at the frontline, and lacking confidence in protection measures were risk factors for PTSD.	A significantly higher prevalence of PTSD was observed in HCWs that were females, working in Wuhan, working at the frontline, received insufficient training and recourses for protection, lack of confidence in protection measures and worried about being infected.	5
Wang et al. (2020)	China (Hubei Province)	202	87.6% of the study participants were female, 51.5% were nurse practitioner, 73.3% were married. Mean age was 32 years and mean work experience was 10 years	202 (100%)	34 (16.8%)	PCL-C	≥38	Gender and job satisfaction were influencing factors. Male, job satisfaction, positive coping were the protective factors. Negative coping were the risk factors.	Mean PCL-C scores was 27 with IQR of 21–34. Mean (IQR) for positive and negative coping were 22 (15–25.25) and 9 (6–11).	6
Wanigasooriya et al. (2020)	United Kingdom	2638	The median age of participants was 42 years. Sex male: 19.9%.	775 (29.4%)	226 (29.2%)	IES-R	≥33	History of mental health conditions was associated with clinically significant symptoms of PTSD.	The availability of adequate PPE, well-being support and lower exposure to moral dilemmas at work showed negative association with PTSD.	5
Yang et al. (2021)	China	19379	8884 (45.8%) participants were between 25 and 34 years old. 3870 (20.0%) participants were men	8863 (45.7%)	493 (5.6%)	PCL-5	>31	Subgroups who married or had dependent children reported higher prevalence of PTSD.	In frontline group, individuals being undergraduate level reported higher prevalence of PTSD.	4
Yang et al. (2022)	China	1993	81.3% of the sample female and mean age 37.10 years.	1197 (60.1%)	123 (10.3%)	PCL-5	>31	Daily Working hours, lack of sleep, type of profession were associated with PTSD	Nurses had higher odds of PTSD than other HCWs but less than physicians, that is 10.3% vs 10.6%.	4

(Continues)



TABLE 1 (Continued)

Author/year	Country	Sample size	Sample characteristics (%)	Nurses	PTSD among nurses <sup>†</sup>	Assessment tool	Cut-off	Risk factors	Key findings	Quality score <sup>‡</sup>
Yin et al. (2020)	China	371	The average age was 35.3 ± 9.48. Sex male: 61.5%.	264 (71.2%)	11 (4.2%)	PCL-5	>33	Females presented higher risk of PTSD. Poor sleep quality and high exposure (high contact frequency with COVID-19 patients) were risk factors for PTSD.	Sleep quality of HCWs plays an important role in the development of PTSD during a pandemic.	6
Zakeri et al. (2021)	Iran	185	77.3% of the participants were female, 66.8% were >30 years of age, 78.2% were married, 88.5% having bachelor's education.	185 (100%)	64 (34.6%)	IES-R	≥33	Not being at risk for coronavirus infection, poor/hor satisfaction with life, and non-resilience were significant risk factors for psychological disorders.	Mean score of PTSD was 29.68 with SD of 11.0	4
Zhou et al. (2022)	China	757	Mean age was 32.6 years and 86.4% of the sample was women.	757 (100%)	102 (13.5%)	IES-R	≥24	Having someone near one, that is relative, friend or colleague died to COVID-19, experience of stigma, not receiving praise, lacking resilience, depressive symptoms, anxiety symptoms were risk factors	Lower prevalence of PTSD than at the initial stage of the COVID-19 outbreak. Resilience, receiving praise were protective factors.	5

Note: All studies are cross-sectional. Data presented as: <sup>†</sup>n (%). <sup>‡</sup>The Loney criteria (Loney et al., 1998).

Abbreviations: DTS-8, The Davidson Trauma Scale; IES-6, Impact of Event Scale-6; IES-R, Impact of Event Scale-Revised; N/A, Not Available; PCL-6, 6-item PTSD Checklist; PCL-5, PTSD Checklist for DSM-5; PCL-C, PTSD Checklist-Civilian Version; PDS-5, Post-traumatic Diagnostic Scale for DSM-5; PTSD, Post-Traumatic Stress Disorder; PTSS, Post-Traumatic Stress Symptoms; PTSS-14, UK-Post-traumatic Stress Syndrome 14-Questions Inventory; SPRINT, The Short Post-traumatic Stress Disorder Rating Interview.



