Mental health outcomes among health-care workers dealing with COVID-19/severe acute respiratory syndrome coronavirus 2 pandemic: A systematic review and meta-analysis

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ABSTRACT

Introduction: The psychological impact of COVID-19 on health-care workers (HCWs) has received attention from researchers to understand the extent of the effects of the ongoing pandemic on this population. The aim of this systematic review and meta-analysis was to synthesize the currently available literature on the topic to determine the prevalence of mental health problems in HCWs.

Materials and Methods: We conducted a systematic review and meta-analysis, searching PubMed, PsycINFO, Scopus, and Cochrane Library databases for articles published from December 2019 to August 15, 2020. We identified studies reporting the prevalence of any mental health condition in HCWs involved directly or indirectly in providing services during the COVID-19 pandemic. The prevalence proportion for individual outcome was extracted as an estimate of interest. We performed random-effects meta-analyses evaluated using Q statistic, I^2 statistic, subgroup analyses, and sensitivity analyses and assessed study quality. This review was done in adherence to the Reporting Items for Systematic Reviews and Meta-Analysis and Meta-analysis of Observational Studies in Epidemiology guidelines. The study protocol was registered prospectively at PROSPERO (CRD42020182005).

Results: We identified 1958 studies, of which 33 studies including 39703 participants (with a median = 393; range = 88–14825) were finally included for analysis. The estimated overall prevalence were as follows: depression 32.4% (95% confidence interval [CI]: 25.9–39.3, I^2 = 99%), anxiety 32.5% (95% CI: 26.4–39.0, I^2 = 99%), insomnia or sleep disturbance 36.6% (95% CI: 36.6–48.3, I^2 = 99%), and stress 37.7% (95% CI: 24.0–52.3, I^2 = 100%).

Conclusion: HCWs who are dealing with the COVID-19 pandemic have a significant prevalence of depression, anxiety, insomnia and poor sleep quality, and stress. The health-care workforce needs to practice self-care now more than ever, while health-care managers and policymakers need to factor in the mental health consequences of COVID-19 on their workforce.

Key words: COVID-19, health-care workers, mental health, meta-analysis, prevalence, systematic review

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Access this article online	
Website: www.indianjpsychiatry.org	**Quick Response Code**
DOI: 10.4103/psychiatry.IndianJPsychiatry_1029_20	

INTRODUCTION

At the end of 2019, a novel coronavirus infection was reported in Wuhan, China, and then a public health emergency of international concern was declared by the World Health Organization.[1,2]

Health-care workers (HCWs) have had to deal with this critical situation by becoming directly involved in the diagnosis and treatment of patients with COVID-19 at the risk of developing various physical, psychological, and mental health problems.[3] Several factors can contribute to these consequences, such as the increasing number of confirmed and suspected cases, a high workload, the fact that this virus is human-to-human transmissible, the association with high morbidity, and potentially fatal outcome, the shortage of personal protective equipment (PPEs), the widespread coverage of the media, the lack of specific treatments, and the feeling of not receiving adequate support.[3]

The literature has reported the presence of psychological and mental health problems among HCWs in the 2003 severe acute respiratory syndrome (SARS) outbreak, showing that HCWs feared contagion and passing the infection to family and friends, and felt uncertainty and stigmatization.[3,4] On the other hand, it has been shown that health-care professionals were experiencing high levels of stress, anxiety, and symptoms of depression, which could have long-term psychological implications.[5,6] HCWs spend hours each day putting on and taking off tight protective gear, adding to physical exhaustion and, in some cases, low tolerability of PPEs.[7]

On the other hand, many of the health workers have avoided contact with their families, especially with older adults who are the risk group and with their immediate relatives, such as their children.[8,9] Health workers with temporary contracts and low salaries are in an even more vulnerable situation.[10]

The burden of mental health conditions has to be known among this population, in order to take necessary measures. Our objective was to investigate the prevalent mental health outcomes among HCWs dealing with the COVID-19 pandemic.

MATERIALS AND METHODS

Literature search strategy

We conducted this systematic review in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis[11] and Meta-analysis of Observational Studies in Epidemiology.[12] The protocol for this review was registered prospectively in PROSPERO (CRD42020182005). The search strategy was developed and finalized with the consensus among all the reviewers. Electronic databases searched were PubMed/MEDLINE, Cochrane Library, Scopus, and PsycINFO. We used different keywords such as "COVID-19," "Healthcare Workers," "Doctors," "Nurses," "Health staffs," "Hospital workers," "Coronavirus," "Mental health," "Stress," "anxiety," "depression," and "Psychologic*," major headings (MeSH), and different operators according to the structure and guidance of the database to achieve a higher precision of the results. The search was limited from December 1, 2019, up to August 15, 2020. The detailed search strategy for each database is provided in Additional File 1. Manual search was performed within the bibliographic list of relevant studies for additional inclusion.

Study selection and eligibility criteria

Initially, we screened the title and abstract of all studies retrieved from the database search. Screening of title and abstracts were done by two groups of authors (AD and SM and HP and AS) consisting of two authors in each group. Full texts were retrieved for relevant studies, and finally, articles selected based on the following criteria:

1. Participant and exposure: Study sample or population being HCWs (doctor, nurse, and others) dealing with COVID-19 pandemic
2. Study design: Cross-sectional, case-control, cohort study at least reporting prevalence of any mental health condition. Studies reporting or having extractable prevalence data
3. Health condition: Depression, anxiety, insomnia, stress, or other mental health outcomes assessed using routinely reported measures, for example, self-report, clinical diagnosis, International Classification of Diseases or Diagnostic and Statistical Manual (DSM) criteria, and validated questionnaires such as the Patient Health Questionnaire-9 (PHQ-9) and Insomnia Severity Index. The diagnosis based on either defined syndrome category or symptoms found significant through screening process.

We excluded commentaries, editorials, letters with inadequate data, reviews, and interventional studies, posters, collective reporting of mental health conditions, preprint documents, and gray literature (including theses). Abstracts that met our inclusion criteria were then reviewed in full text to form a final list of included studies. We imposed no language or publication restrictions.

Data extraction

We extracted data from each included study in a standardized excel sheet. The following information were extracted: study identification by the name of the first author, year of publication, country, data collection period, study design, gender distribution (by % female), total participants, number of participants by profession, diagnosis, assessment methods for diagnosis or scale used and their respective cutoff value, and number of

participants screened positive for symptoms according to the aforementioned criteria. The prevalence proportion for individual outcome was extracted as an estimate of interest. Two reviewers extracted data independently (AD and SM), and any discrepancy was resolved by discussion with a third reviewer (HP).

