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The Global Prevalence of Anxiety, Depression, and Insomnia among Healthcare Workers during the Covid-19 Pandemic: A Systematic Review and Meta-Analysis

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Abstract

Background: Covid-19 disease has posed a serious challenge to countries' healthcare systems at the present outbreak. Meanwhile, the healthcare providers' mental health has been affected. This systematic review and meta-analysis aimed to investigate the pooled prevalence of depression, anxiety, and insomnia among healthcare workers in a short period during the COVID-19 pandemic.

Materials and Methods: A systematic search was conducted through Web of Science, Scopus, Medline, and Embase databases, as well as preprint servers of medRxiv and SSRN, up to August 24, 2020.

Results: This review comprised 69 articles with a total sample size of 108,931 individuals selected from medical staff. The pooled prevalence of anxiety, depression, and insomnia were 37% (95% CI: 31 to 43%), 34% (95% CI: 29 to 38%), and 39% (95% CI: 25 to 53%), respectively. A subgroup analysis showed that the prevalence of anxiety, depression, and insomnia was higher in females and nurses than in others.

Conclusions: Findings indicated a high impact of the COVID-19 pandemic on the prevalence of anxiety, depression, and insomnia among medical professionals involved in the crisis with a variety of territories and occupations of both genders.

Keywords: COVID-19, Anxiety, Depression, Insomnia, Health Personnel

Introduction

On December 27, 2019, the World Health Organization office in China reported cases of pneumonia from the live animal market in Wuhan city, the capital of Hubei province [1]. On January 7, 2020, the etiologic agent of this pneumonia was identified as the "new coronavirus" (2019-ncoV), not previously seen in humans. The disease caused by 2019-ncoV was later named Coronavirus 2019 (COVID-2019), which was renamed SARS-CoV-2 considering its close resemblance to SARS-COV [2].

At the moment, many countries worldwide are facing the COVID-19 pandemic. Although limiting the crisis through a lockdown and widespread vaccination is important to reduce the virus's physical impacts, the pandemic's mental health consequences seem to be another substantial issue [3,4].

Health care workers (HCWs), who are directly involved in diagnosing, treating, and curing patients with COVID-19, are at risk for physical and mental problems. The HCWs are exposed to a heavy psychological burden due to the increasing number of suspected cases, overworking for long periods, lacking enough personal protective equipment, worrying about transmitting the disease to the family and friends, and lacking the required medications and sufficient support for all patients [5-8]. Since HCWs play a key role in controlling the epidemic and reducing the complications of the disease, maintaining their health is not only important from an individual point of view but also ensures the general public health. Previous studies have shown an increased prevalence of mental disorders among HCWs after initiating the Coronavirus pandemic. In a country-wide survey among HCWs conducted from March 2 to April 2, 2020, in China, the prevalence of depression and anxiety were 15.5% and 12.7%, respectively [9]. Moreover, the prevalence of depression and anxiety among HCWs during the COVID-19 pandemic was 28.1% and 33.1%, respectively, in a cross-sectional study in the UK [10].

At the beginning of this pandemic, all healthcare workers were under tremendous pressure. Excessive workload combined with fear of infection may cause mental disorders. The prevalence of mental disorders as an indicator of the imposed burden can show the importance of mental health in HCWs. On the other hand, the prevalence can vary over time with changes in factors such as better understanding of the disease and improvement in medical care facilities.

Differentiating short- and long-term impacts of the pandemic, in terms of time-horizon, on HCWs' mental health is necessary for policymaker guidance towards more evidence-based planning to overcome associated challenges. Thus, this systematic review and meta-analysis aimed to show the globally pooled prevalence of anxiety, depression, and insomnia among HCWs from a short-term perspective during the COVID-19 pandemic. To do so, individual studies conducted during the first 8 months after the onset of the pandemic were considered.

Materials and Methods

To conduct this systematic review and meta-analysis, PRISMA (Preferred Items for Reporting Systematic Reviews and Meta-Analyses) checklist was followed [11].

All relevant English articles on the prevalence of insomnia, anxiety, and depression among healthcare providers in dealing with COVID-19 were included in this review. Abstracts without full texts, editorials, case reports, and reviews were excluded from the study. Also, articles that did not use a valid questionnaire to measure anxiety, depression, and insomnia were excluded. Studies conducted on children, the general population, and hospitalized patients were excluded as well. Moreover, since the prevalence of an outcome in a case-control study cannot provide a good estimate in the reference population, such studies were also excluded.