South Korea ( $k=2$ ), United Kingdom ( $k=2$ ), Brazil ( $k=1$ ), Colombia ( $k=1$ ), Cyprus ( $k=1$ ), Ecuador ( $k=1$ ), India ( $k=1$ ), Iran ( $k=1$ ), Ireland ( $k=1$ ), Japan ( $k=1$ ), Jordan ( $k=1$ ), Lithuania ( $k=1$ ), Mexico ( $k=1$ ), Norway ( $k=1$ ), Qatar ( $k=1$ ), Turkey ( $k=1$ ), Uganda ( $k=1$ ) and United Arab Emirates ( $k=1$ ). Most of the study participants were derived from the studies conducted in China ( $n=19623$ ). Six studies were published in 2020, twenty-four in 2021, nineteen in 2022 and six in 2023. Only twelve studies presented a nurse population of over 750. Thirty-three of the studies reviewed the prevalence of negative mental health outcomes (e.g. anxiety, depression, PTSD, perceived stress, substance abuse disorder, insomnia) in physicians, nurses, midwives, healthcare technicians and health students with the remaining 22 studies focused specifically on the mental health status in nurses. All studies used validated measurements for the diagnosis of PTSD: IES-R=Impact of Event Scale-Revised ( $k=26$ ), PCL=PTSD Checklist for DSM-5 ( $k=19$ ), DTS-8=The Davidson Trauma Scale ( $k=2$ ), SPRINT=The Short Post-Traumatic Stress Disorder Rating Interview ( $k=2$ ), PDS-5=Post-traumatic Diagnostic Scale for DSM-5 ( $k=2$ ), PTSS-14=UK-Post-traumatic Stress Syndrome 14-Questions Inventory ( $k=1$ ), PC-PTSD-5=The Primary Care PTSD Screen for DSM-5 ( $k=1$ ), PDS-5=Post-traumatic Diagnostic Scale-5 ( $k=1$ ) and TSQ=Trauma Screening Questionnaire-10 ( $k=1$ ).

## Quality appraisal

Of the 55 studies, 22 studies scored 4 out of 8, 23 studies scored 5, 8 studies scored 6, and 2 studies scored 7 (Supplementary material Table S3). Ninety-eight percent of the studies clearly defined their target population, used standardised data collection methods and used validated measurement tools. 75% presented a representative sample of the study population ( $\geq 300$  sample size). 50% of the studies selected their participants through probability sampling and 21% provided estimates with confidence intervals and detailed by subgroups. 25% had a response rate over 80% and 5.4% of the studies clearly described their non-responders. Overall, 264 points were recorded out of 440, which resulted in a general quality score of 60%. The quality score ranged from 4–7, with 5 as the median score. Fifty-five studies with moderate-high quality were included for final analysis (Supplementary material Table S3).

## Prevalence rates and symptoms of PTSD

The prevalence of PTSD was assessed in all fifty-five studies, with a noticeable variation in the number of nurses diagnosed with this disorder ranging from 2.20% to 74.4%. Most studies presented PTSD prevalence rates in the 31–40% ( $k=11$ ), followed by, >51% ( $k=11$ ), 11–20% ( $k=11$ ), 21–30% range ( $k=9$ ), 1–10% ( $k=8$ ) and 41–50%

( $k=5$ ). The symptomatology of PTSD varied greatly among studies. For instance, Yin et al. (2020) reported that 4.20% of the Chinese nurses that were evaluated presented probable PTSD. In general, females were more vulnerable to PTSD and showed more intrusive thoughts than males (Yin et al., 2020). In the United States, Sagherian et al. (2023) revealed that 53.38% of full-time nurses presented high levels of post-traumatic stress (Sagherian et al., 2023). Nurses who worked more or skipped rest breaks had significantly higher PTSD scores. On the other hand, Kader et al. (2021) reported that 74.4% of nurses experienced moderate to severe levels of perceived stress in Qatar. Surprisingly, nurses with previous ICU experience presented less probable diagnosis of PTSD than those without previous ICU experience (Kader et al., 2021).

## Associated risk factors

The papers whose source population were HCWs and provided prevalence estimates at the nurse subgroup level were included. However, some of these papers did not provide risk factors at the nurse level. Based on the sample overall proportion, nurses accounted for the majority of participants, and therefore, it was determined these papers could be kept for the risk factor analysis. The main risk factor for presenting PTSD was having a concomitant prior mental health disorder (such as depression and anxiety) (Alonso et al., 2021; Asnakew et al., 2021; Bahadirli & Sagaltici, 2021; Blanco-Daza et al., 2022; Chatzittofis et al., 2021; Fournier et al., 2022; Greenberg et al., 2021; Hickling & Barnett, 2022; Kader et al., 2021; Lowry et al., 2023; Mao et al., 2022; Ranieri et al., 2021; Wanigasooriya et al., 2020; Zhou et al., 2022), being a female (Alonso et al., 2021; Ayalew et al., 2022; Fournier et al., 2022; Gu et al., 2022; Lowry et al., 2023; Machado et al., 2023; Marcomini et al., 2021; Martínez-Caballero et al., 2021; Mehta et al., 2022; Renzi et al., 2023; Yin et al., 2020), having high exposure or direct contact with COVID-19 patients/being a frontline worker (Cousin Cabrolier et al., 2023; Gonzalez Mendez et al., 2022; Guillen-Burgos et al., 2022; Sagherian et al., 2022; Yin et al., 2020), having insufficient protective conditions or feeling at risk during the professional practice (Asnakew et al., 2021; Cousin Cabrolier et al., 2023; Flateau et al., 2021; Havaei et al., 2021; Leng et al., 2021; Mehta et al., 2022; Wang et al., 2020), having intensive workload or working with 24-hour shifts (Bahadirli & Sagaltici, 2021; Gonzalez Mendez et al., 2022; Leng et al., 2021; Meena et al., 2022; Sagherian et al., 2022, 2023; Yang et al., 2021) and working as ICU/Isolation unit/sub-intensive COVID-19 ward nurse (Azoulay et al., 2021; Leng et al., 2021; Li et al., 2021; Moon et al., 2021; Renzi et al., 2023). The complete representation of the risk factors is presented in (Supplementary material Table S5).