The main outcomes were prevalence of depression, anxiety, insomnia, stress or other mental health ailments such as obsessive–compulsive disorder (OCD), and somatization symptoms by using various screening instruments.

Quality assessment

Two reviewers (AD and SM) independently judged the methodological quality of studies included in the meta-analysis using a modified version of the "Newcastle–Ottawa Scale."[13] Quality of studies was evaluated in five different domains: "sample representativeness," "sample size," "ascertainment of mental ailments (depression, anxiety, insomnia, stress, etc.)," "comparability between respondents and nonrespondents," and "statistical quality."

According to the total number of points assigned, each study was judged to be at low risk of bias (≥3 points) or high risk of bias (<3 points).[13] Any discrepancies concerning the author's judgments were referred to a third reviewer (RTC) and resolved by consensus.

Data synthesis and analysis

We used MetaXL software version 5.3 (EpiGear International, Sunrise Beach, Queensland, Australia) for meta-analysis and generation of forest plot that showed combined estimates with 95% CI. We pooled the prevalence of the studies structured around individual outcomes using double arcsine transformation method.[14] The overall pooled prevalence was estimated by random-effects model for having high heterogeneity, evaluated using Q statistic and the I^2 statistic.[15] Values of I^2 statistic of 25%, 50%, and 75% were considered to have, respectively, low, medium, and high magnitude of heterogeneity between studies. Subgroup analysis, according to the outcome assessment and profession, was carried out. Sensitivity analysis was also carried out to assess the change in pooled prevalence by selective exclusion of studies.

RESULTS

Identification of studies

We identified 1934 studies from the database searches with a predefined strategy along with 24 additional papers obtained from bibliographic hand search. Out of these, 1186 studies were excluded during screening for duplicates and did not meet the inclusion criteria. We further assessed 94 full texts and finally included 33 studies for analysis [Figure 1].

### Characteristics of included studies

In 33 included studies, collective participants were 39703 with a median population of 393 (range: 88–14825). Among the included studies, all were of cross-sectional design, mostly in institutional settings and conducted in 2020. Most of the studies reported prevalence data from China,[3,16-31] three from India,[32-34] two studies from Pakistan,[35,36] individual studies from Turkey,[37] Singapore,[38] Brazil,[39] Italy,[40] Poland,[41] Iran,[42] Jordan,[43] Nepal,[44] and the US,[45] and one study collectively from Singapore and India.[10] All the studies varied in population, reported outcome, and assessment methods. Thirty studies reported the prevalence of depression,[3,10,16,17,19,21-24,26-46] 31 reported anxiety,[3,10,16-19,21,23-46] 11 reported insomnia or sleep disturbances,[3,16,20,21,23,24,26,27,30,36,46] and 17 studies reported stress and related disorders.[3,10,16,17,22,25,27,32,34-38,40,42,45,46] Out of these, few studies additionally measured the prevalence of OCD and somatic symptoms,[26] fear,[19] social support,[22,23] and burnout.[40,45] Reported population characteristics, response rate, number of participants, and assessment methods used are depicted in the summary of findings table [Table 1]. The pooled prevalence for depression, anxiety, and insomnia along with subgroups according to the assessment tool used, were analyzed. Outcome like stress or posttraumatic stress disorder (PTSD) was not comparable enough, still the pooled prevalence along with the possible source of heterogeneity was described. Studies which reported medical (doctors and nurses) versus other HCWs were pooled for a summary estimate of prevalence for subgroup comparison.

Quality of included studies

We used a modified version of the Newcastle–Ottawa Scale for all the included studies because of cross-sectional design. Based on the assessment of the risk of bias of individual studies, the majority of studies are rated as low risk of bias. Studies were mostly at low risk of bias regarding sample size, response, assessment of outcome, and statistical tests. However, the studies were at high risk of bias in sample representativeness [Table 2].

Prevalence of depression

Depression was reported in 30 studies covering 37655 participants (median = 374.5),[3,10,16,17,19, 21-24,26-46] using various assessment methods such as PHQ-9,[3,17,27,30,34,41,43,44] the Depression, Anxiety, and Stress Scale-21 (DASS-21),[10,32,35-38,40,45] Zung Self-Rating Depression Scale (SDS),[21,23,29,31] Center for Epidemiologic Studies Depression Scale (CES-D),[22,24] Hamilton Depression Rating Scale,[17] Beck Depression Inventory-2,[16] PHQ-4,[26,42] and Hospital Anxiety and Depression Scale.[28,33,39,46] The pooled prevalence of depression was 32.4% (95% CI: 25.9–39.3, I^2 = 99%) [Figure 2]. The prevalence was variable among subgroups. The prevalence for PHQ-9 subgroup pooled from three studies was 42.8% (95% CI: 22.0–64.3, I^2 = 100%) which is much higher than DASS-21 (36.7% [95% CI: 18.3–56.3,
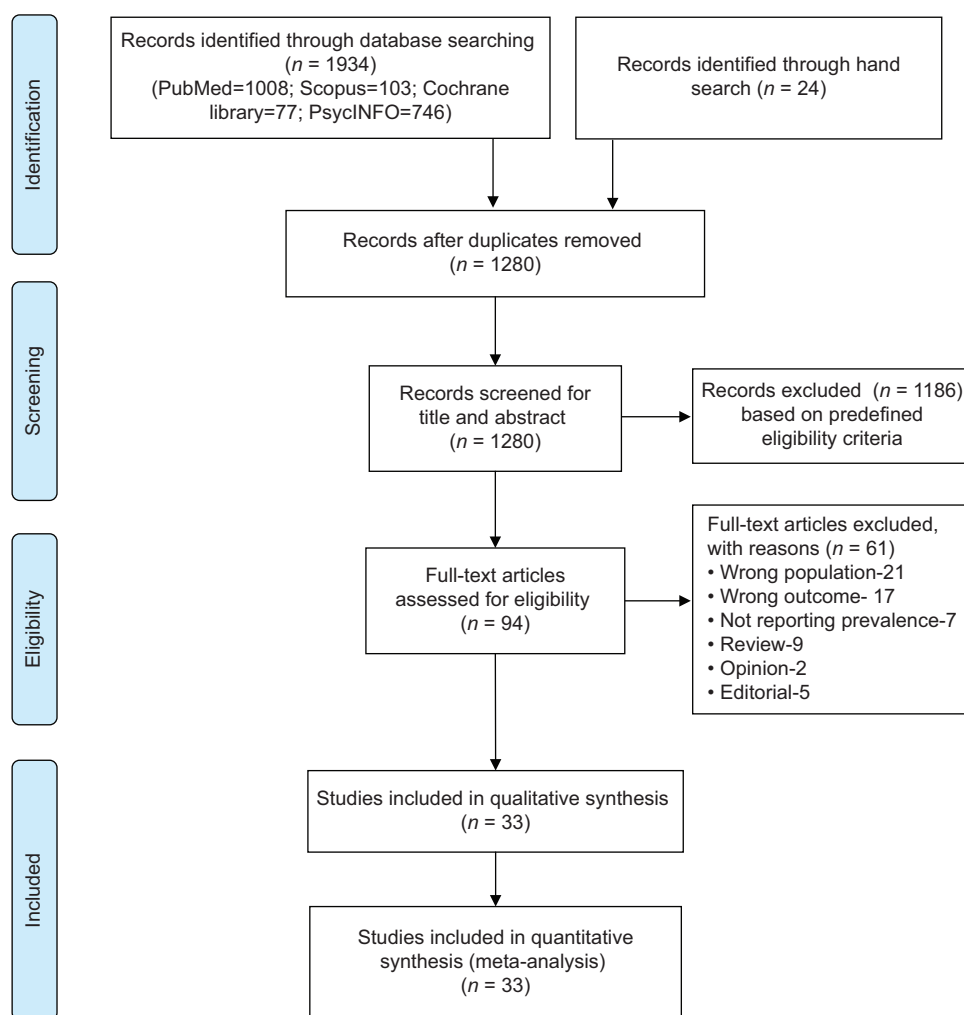
Figure 1: Study selection process