To collect the data, two independent researchers searched databases of Web of Science, Scopus, Medline (PubMed), and Embase up to August 24, 2020. Moreover, preprint servers of medRxiv and SSRN were investigated. A search strategy was prepared using the combination of the following keywords: ("medical staff*" OR "Health Personnel" OR healthcare OR "Healthcare Worker*" OR "Health Care Provider*" OR "healthcare professional*") AND (COVID-19 OR "2019 novel coronavirus disease" OR "COVID-19 pandemic" OR "SARS-CoV-2 infection" OR "2019-nCoV infection" OR "coronavirus disease 2019" OR "severe acute respiratory syndrome coronavirus 2" OR 2019-nCoV OR "Wuhan coronavirus" OR SARS-CoV-2) AND (Depression OR "Depressive Symptom*" OR anxiety OR Nervousness OR insomnia OR "Sleep Initiation and Maintenance Disorders" OR "Early Awakening" OR "Sleep Initiation Dysfunction*" OR "mental health" OR psychological)

All identified studies were exported to the EndNote software (version X8, for Windows, Thomson Reuters, and Philadelphia, PA, USA). After removing the duplicates, two independent researchers evaluated titles and abstracts according to the study eligibility criteria. In the case of inconsistency between reviewers, a third reviewer assessed the eligibility criteria for the study to be included in the review.

Two independent researchers developed data extraction sheets to obtain relevant data, including the first author's name, publication date, occupation, study location, study design, sample size, response rate, age, and gender. The

prevalence of anxiety, depression, and insomnia, as well as outcome assessment methods and their cut-off points, were also collected. In the case of missing information, the necessary calculations were made.

The risk of bias in the primary studies was evaluated using the Newcastle-Ottawa quality assessment scale (NOS) for the case-control designs, and a customized version was developed for cross-sectional studies by two independent authors. The NOS is a star system developed to judge studies over three broad aspects: the selection of the study groups, the comparability of the groups, and the ascertainment of either exposure or outcome of interest. Each item on the scale is scored from one, which can be adapted to the specific topic of interest, to two. Thus, the maximum attainable stars (scores) for each study is nine, and studies with less than five stars indicate a high risk of bias [12].

In order to estimate the pooled prevalence of mental disorders among the medical staff during the COVID-19 pandemic within the 95% confidence interval (CI), the prevalence of anxiety, depression, and insomnia were examined in different articles from all over the world. Since CIs and standard errors (SEs) were not reported in some studies, the binomial distribution was applied to calculate them.

In the case of proportions near boundaries (in this instance, prevalence near 100% or zero), metan command was used to exclude the studies with such prevalence from the pooled estimate. Hence, the metaprop command was applied to estimate the exact binomial and score test based on CI for these proportions [13]. Also, the X^2 test at the 10% significant level (P<0.1) and the I^2 index were used to assess the between-study heterogeneity. According to the notable between-study heterogeneity, Der-Simonies and Laird random-effects models were used to calculate the pooled prevalence of anxiety, depression, and insomnia in medical staff [14].

Further, the pooled prevalence of anxiety, depression, and insomnia was estimated in different subgroups based on the variables such as gender, occupation, and the assessment tool. In order to reduce the strata of occupations, three categories of doctors, nurses, and other occupations (including administrative staff, technicians, public health administrators, midwives, residents, or medical students) were considered.

Moreover, a meta-regression analysis was carried out based on gender, occupation, and country of the study to investigate the potential source of heterogeneity. The publication bias was not examined in this study. Given that the estimated pooled prevalence and the probability of proportion are always positive numbers, any probable asymmetry in the funnel plot is not due to the publication bias [15]. In order to perform all statistical analyses, STATA 11 (StataCorp, College Station, TX, USA) was used.

Results

After the initial search through international databases, 1,907 studies were retrieved, the results of which were screened. Finally, 69 articles were included in the systematic review and meta-analysis. Fig.1 illustrates the process of selecting the relevant studies.

The total sample size for 69 included studies consisted of 102,349 medical staff. A total of 26,272 staff were male and 74,807 were female. According to occupation, 25,601 individuals were doctors, 47,449 were nurses, and 17,676 had other occupations within the medical realm. The evaluated studies (n = 69) were conducted in China (n = 31), Italy (n =7), Iran (n =3), and Turkey (n =3). Furthermore, two studies were conducted in each of the following countries: Oman, the USA, and Pakistan. In the following countries, one study was carried out: Thailand, Russia, Brazil, Switzerland, Korea, Taiwan, Philippines, Israel, Jordan, United Arab Emirates, Poland, Ecuador, Nepal, Saudi Arabia, Singapore, India, and Serbia. Moreover, one study was conducted in 30 countries, and one study was performed in two countries. Characteristics of the included studies are summarized in Table 1.