## Meta-analysis results of PTSD prevalence

Pooled estimates of PTSD prevalence were calculated for the 55 studies explicitly reporting the absolute number of nurses diagnosed with possible PTSD and the prevalence rate of PTSD symptoms ( $n=40\,548$  nurses). All reported pooled prevalence estimates were back-transformed (inverse of the logit transformation) for presentation. The visual inspection of the forest plot identified a potential outlier (Qutishat et al., 2021). Externally standardised residuals, DIFFITS values, Cook's distances covariance ratios, estimates of  $\tau^2$  and test for residual heterogeneity point to Qutishat et al. (2021; study 21) as an outlier potentially contributing to high heterogeneity at the cut-off (2) (Figure 2).

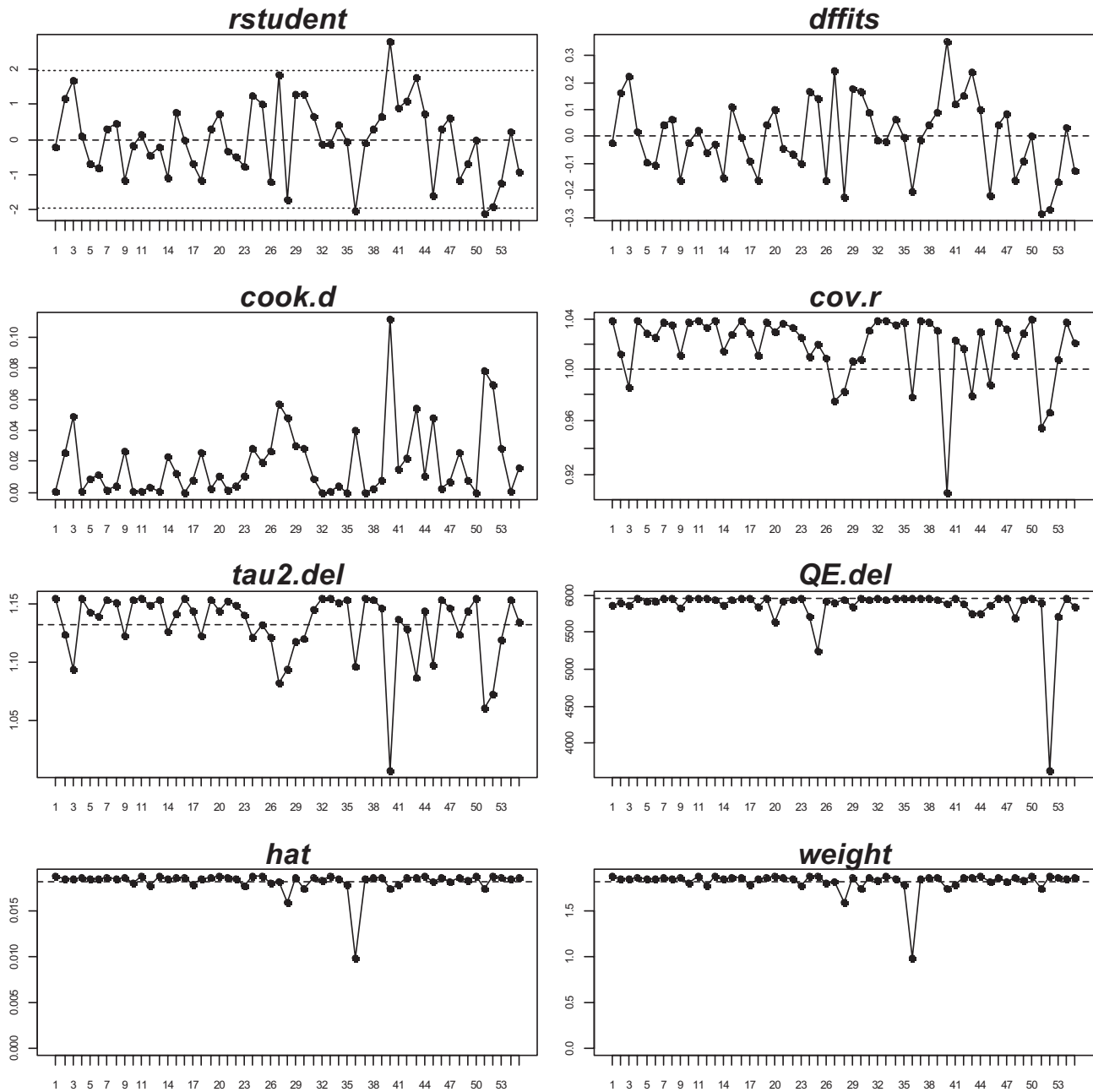
The overall pooled PTSD prevalence was 29.1% (95% C.I. = 23.5%, 35.5%) using a meta-analytic random-effects logistic regression model. The  $I^2$  statistic was 99.3%, the between-study variance was  $\tau^2=1.1811$ , and a fixed-effect heterogeneity test (Wald-type  $\chi^2=5967.2$ , d.f. = 54,  $p<0.0001$ ) indicated substantial heterogeneity across all studies (Figure 3). The regression test of funnel plot asymmetry indicated significant publication bias (Egger's test  $z=-13.4$ ;  $p<0.001$ ); however, the high variability among PTSD studies (i.e.  $I^2 > 50\%$ ; also see funnel plot in Supplemental material-Figure 1) limits inferences from this test (Ioannidis & Trikalinos, 2007).