$I^2 = 99\%$]), SDS (31.4% [95% CI: 22.5–41.0, $I^2 = 80\%$]), and CES-D (22.4% [95% CI: 17.4–27.9, $I^2 = 97\%$]) subgroup. The pooled estimate was reduced only by 2.1% after elimination of studies with high risk of bias. In sensitivity analysis, it was found that no study influenced the estimate >1.4%.

Prevalence of anxiety
The presence of anxiety was reported in 31[3,10,16-19,21,23-46] out of 33 included studies covering 23472 people with a median sample size of 356. The overall prevalence was found to be 32.5% (95% CI: 26.4–39.0, $I^2 = 99\%$) [Figure 3]. In nine studies, the reported outcome was assessed by General Anxiety Disorder-7 (GAD-7)[3,17,24,27,30,34,41,43,44] where pooled prevalence was 45.1% (95% CI: 33.8–56.5, $I^2 = 99\%$). The estimated prevalence of 'Zung Self-Rating Anxiety Scale' subgroup (consists of six studies[18,21,23,25,29,31]) and 'DASS-21' subgroup (consists of eight studies[10,32,35-38,40,45]) were 14.0% (95% CI: 9.0–19.7, I2 = 85%) and 39.0% (95% CI: 22.8–55.9, I2 = 99%), respectively. The cutoff value for GAD-7 and other measuring scales varied across studies which might have contributed to this large variation between subgroups. The resulting summary statistic was not changed >1.7% after

serial exclusion of individual studies and studies with high risk of bias.

Prevalence of insomnia
The prevalence of insomnia or poor sleep quality or sleep disturbance was reported in 11 (n = 10411; median = 1045) of 33 included studies.[3,16,20,21,23,24,26,27,30,36,46] The calculated pooled prevalence was 36.6% (95% CI: 25.6–48.3, $I^2 = 99\%$), as shown in Figure 4. No studies influenced changing the outcome >2.2% except for the study by Wang *et al.*,[46] after exclusion of which, the resulting prevalence was 39.8% (95% CI: 29.3–50.9, $I^2 = 99\%$).

Prevalence of stress
The assessment and reporting of stress was heterogeneous across studies. Seventeen out of 33 studies estimated the prevalence of stress symptoms[3,10,16,17,22,25,27,32,34-38,40,42,45,46] which included 27238 participants with a median value of 393; three of those used Impact of Event Scale–Revised (IES-R),[3,17,27] two reported both IES-R and DASS-21,[10,38] and others used PTSD-Self-Rating Scale (PTSD-SS),[25] Perceived Stress Scale,[16,34,46] PTSD

Table 1: Summary of included studies

Author	Year	Data collection period	Country	Female (%)	True sample	Doctors	Nurse	Others	Response rate (%)	Diagnosis	Scale used	Cutoff value	Symptoms present, % (n)
Chew N. *et al.*	2020	February 19-April 17	Singapore, India	64.35	906	268	355	283	90.6	Depression Anxiety Stress PTSD	DASS-21 IES-R	>9 >7 >14 ≥24	10.6 (96) 15.7 (142) 5.2 (47) 7.4 (67)
Du J. *et al.*	2020	February 13-February 17	China	60.45	134	47	55	32	43.2	Depression Anxiety Insomnia Stress	BDI-2 BAI Unknown PSS	≥14 ≥8 NA ≥14	12.7 (17) 20.9 (28) 35.1 (47) 32.8 (44)
Elbay RY. *et al.*	2020	March 10-March 15	Turkey	56.80	442	NA	NA	NA	NA	Depression Anxiety Stress	DASS-21	NA NA NA	64.7 (286) 51.6 (224) 41.2 (182)
Huang J. *et al.*	2020	February 7-February 14	China	81.30	230	70	160	NA	93.5	Anxiety Stress	SAS PTSD-SS	≥50 ≥50	23.0 (53) 27.4 (63)
Huang Y. *et al.*	2020	February 3-February 17	China	NA	2250	NA	NA	NA	85.3	Depression Anxiety Insomnia	CES-D GAD-7 PSQI	≥28 ≥9 ≥7	19.8 (446) 35.6 (802) 23.6 (531)
Lai J. *et al.*	2020	January 29-February 3	China	76.69	1257	764	493	NA	68.7	Depression Anxiety Insomnia Stress	PHQ-9 GAD-7 ISI IES-R	≥5 ≥5 ≥8 ≥9	50.4 (634) 44.6 (560) 34.0 (427) 71.5 (899)
Li G. *et al.*	2020	February 8-February 15	China	100.00	4369	NA	NA	NA	82.2	Depression Anxiety Stress	PHQ-9 GAD-7 IES-R	≥10 ≥8 >33	14.2 (621) 25.2 (1101) 31.6 (1382)
Liu C. *et al.*	2020	February 10-February 20	China	84.57	512	NA	NA	NA	85.3	Anxiety	SAS	>50	12.5 (64)
Lu W. *et al.*	2020	February 25-February 26	China	74.41	2399	2042		257	94.88	Depression Anxiety	HAMD HAMA	≥7	11.7 (268) 31.9 (569)
Qi J. *et al.*	2020	February	China	80.86	1306	NA	NA	NA	93.6	Sleep	PSQI; AIS	>6	71.7 (936); 45.5 (594)
Sheng X. *et al.*	2020	NA	China	90.53	95	NA	95	NA	96.8	Depression Anxiety Insomnia	SDS SAS PSQI	≥50 ≥50 >7	26.3 (25) 5.3 (5) 16.8 (16)
Song X. *et al.*	2020	February 28-March 18	China	64.32	14,825	6093	8732	NA	NA	Depression PTSD	CES-D PCL-5	≥16 >33	25.2 (3733) 9.1 (1353)
Tan B. *et al.*	2020	February 19-March 13	Singapore	68.30	470	135	161	174	94	Depression Anxiety Stress PTSD	DASS-21 IES-R	≥9 >7 >14 ≥24	8.9 (42) 14.5 (68) 6.6 (31) 7.7 (36)
Wang S. *et al.*	2020	January 30-February 7	China	90.24	123	48	75	NA	NA	Depression Anxiety Insomnia	SDS SAS PSQI	≥50 ≥50 >7	25.2 (31) 7.3 (9) 38.2 (47)