Five moderators were assessed to explain this heterogeneity among PTSD studies: world region (China vs other countries), sample size ( $<750$  vs.  $\geq 750$ ), study primary target population (Nurses vs. all HCWs), study period (2020; 2021; 2022; 2023) and assessment instrument used (IES-R vs. Other instruments). Among these moderators, only study region explained significant variation, where the PTSD prevalence in China (0.173, 95% C.I. = 0.107 to 0.269,  $k=13$ ) was significantly lower ( $z$ -test = 2.7,  $p=0.007$ ) than the prevalence found in other countries (0.336, 95% C.I. = 0.271 to 0.409,  $k=42$ ) (Figure 4). There was no difference among studies ( $z$ -test = -0.51,  $p=0.6071$ ) with samples sizes smaller than 750 (0.3, 95% C.I. = 0.235 to 0.273,  $k=43$ ) or greater than 750 (0.263, 95% C.I. = 0.162 to 0.397,  $k=12$ ) and no differences in PTSD prevalence among study periods (year 2020 = 0.237, 95% C.I. = 0.116 to 0.423,  $k=6$ ; year 2021 = 0.345, 95% C.I. = 0.256 to 0.457,  $k=24$ ; year 2022 = 0.233, 95% C.I. = 0.158 to 0.330,  $k=19$ ; year 2023 = 0.339, 95% C.I. = 0.179 to 0.547,  $k=6$ ; between-group  $Q$ -test = 3.49, d.f. = 3,  $p=0.3214$ ). Target population did not explain variation in PTSD prevalence (HCWs prevalence = 0.272, 95% C.I. = 0.206 to 0.351,  $k=34$ ; nurses = 0.323, 95% C.I. = 0.230 to 0.432,  $k=21$ ;  $z$ -test = 0.78,  $p=0.4241$ ). Finally, the assessment instrument used in the studies did not explain variation in PTSD prevalence (IES-R = 0.32, 95% C.I. = 0.234 to 0.420,  $k=25$ ; other instruments = 0.268, 95% C.I. = 0.197 to 0.354,  $k=29$ ;  $z$ -test = -0.82,  $p=0.4107$ ).

## DISCUSSION

This literature review explored the prevalence of PTSD and its associated risk factors in nurses working during the COVID-19 pandemic. In the general population, the emergence of the COVID-19 pandemic increased the symptoms of psychological distress and negative mental health outcomes. In eight different countries, Xiong et al. (2020) detected high rates of anxiety, depression, PTSD, psychological distress and stress in the general population. A recent meta-analysis calculated the prevalence of PTSD among the general population to be 15% (95% CI: 11% to 21%) during the COVID-19 pandemic (Zhang et al., 2021). The pooled prevalence of PTSD among nurses during the COVID-19 pandemic in our meta-analysis was 29.1% (95% CI: 23.5% to 35.5%); therefore, much higher than that found in the general population.