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Table 1: Contd...

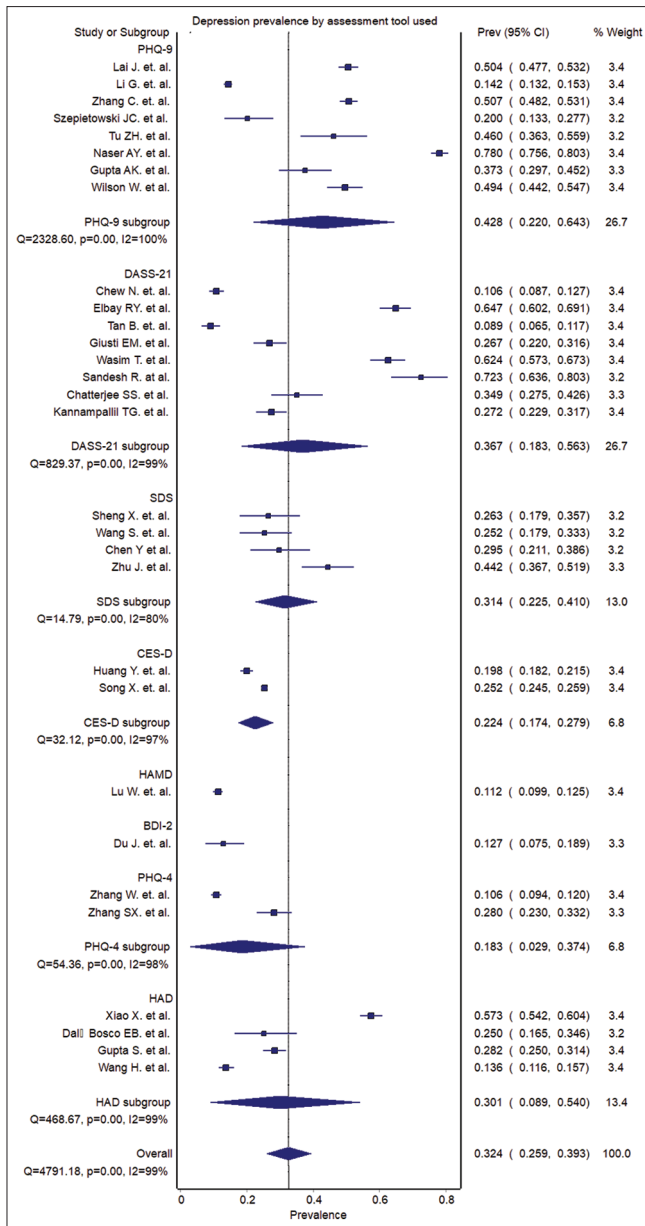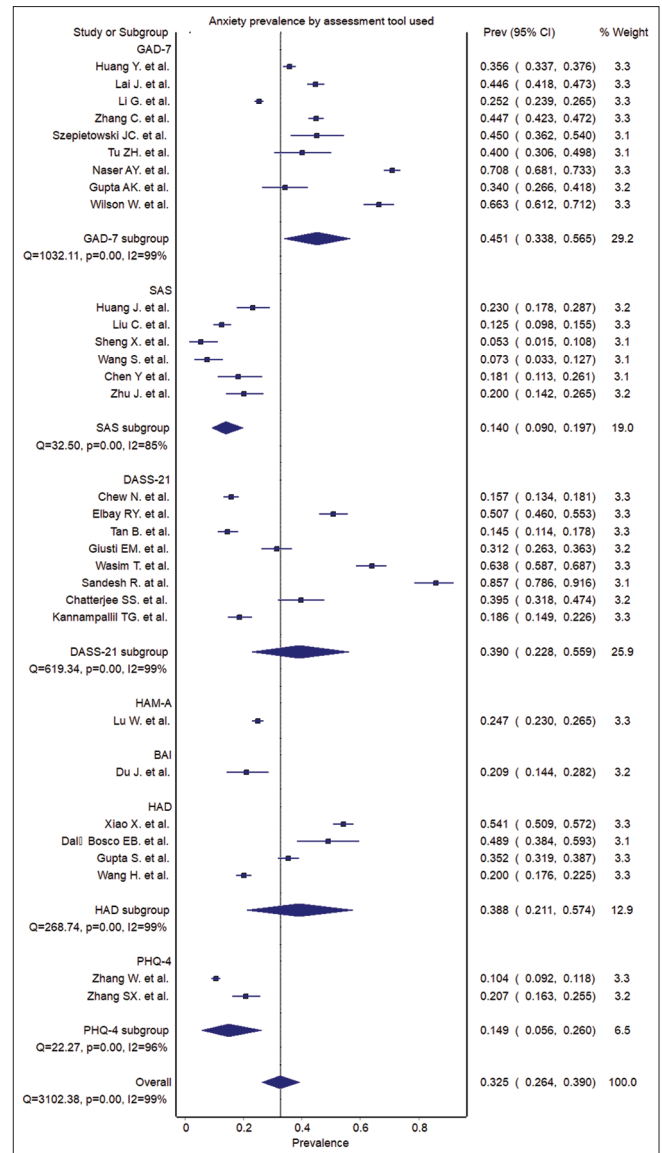| Author	Year	Data collection period	Country	Female (%)	True sample	Doctors	Nurse	Others	Response rate (%)	Diagnosis	Scale used	Cutoff value	Symptoms present, % (n)
Xiao X. *et al.*	2020	NA	China	67.22	958	378	359	221	NA	Depression	HAD	≥8	57.3 (549)
										Anxiety		≥8	54.1 (518)
Zhang C. *et al.*	2020	January 29-February 3	China	82.73	1563	454	984	125	80.3	Depression	PHQ-9	≥5	50.7 (792)
										Anxiety	GAD-7	≥5	44.7 (699)
										Insomnia	ISI	≥8	36.1 (564)
										Stress	IES-R	≥9	73.4 (1147)
Zhang W. *et al.*	2020	February 19-March 6	China	64.21	2182	927		1255	NA	Depression	PHQ-4 (GAD-2 and PHQ-2)	≥3 (PHQ-2)	10.6 (232)
										Anxiety		≥3 (GAD-2)	10.4 (228)
										Insomnia	ISI	>8	33.9 (739)
										Somatic symptoms; OCD; phobic anxiety	SCL-90-R	Subscale score≥2	2.2 (20); 3.5 (77); 2.9 (63)
Dal'Bosco EB. *et al.*	2020	Mar 2020-Apr 2020	Brazil	90.70	88	NA	88	NA	NA	Depression	HAD	≥8	25.0 (22)
										Anxiety			48.9 (43)
Giusti EM. *et al.*	2020	Apr 16-May 11	Italy	62.42	330	140	86	105	41.25	Emotional exhaustion	MBI	≥17	64.2 (212)
										Depersonalization		≥7	26.1 (86)
										Reduced personal accomplishment		≤38	74.2 (245)
										Depression	DASS-21	Above the 75° percentile based on normative data	26.7 (88)
										Anxiety			31.2 (103)
										Stress			34.2 (113)
										PTSD	IES-6	≥9	36.7 (121)
Szepietowski JC. *et al.*	2020	NA	Poland	78.30	120	58	62	NA	97.6	Depression	PHQ-9	≥10	20.0 (24)
										Anxiety	GAD-7	≥5	45.0 (54)
Wasim T. *et al.*	2020	May 20-June 30	Pakistan	51.97	356	214	78	64	NA	Depression	DASS-21	NA	62.35 (222)
										Anxiety		NA	63.76 (227)
										Stress		NA	55.33 (197)
										Insomnia	ISI	≥8	53.37 (190)
Zhang SX. *et al.*	2020	April 5-April 20	Iran	58.60	304	NA	NA	NA	NA	Depression	PHQ-4	NA	28.0 (85)
										Anxiety		NA	20.6 (63)
										Distress	K6	NA	20.1 (61)
Chen Y. *et al.*	2020	NA	China	90.50	105	NA	NA	NA	84.7	Depression	SDS	≥53	29.5 (31)
										Anxiety	SAS	≥50	18.1 (19)
Zhu J. *et al.*	2020	February 1-February 29	China	83.00	165	79	86	NA	NA	Depression	SDS	≥50	44.2 (73)
										Anxiety	SAS	≥50	20.0 (33)
Tu ZH. *et al.*	2020	February 7-February 25	China	100.00	100	NA	100	NA	100	Depression	PHQ-9	≥4	46.0 (46)
										Anxiety	GAD-7	≥4	40.0 (40)
										Insomnia	PSQI	≥7	60.0 (60)
Naser AY. *et al.*	2020	March 22-March 28	Jordan	56.10	1163	560	151	452	NA	Depression	PHQ-9	≥5	78.0 (907)
										Anxiety	GAD-7	≥5	70.8 (823)
Sandesh R. *et al.*	2020	May	Pakistan	42.90	112	NA	NA	NA	NA	Depression	DASS-21	NA	72.3 (81)
										Anxiety		NA	85.7 (96)
										Stress		NA	90.2 (101)

Contd...

Table 1: Contd...

Author	Year	Data collection period	Country	Female (%)	True sample	Health-care workers			Response rate (%)	Diagnosis	Scale used	Cutoff value	Symptoms present, % (n)
						Doctors	Nurse	Others					
Chatterjee SS. *et al.*	2020	March 28-April 6	India	21.71	152	152	NA	NA	NA	Depression	DASS-21	NA	34.9 (53)
										Anxiety		NA	39.5 (60)
										Stress		NA	32.9 (50)
Gupta AK. *et al.*	2020	May 11-June 10	Nepal	52.70	150	NA	NA	NA	NA	Depression	PHQ-9	≥5	37.3 (56)
										Anxiety	GAD-7	≥5	34.0 (51)
Gupta S. *et al.*	2020	March 30-April 2	India	25.77	749	749	NA	NA	85.7	Depression	HAD	≥8	28.2 (211)
										Anxiety			35.3 (264)
Kannampallil TG. *et al.*	2020	April 10-April 25	United States	55.00	393	393	NA	NA	28.58	Depression	DASS-21	≥10	27.2 (107)
										Anxiety		≥8	18.6 (73)
										Stress		≥15	24.7 (97)
										Burnout	PFI	≥1.33	40.7 (160)
Wang H. *et al.*	2020	February 2-February 3	China	85.80	1045	149	773	123	80.1	Depression	HAD	>10	13.6 (142)
										Anxiety	HAD	>10	20.0 (209)
										Stress	PSS	>29	21.34 (223)
										Insomnia	ISI	>14	10.4 (109)
Wilson W. *et al.*	2020	April 10-April 25	India	46.60	350	295	55	NA	NA	Depression	PHQ-9	NA	49.4 (173)
										Anxiety	GAD-7	≥5	66.3 (232)
										Stress	PSS	NA	82.6 (289)

DASS-Depression, Anxiety, and Stress Scale; SAS-Self-rating Anxiety Scale; CES-D Center for Epidemiologic Studies Depression Scale; PHQ-9 Patient Health Questionnaire-9; GAD-7 General Anxiety Disorder-7; ISI-Insomnia Severity Index; HAMD-Hamilton Depression Rating Scale; HAMA-Hamilton Anxiety Rating Scale; SDS-Self-Rating Depression Scale; PCL-5 PTSD Checklist for DSM-5; HAD-Hospital Anxiety and Depression Scale; OCD-Obsessive-compulsive disorder; BAI-Beck's Anxiety Inventory; PSQI-Pittsburgh Sleep Quality Index; PFI-Professional Fulfillment Index; MBI-Maslach Burnout Inventory; NA - Not available; SCL-90-R Symptom Checklist-90-Revised; AIS-Athens Insomnia Scale; Stress Scale; PTSD-Posttraumatic Stress Disorder; PTSD-SS PTSD-Self-Rating Scale; IES-R-Impact of Event Scale-Revised; BDI-2-Beck Depression Inventory-2; PSS-Perceived