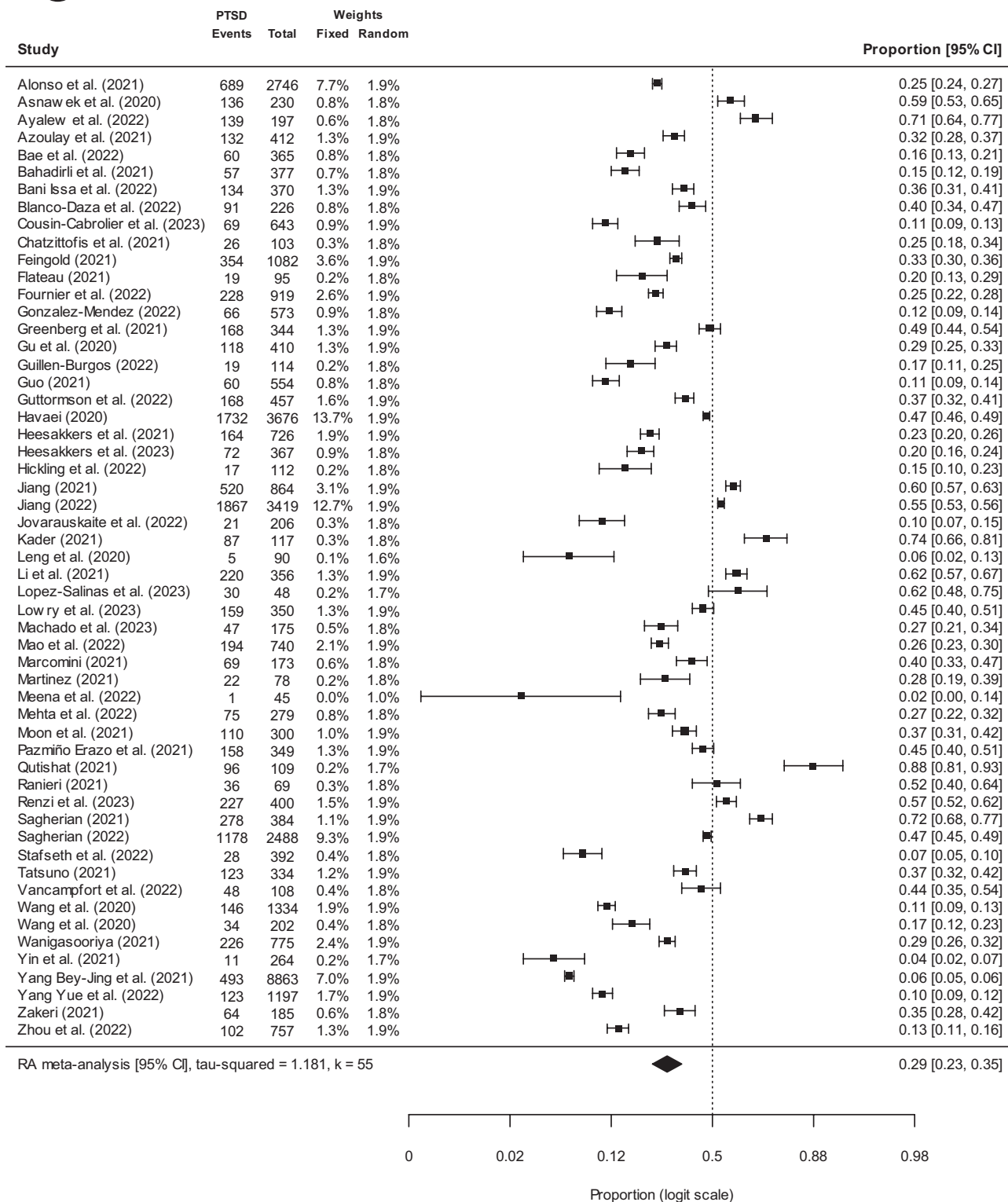
According to Xiong et al. (2020), risk factors associated with negative mental health outcomes were being female, of a younger age group ( $\leq 40$ ), the presence of chronic/psychiatric illnesses, unemployment, student status and frequent exposure to social/media news concerning COVID-19 (Xiong et al., 2020). This critical situation increases in frontline workers because they face extremely challenging scenarios, often outside ordinary levels of medical training and work experience. HCWs have been identified as a vulnerable population for anxiety and depression during any infectious disease outbreak, including the current public health emergency (Luo et al., 2020). Extremely high prevalence rates for anxiety (33%) and depression (28%) have been reported among healthcare workers, the general public, and patients with pre-existing conditions during the COVID-19 pandemic (Luo et al., 2020). da Silva and Neto (2021) suggest healthcare professionals, regardless of their age, showed significantly higher levels of anxiety, somatization and insomnia compared to professionals from other areas. Pappa et al. (2020) provided evidence females and nurses exhibited higher rates of affective symptoms compared to males and medical staff. Our study identified many similar risk factors to both the general and HCW populations, in addition to nurse-specific factors during the COVID-19 pandemic. These include having a concomitant prior mental health disorder, being a female, having high exposure or direct contact with COVID-19 patients/being a frontline worker, having insufficient protective conditions/feeling of risk during professional practice, having intensive workload or working with 24-hour shifts, working as an intensive care unit (UCI), isolation unit or sub-intensive COVID-19 ward nurse, having a young age, being afraid of being infected or fear of infecting family members, lack of experience/few years in nursing and having insufficient work experience with COVID-19 (for complete list see: Supplementary material Table S5).



**FIGURE 2** Plot of sensitivity analyses (leave-one-out) and outlier assessment for the 55 studies included in the meta-analysis. Statistics include: externally standardised residuals (*rstudent*), DIFFITS values (*dffits*), Cook's distances (*cook.d*), covariance ratios (*cov.r*), estimates of  $\tau^2$  (*tau2.del*), test for residual heterogeneity (*QE.del*) and relative weighting in the meta-analysis (*weight*).

Pan et al. (2021) reported the number and chronicity of mental health disorders reflected a graded dose–response relationship, in which persons with severe or chronic mental health outcomes presented a greater impact on their mental health status, more fear of COVID-19, and less positive coping strategies when compared with other individuals (Pan et al., 2021). This same sentiment was echoed in the findings of this review. Persons with pre-existing mental health conditions may be vulnerable to recurrence due to drastic changes the COVID-19 pandemic brought upon us, such as stay-at-home orders, social isolation, economic

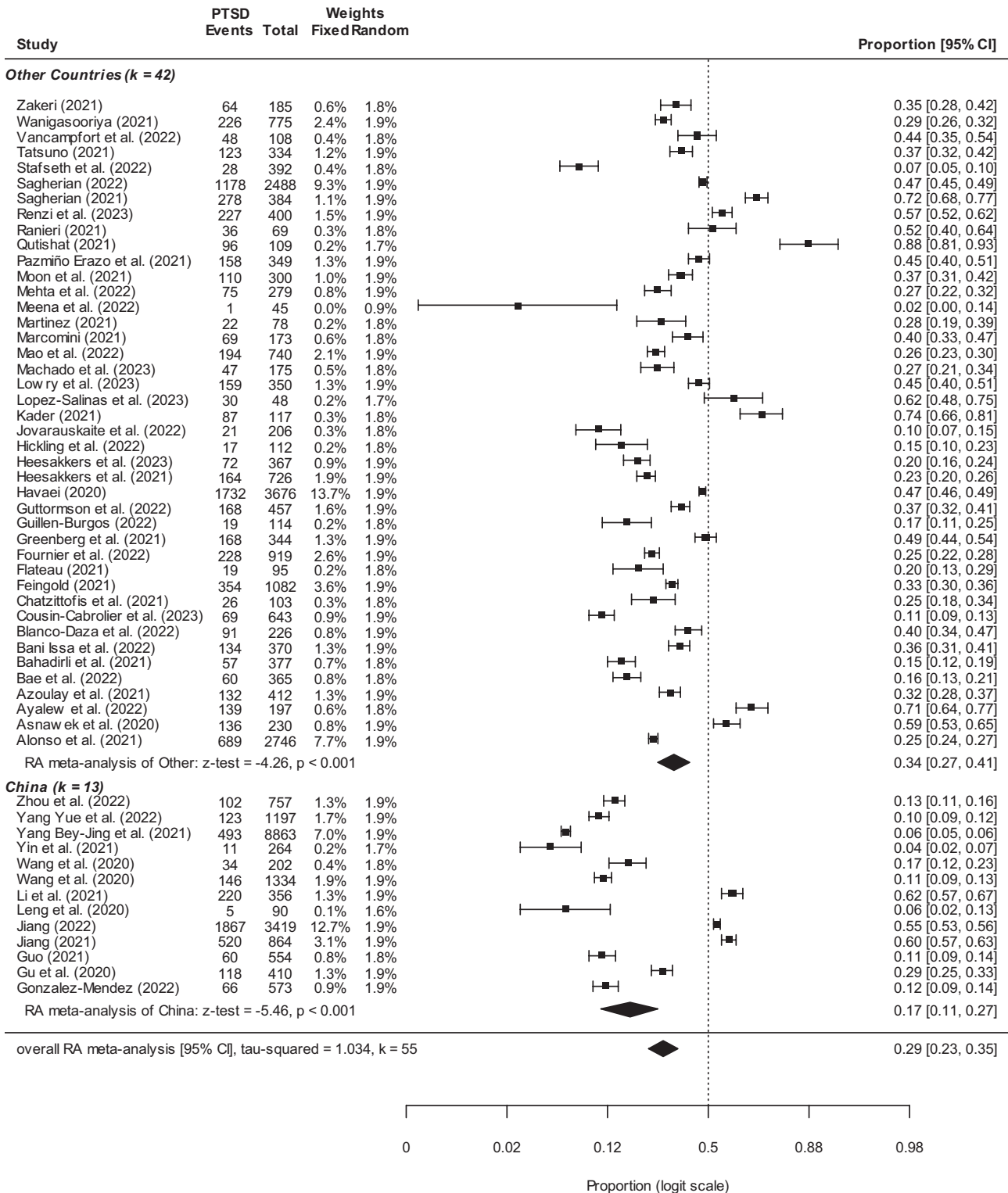
distress, etc. Personal characteristics of nurses, such as being afraid of infection or having prior mental health co-morbidities, have been previously associated with increased risk for developing anxiety, depression, and PTSD (Azoulay et al., 2021; Giusti et al., 2020). Previous studies focused on previous epidemics and pandemics found increased workload, fear of infection, fatigue, and inadequate supply of personal protective equipment (PPE) had a major impact on the mental health status of HCWs (Barello et al., 2020; Salazar de Pablo et al., 2020). These are also highly cited risk factors in this review ( $k=17$ ).