Figure 2: Prevalence of depression (pooled and by subgroup of assessment tool)

Figure 3: Prevalence of anxiety (pooled and by subgroup of assessment tool)

Checklist for DSM-5,[22] and DASS-21[32,35-37,40,45] for assessment. The reporting was for stress, distress, and PTSD. The studies which used IES-R scale also differed from each other in terms of using cutoff value. Lai *et al.*[3] and Zhang *et al.*[27] reported a cutoff value of ≥9, Chew *et al.*[10] and Tan *et al.*[38] used ≥24, whereas Li *et al.*[17] used >33 as cutoff. Initially, on analyzing overall stress by including all the studies, the pooled prevalence estimate was found to be 37.7% (95% CI: 24.0–52.3, $I^2 = 100\%$) [Figure 5], and then after considering this clinical variation, we re-analyzed by serially excluding studies. In the sensitivity analysis, on excluding studies by Sandesh *et al.*,[35] and Wilson *et al.*,[34] the resultant prevalence changed drastically and was found to be 30.9% (95% CI: 18.1–45.3, $I^2 = 99\%$), whereas excluding

other studies individually changed the prevalence within 2.4%. This change was probably seen due to the lower cutoff value used for those two studies.

For the pooled prevalence estimate, we used IES-R data from the studies by Chew *et al.* and Tan *et al.*, who reported both the IES-R and the DASS-21 measures. On using DASS-21 in place of IES-R data for those two studies, not much change was found in the pooled prevalence, with the estimate merely changing to 37.3% (95% CI: 23.6–52.0, $I^2 = 99\%$).

Other psychological outcomes

Among the selected articles, other outcomes appeared such as fear,[19] social support,[22,23] burnout,[40,45] and OCD and phobic anxiety[26] but were not included in the analysis because they were reported in few articles [Table 1].

Table 2: Quality assessment using modified Newcastle-Ottawa Scale

Study	Selection			Outcome		Total score
	Sample representativeness	Sample size	Response rate	Assessment of outcome	Statistical tests	
Chew N. *et al.*	*	*	*	*	*	5
Du J. *et al.*	-	-	-	*	*	2
Elbay RY. *et al.*	-	-	-	-	*	1
Huang J. *et al.*	-	-	*	*	-	2
Huang Y. *et al.*	-	*	*	*	*	4
Lai J. *et al.*	*	*	-	*	*	4
Li G. *et al.*	*	*	*	*	*	5
Liu C. *et al.*	-	-	*	*	*	3
Lu W. *et al.*	-	*	*	*	-	3
Qi J. *et al.*	-	*	*	*	*	4
Sheng X. *et al.*	-	-	*	*	-	2
Song X. *et al.*	*	*	-	*	*	4
Tan B. *et al.*	*	-	*	*	*	4
Wang S. *et al.*	-	-	-	*	*	2
Xiao X. *et al.*	*	*	-	*	-	3
Zhang C. *et al.*	*	*	-	*	-	3
Zhang W. *et al.*	-	*	-	*	*	3
Dal'Bosco EB. *et al.*	-	-	-	*	*	2
Giusti EM. *et al.*	-	*	-	*	*	3
Szepietowski JC. *et al.*	*	-	*	*	*	4
Wasim T. *et al.*	*	*	-	-	*	3
Zhang SX. *et al.*	*	*	-	-	-	2
Chen Y *et al.*	-	-	*	*	*	3
Zhu J. *et al.*	*	-	-	*	*	3
Tu ZH. *et al.*	*	-	*	*	*	4
Naser AY. *et al.*	-	*	-	*	*	3
Sandesh R. *et al.*	-	-	-	-	*	1
Chatterjee SS. *et al.*	-	-	-	-	*	1
Gupta AK. *et al.*	*	-	-	*	*	2
Gupta S. *et al.*	*	*	*	*	*	5
Kannampallil TG. *et al.*	*	*	-	*	*	4
Wang H. *et al.*	*	*	*	*	*	4
Wilson W. *et al.*	-	*	-	*	*	3

One asterisk (*) symbol carries one point

Subgroup analysis

A subgroup analysis was carried out according to the profession. It is evident that the prevalence of depression, anxiety, and insomnia was higher among medical professionals [Table 3].

DISCUSSION

Principal finding

HCWs that faced patients with COVID-19 were found to have a significant prevalence rate of depression, anxiety, insomnia and poor sleep quality, and stress.

Discussion in relation to other studies

We found a higher rate of depression and anxiety compared with non-HCWs (25.9% and 24.5%) in China during the same period.[47] This makes it easier to determine that the symptoms are mainly due to the professional work of health workers and may have less to do with the measures of confinement and general quarantine taken by governments. We also found a significant prevalence of insomnia and poor sleep quality (36.6%) and stress (37.7%). Higher prevalence was also seen among the personnel who work in the same hospital. However, there was a wide difference of assessed outcomes between those who were in direct contact with the patients (generally doctors and nurses) and the other professionals and administrative staff – for medical personnel on the frontline, the prevalence of anxiety and insomnia was found to be higher, and in the case of depression, the prevalence was more than double that of rates found in nonfrontline staff.

In other diseases that appeared as an outbreak, such as SARS in 2003 and Ebola disease in the period 2014–2016, an association was also found between mental health problems (depression, anxiety, posttraumatic stress, fear, and frustration) in health workers as well as in the general population.[48,49] It is difficult to conclude whether the findings of the present study are exclusively related to COVID-19 or not. However, the findings clearly show a very high prevalence of mental health problems among HCWs.

There are several factors that may have contributed to the appearance of these symptoms. As the pandemic has
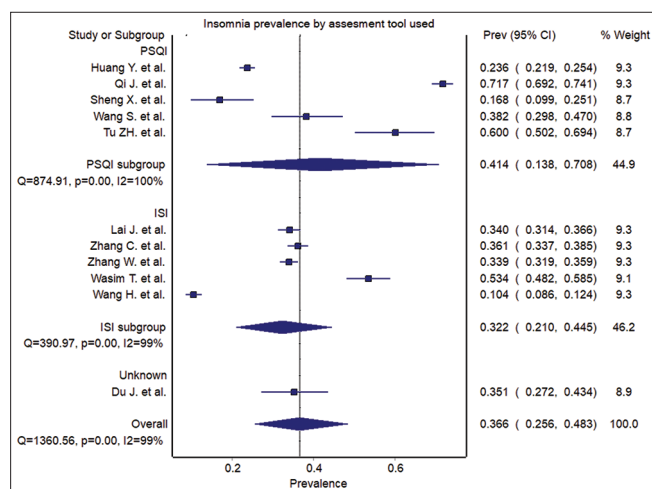
Figure 4: Prevalence of insomnia (pooled and by subgroup of assessment tool)

Table 3: Results of subgroup analysis by profession (medical and other health-care workers)		
	Prevalence according to profession (95% CI, I²)	
	Medical (doctors and nurses)	Other health-care workers
Depression	28.0% (19.4-37.4, 98.8%)	13.1% (3.2-27.4, 97.8%)
Anxiety	28.6% (21.5-36.3, 98.2%)	20.0% (7.5-36.1, 97.9%)
Insomnia	32.2% (22.3-43.1, 98.2%)	21.4% (6.7-40.7, 96.4%)

CI - Confidence interval

progressed, there has been a demand-supply mismatch with regard to PPEs, laboratory tests, available beds, a shortage of mechanical ventilators, and other resources necessary to protect health workers from the COVID-19 infection. The anxiety generated by working in environments with so much pressure along with lack of rest, can indirectly increase the probability of acquiring COVID-19 from working in health centers.[48] Other factors such as fear of becoming infected,[50] fear of being quarantined, and feeling of betrayal by employers and/or the government in outbreak situations[48] might have a significant role in deteriorating the mental health. A significant number of HCWs described how confinement increases fear and anxiety.[51] On the other hand, a detrimental situation that affects HCWs is the lack of available HCWs who can provide care.[52] The infection rates are exceptionally high, and the professionals that are not infected replace to those infected.[53]

Our findings show a high prevalence of mental health disorders among HCWs. However, some groups seem to be more susceptible to develop such disorders. Huang *et al.*[25] found that the incidence of anxiety in female medical staff was higher than that in male staff, and similarly, anxiety in nurses was higher than that in doctors. Moreover, it has been found that apart from the type of health-care work done, other factors too might be at play in leading to the development of psychological problems in health-care professionals. Zhang *et al.*[27] reported that insomnia
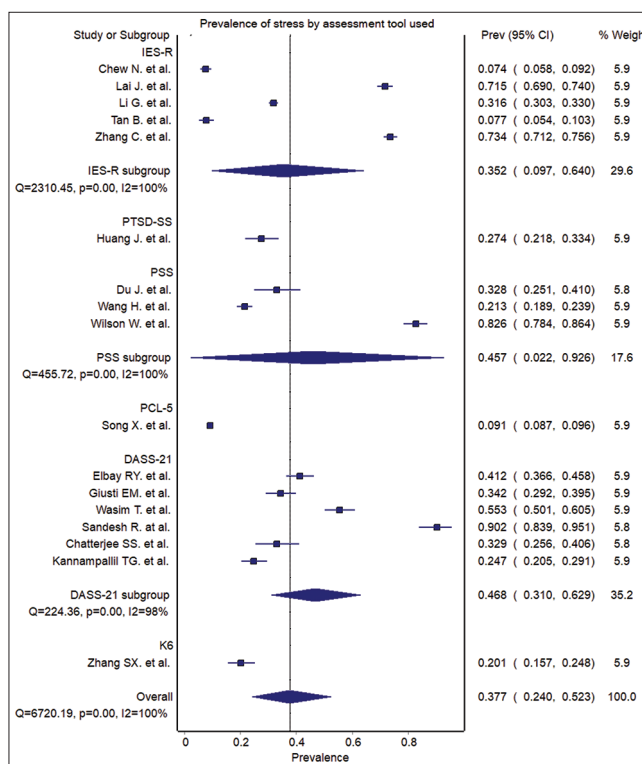
Figure 5: Prevalence of stress (pooled and by subgroup of assessment tool)

symptoms were associated with an education level of high school or below, currently working in an isolation unit, being worried about getting infected, perceived lack of helpfulness in terms of psychological support from news or social media with regard to COVID-19, and having very strong uncertainty regarding effective disease control. Song *et al.*[22] reported that a higher risk of developing depressive symptoms and PTSD was associated with being middle aged, having worked for fewer years, having longer daily working hours, and lower levels of social support. This scenario indicates toward the vulnerability and propensity to the mental health issues in HCWs which needs a call for action.[54]

Potential biases in the review process
The process of systematic review was rigorous. The review was preceded by the publication of a protocol in PROSPERO with all review methods described, and we did not change the methods. All review authors are appropriately trained and have experience in review preparation.

Sources of heterogeneity
We found high heterogeneity among study results, which may be explained by the differences in the sample, assessment methods, tools, and their cutoff value used. In the case of analysis of stress, on including all the studies, the pooled prevalence estimate was 37.7%; considering this clinical variety in these studies, we re-analyzed them by serially excluding certain studies. In the sensitivity analysis,

the resultant prevalence changed drastically and was found to be 30.9%. Probably, this change may be explained with the lower cutoff value used by two studies.

Limitations

The most important limitation is the high heterogeneity in the selected studies. The authors used different scales and cutoff points in some studies. It is important to improve the study designs and include more homogeneous population and methods which could decrease the heterogeneity. All included studies have relied only on screening instruments which are lagging behind clinical diagnosis. In this review, most of the included studies were from China which restricts the generalizability of the study. However, the study could be more generalizable for Asian countries than others.

Future recommendation

However, it is difficult to draw conclusions from factors that are independent of the profession of the HCW because these factors depend on unique local milieu. Since most of our results are from China, generalizability of the findings to countries with different cultures may be limited. As more studies of psychological problems in HCWs from around the world become available, future systematic reviews and meta-analyses may be better placed in terms of the generalizability of their findings.

Despite the elevated prevalence of common mental disorders in the health-care workforce during this pandemic, provision of professional attention to these problems seems inadequate.

The health-care workforce needs to practice self-care now more than ever, while health-care managers and policymakers need to factor in the mental health consequences of COVID-19 on their workforce and plan measures that are commensurate with the scope of the problem.