**FIGURE 3** Forest plot of the pooled prevalence for PTSD among 55 studies reporting effects of the COVID-19 pandemic on the psychological health of nurses (2020–2023). Pooled prevalence estimated from a random-effects (RA) logistic regression meta-analysis model. Presented includes the fixed-effect weights (inverse variance) and random-effects weights (inverse variance + tau-squared) of a random-effects meta-analysis.

Being a female was another interesting risk factor for PTSD among nurses. This fact is consistent with previous studies on negative mental health outcomes in HCWs, which found a higher risk for PTSD in females, regardless

of profession (D'Ettorre et al., 2020). Gonzalez-Sanguino et al., 2021 hypothesized that women apart from serving as HCWs, are also involved in other demanding activities such as being caregivers and home managers for the



**FIGURE 4** Forest plot of the pooled prevalence among China and other countries for PTSD among 55 studies reporting effects of the COVID-19 pandemic on the psychological health of nurses (2020–2021). Pooled prevalence estimated from a random-effects (RA) logistic regression meta-analysis model. Presented includes the fixed-effect weights (inverse variance) and random-effects weights (inverse variance + tau-squared) of a random-effects meta-analysis.

family and these responsibilities may overload women, making them more likely to present anxiety and post-traumatic stress symptoms (PTSS) (Gonzalez-Sanguino et al., 2021). On the other hand, Song et al., 2020 found

higher prevalence rates of PTSD among male HCWs in China and concluded that this difference may be due to the timing of the study, which was carried out later during the pandemic, and the mental health of the female





HCWs may have gradually improved over time (Song et al., 2020). However, Song et al., 2020 was not included in this review because it was excluded during quality assessment. Only one included study also listed being male as a risk factor (Qutishat et al., 2021). They stated their results may be due to females being more likely to seek social support. Women have been shown to be more aware of their feelings/experiences and are less hesitant of expressing their emotions; this behaviour may lead to a self-regulation of emotions which in turn can reduce the impact of stressors over time (Neitzke, 2016).

Being a younger nurse was also found to be a risk factor for PTSD. A study carried out in the general population determined that older adults have fewer negative emotions and better mental health status than younger adults during the COVID-19 pandemic (Bruine de Bruin, 2021). It is also possible that older nurses have more experience with public health emergencies and are better prepared professionally and psychologically to cope with overwhelming situations. Like this hypothesis, an Italian commentary focusing on organisational changes for nursing management techniques found that recently graduated nurses might have a difficult time delivering optimum quality of care during public health emergencies (Bambi et al., 2020).

During the first stage of the COVID-19 pandemic, many countries faced a lack of PPE leading to increased levels of stress and insecurity among HCWs. Among nurses from Michigan, Arnetz et al. (2020) found an inversely proportional relationship between adequate access to PPE and negative mental health outcomes. In this study, nurses lacking access to adequate PPE were more likely to present symptoms of depression, anxiety, and PTSD. The severity of PTSD in the nurse group decreased as the PPE access increased (Arnetz et al., 2020). Unfortunately, the lack of access to PPE is still a reality for many HCWs, especially in developing countries with low health care expenditure. In many cases, barrier devices are perceived by front-line workers as an extension of their ability to defend themselves against infectious pathogens. This extra shield may reduce the perception of danger against contagious respiratory infections (Giorgi et al., 2020). Therefore, it is necessary to emphasise the importance of providing HCWs with adequate healthcare infrastructure and anti-contagion measures to inspire trust and psychological resilience against negative mental health outcomes.

Regarding the clinical setting, increased risk for PTSD was observed in nurses working in inpatient settings (ICU or sub-intensive COVID-19 wards). Exposure to constantly stressful/tragic experiences in ICU wards may have a significant impact on the mental health of nurses.