CONCLUSION

HCWs who are dealing with COVID-19 pandemic have a significant prevalence of depression, anxiety, insomnia and poor sleep quality, and stress. Stakeholders and concerned authorities need to provide effective strategies to improve the mental health of these individuals.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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Additional File 1: Detailed search strategy for different databases

PubMed search table

((Coronavirus*[TIAB] OR Corona virus*[TIAB] OR COVID*[TIAB] OR SARS[TIAB] OR Severe Acute Respiratory Syndrome[TIAB] OR ncov*[TIAB] OR "Severe Acute Respiratory Syndrome Coronavirus 2" [Supplementary Concept] OR "COVID-19" [Supplementary Concept] OR COVID-19 vaccine [Supplementary Concept] OR COVID-19 serotherapy [Supplementary Concept] OR spike glycoprotein, COVID-19 virus [Supplementary Concept] OR COVID-19 diagnostic testing [Supplementary Concept] OR COVID-19 drug treatment [Supplementary Concept] OR (wuhan [TIAB] AND (coronavirus [TIAB] OR coronavirus [TIAB] OR pneumonia virus[TIAB])) OR COVID19[TIAB] OR COVID-19[TIAB] OR coronavirus-2019[TIAB] OR corona-virus-2019[TIAB] OR SARS-CoV-2 [TIAB] OR SARSCoV-2 [TIAB] OR SARSCoV2 [TIAB] OR SARS2 [TIAB] OR SARS-2 [TIAB] OR "severe acute respiratory syndrome 2"[TIAB] OR 2019-nCoV[TIAB] OR ((novel coronavirus [TIAB] OR novel corona virus[TIAB]) AND 2019[TIAB])) AND (("Mental health"[Title/Abstract] OR "mental disorder*"[Title/Abstract] OR "Psychiatric disorder*"[Title/Abstract] OR Psychologic*[Title/Abstract] OR psych*[Title/Abstract] OR Stress[Title/Abstract] OR acute stress disorder[MeSH Terms] OR Feeling*[Title/Abstract] OR Fear[Title/Abstract] OR mood[Title/Abstract] OR disorder, mood[MeSH Terms] OR Behaviour*[Title/Abstract] OR Panic[Title/Abstract] OR disorder, panic[MeSH Terms] OR Mani*[Title/Abstract] OR mania[MeSH Terms] OR Neurotic[Title/Abstract] OR disorder, neurotic[MeSH Terms] OR Neuros*[Title/Abstract] OR Insomnia[Title/Abstract] OR Sleep[Title/Abstract] OR Anxiety[Title/Abstract] OR anxious[Title/Abstract] OR anxiety disorders[MeSH Terms] OR distress[Title/Abstract] OR Depressi*[Title/Abstract] OR depressive disorders[MeSH Terms] OR "Personality disorder*"[Title/Abstract] OR "self-esteem"[Title/Abstract] OR "quality of life"[Title/Abstract] OR "Social Discrimination"[Title/Abstract] OR "social exclusion" [Title/Abstract] OR cogniti*[Title/Abstract]) OR (health knowledge, attitudes, practice[MeSH Terms]))) AND (Physician*[Title/Abstract] OR Doctor*[Title/Abstract] OR nurs*[Title/Abstract] OR "Healthcare professional*"[Title/Abstract] OR "Health Workers"[Title/Abstract] OR "Healthcare Workers"[Title/Abstract] OR "Medical Personnel"[Title/Abstract] OR "Health staffs" [Title/Abstract] OR "Hospital staffs"[Title/Abstract] OR "Hospital workers"[Title/Abstract])

CENTRAL Search Table

coronavir* OR "corona virus" OR betacoronavir* OR covid19 OR "covid 19" OR nCoV OR "CoV 2" OR CoV2 OR severe acute respiratory syndrome coronavirus 2 OR sarscov2 OR 2019nCoV OR "novel CoV" OR "wuhan virus" in Title Abstract Keyword AND "Mental health" OR "mental disorder*" OR "Psychiatric disorder*" OR Psychologic* OR psych* OR Stress OR "acute stress disorder" OR Feeling* OR Fear OR Mood OR Behaviour* OR Panic OR Mani* OR mania OR Neurotic OR Neuros* OR Insomnia OR Sleep OR Anxiety OR anxious OR "anxiety disorder*" OR distress OR Depressi* OR "depressive disorder*" OR "Personality disorder*" OR "self-esteem" OR "quality of life" OR "Social Discrimination" OR "social exclusion" OR cogniti* in Title Abstract Keyword AND physician* or doctor* or nurs* or "healthcare professional*" or "health workers" or "healthcare workers" or "medical personnel" or "health staffs" or "hospital staffs" or "hospital workers" in Title Abstract Keyword - (Word variations have been searched)

PsycINFO Search Table

(coronavir* OR "corona virus" OR betacoronavir* OR covid19 OR "covid 19" OR nCoV OR "CoV 2" OR CoV2 OR severe acute respiratory syndrome coronavirus 2 OR sarscov2 OR 2019nCoV OR "novel CoV" OR "wuhan virus") OR ((wuhan OR hubei OR huanan) AND ("severe acute respiratory" OR pneumonia*) AND (outbreak*)) AND ("Mental health" OR ("mental disorder" OR "mental disorders") OR ("psychiatric disorder" OR "psychiatric disorders") OR Psychologic* OR psych* OR Stress OR "acute stress disorder" OR Feeling* OR Fear OR Mood OR Behaviour* OR Panic OR Mani* OR mania OR Neurotic OR Neuros* OR Insomnia OR Sleep OR Anxiety OR anxious OR ("anxiety disorder" OR "anxiety disorders") OR distress OR Depressi* OR ("depressive disorder") OR ("personality disorder" OR "personality disorders") OR "self-esteem" OR "quality of life" OR "Social Discrimination" OR "social exclusion" OR cogniti*) AND (physician* or doctor* or nurs* or "healthcare professional*" or "health workers" or "healthcare workers" or "medical personnel" or "health staffs" or "hospital staffs" or "hospital workers")

SCOPUS Search Table

TITLE-ABS-KEY (coronavir* OR "corona virus" OR betacoronavir* OR covid19 OR "covid 19" OR ncov OR "CoV 2" OR cov2 OR severe AND acute AND respiratory AND syndrome AND coronavirus 2 OR sarscov2 OR 2019ncov OR "novel CoV" OR "wuhan virus") OR TITLE-ABS-KEY (wuhan OR hubei OR huanan) AND TITLE-ABS-KEY ("severe acute respiratory" OR pneumonia*) AND TITLE-ABS-KEY (outbreak*) AND TITLE-ABS-KEY ("Mental health" OR "mental disorder*" OR "Psychiatric disorder*" OR psychologic* OR psych* OR stress OR "acute stress disorder" OR feeling* OR fear OR mood OR behaviour* OR panic OR mani* OR mania OR neurotic OR neuros* OR insomnia OR sleep OR anxiety OR anxious OR "anxiety disorder*" OR distress OR depressi* OR "depressive disorder*" OR "Personality disorder*" OR "self-esteem" OR "quality of life" OR "Social Discrimination" OR "social exclusion" OR cogniti*) AND TITLE-ABS-KEY (physician* OR doctor* OR nurs* OR "healthcare professional*" OR "health workers" OR "healthcare workers" OR "medical personnel" OR "health staffs" OR "hospital staffs" OR "hospital workers")