The aforementioned associated risk factors show the need for policy enactment to protect nurses from the huge psychological burden of traumatic events

related to the COVID-19 pandemic. Firstly, more attention should be directed at nurses presenting with the described predictors of increased risk for PTSS (being a nurse vs other HCW group, being a young nurse, presenting pre-existing mental health conditions, working as an intensive care unit (ICU), Isolation unit or sub-intensive COVID-19 ward nurse and being a female). Therefore, healthcare institutions must ensure the proper and timely dissemination of supportive resources related to COVID-19. For example, passive educational training through email, pamphlets, and websites has been shown to be effective in reducing PTSS in nurses experiencing high stress levels. Basic information on the natural history of the disease and effective control measures can lower the risk for stress symptomatology among HCW (Chew et al., 2020). Additionally, hospital management and administrations should always anticipate the impact of public health emergencies on the mental health of their HCWs and provide sufficient training in evidence-based anticipatory techniques for coping with stressful events, such as the ongoing pandemic. These interventions may reduce the prevalence rates of PTSD among nurses and encourage them to support other colleagues after facing adverse situations (Guay et al., 2019). Theorell, 2020 recommends the application of supportive leadership to minimise the impact of stressful events on the mental health of HCWs during the COVID-19 pandemic. This includes providing flexible work schedules (adaptable to ever-changing situations), promoting adequate sleep hygiene, providing social support to family members, including HCWs in decision making, facilitating good coping mechanisms and implementing cultural experiences, such as easy electronic access to movies, concerts and lectures during leisure time (Theorell, 2020).

There are several strengths and limitations in this review. To our knowledge, this is one of the most complete syntheses that explore the prevalence and risk factors for PTSD (excluding other mental health conditions such as anxiety and depression) in the nurse subpopulation during the global COVID-19 pandemic. Additionally, the multi-national and multi-regional nature of this study was able to capture a representative population size. Therefore, the mental health characteristics observed in the study participants may be generalised with some degree of confidence.

Variations in prevalence rates across studies were noticed, probably due to the implementation of various measurement scales, reporting patterns and possibly international/cultural differences among populations. This heterogeneity across studies is one of the major limitations that we observed. The various assessment scales implemented had different cut-off values. Thus, the threshold criteria for case definition varied among studies. Some studies compared HCW subpopulations, while other compared nurse population in different





wards. Although we included studies from 18 countries, sampling bias may exist as most of the study participants were captured in China. Moreover, we only included publications in the English and Spanish language, which may have affected publication bias.

## CONCLUSION

This systematic literature review and meta-analysis examined the prevalence of PTSD in nurses, as a specific subgroup of HCWs and stressed the associated risk factors. Relatively high prevalence rates of PTSD were reported in most studies, leading the pooled estimate to be higher than a recent PTSD estimate for the general population during the COVID-19 pandemic. The main risk factors associated with PTSD included having a concomitant prior mental health disorder, being a female, having high exposure or direct contact with COVID-19 patients, having insufficient protective conditions/feeling of risk during professional practice, having intensive workload or working with 24-hour shifts and working as ICU/Isolation unit/sub-intensive COVID-19 ward nurse. These findings can help to prioritise and quantify support needs for nurses and inform tailored mental health interventions to enhance resilience among this HCW group and mitigate their vulnerabilities.

## RELEVANCE FOR CLINICAL PRACTICE

Our findings confirmed that the COVID-19 pandemic was associated with significant levels of PTSD among frontline nurses globally (29.1%). This study highlighted the main risk factors associated with PTSD among nurses (having prior mental health co-morbidities, being a female, having direct contact with COVID-19 patients, having insufficient protective conditions and having intensive workload). This new knowledge can help health authorities design future psychological, social, and administrative interventions to mitigate the heavy psychological distress that nurses face during COVID-19 waves and/or future pandemics.

## AUTHOR CONTRIBUTIONS

SHB designed and conducted the literature search. SHB and JP applied the inclusion and exclusion criteria to the studies that were retrieved. SHB, JP and AC performed the quality assessment tool to all papers independently in two different rounds. JB, ML and DW supervised the design, reviewed the results and revised the manuscript drafting. ML revised the meta-analysis coding and interpretation. All authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors. All authors agree with the content of this manuscript.

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## CONFLICT OF INTEREST STATEMENT

The authors report there are no competing interests to declare.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in PROSPERO at <https://www.crd.york.ac.uk/prosp/ero/>, reference number CRD42022279692. These data were derived from the following resources available in the public domain: PROSPERO, <https://www.crd.york.ac.uk/prosp/ero/#searchadvanced>.

## ETHICS STATEMENT

This study did not require ethical permission since we used secondary published data, that was already ethically approved by its time of publication.

## PATIENT CONSENT FOR PUBLICATION STATEMENT

Not applicable.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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