Risk of bias within studies: The NOS results for each study are presented in Supplementary Table 1.

Forest plots of pooled prevalence of mental health disorders (anxiety, depression, and insomnia) are presented in Figs. 2 to 4. Anxiety prevalence was estimated in 61 studies. In the present meta-analysis, the pooled prevalence of anxiety was 37% (95% CI: 31 to 43%). Depression was investigated in 50 studies. The pooled prevalence of depression was 34% (95% CI: 29 to 38%). Insomnia was estimated in 10 studies. The pooled prevalence of insomnia was 39% (95% CI: 25 to 53%) (Table 2).

According to the results of the X^2 test and I^2 index, significant heterogeneity was observed in the pooled prevalence of anxiety (I^2=99.6%, P=0.001), depression (I^2=99.4%, P=0.001), and insomnia (I^2=99.6%, P=0.001).

Table 1. Full description of the included articles published on anxiety, depression, and insomnia in healthcare workers

First author (Publication Year)	Country	Sample size (Response rate)	Age*	Gender		Occupation			Outcome					
				Male	Female	Doctor	Nurse	Other	Anxiety		Depression		Insomnia	
				n (%)	n (%)	n (%)	n (%)	n (%)	Assessment cut-off	n (%)	Assessment cut-off	n (%)	Assessment cut-off	n (%)
Ahmed, M. A. (2020)[16]	Worldwide (30 countries)	650 (97.1)	NR	160 (24.6)	490 (75.3)	0	0	650 (100)	NR	585 (90)	-	-	-	-
Alshekaili,M. (2020)[17]	Oman	1,139 (97.6)	36.3 ± 6.5	228 (20.0)	911 (80.0)	384 (33.7)	449 (39.5)	305 (26.8)	DASS-21 ≥8	388 (34.1)	DASS-21 ≥10	368 (32.3)	ISI ≥14	211 (18.5)
Amerio, A. (2020)[18]	Italy	131 (25)	52.3 ± 12.2	68 (51.9)	63 (48.0)	131 (100)	0	0	-	-	PHQ-9 ≥10	30 (22.9)	-	-
An, Y. (2020)[19]	China	1,103 NR	32.2 ± 7.6	102 (9.2)	1,001 (90.7)	0	1,103 (100)	0	-	-	PHQ-9 ≥5	481 (43.6)	-	-
Apisarnthanarak, A. (2020)[20]	Thailand	160 NR	32 (23–62range)	65 (40.6)	95 (59.4)	52 (32.5)	61 (38.1)	47 (29.4)	GAD-7 ≥5	68 (42.5)	-	-	-	-
Bachilo, E. (2020)[21]	Russia	812 (100)	NR	154 (19)	658 (81)	641 (79.0)	146 (17.9)	25 (3.1)	GAD-7 ≥5	396 (48.7)	PHQ-9 ≥5	468 (57.6)	-	-
Badahdah, A. (2020)[22]	Oman	509 NR	37.6 ± 7.6	100 (19.7)	407 (80.3)	194 (38.1)	315 (61.9)	0	GAD-7 ≥5	328 (64.5)	-	-	-	-
Barello, S. (2020)[23]	Italy	376 (32.6)	40 ± 11	99 (26.3)	277 (73.6)	67 (17.8)	271 (72.1)	38 (10.1)	-	-	MBI ≥4	195 (51.8)	-	-
Buselli, R. (2020)[24]	Italy	106 (41)	50 ± 9.9	27 (25.5)	79 (74.5)	0	58 (55)	48 (45)	STAI ≥40	57 (54)	-	-	-	-
Cai, H. (2020)[25]	China	534 NR	36.4 ± 16.1	167 (31.3)	367 (68.7)	233 (43.6)	248 (46.4)	53 (9.9)	NR	436 (81.6)	-	-	-	-
Çalişkan, F. (2020)[26]	Turkey	290 NR	31.8 ± 6.9	179 (61.7)	111 (38.2)	290 (100)	0	0	HADS ≥10	103 (35.5)	HADS >7	180 (62)	-	-
Cao, J. (2020)[27]	China	102 (97.10)	31.7 ± 6.8	25 (24.5)	77 (75.5)	40 (39.2)	54 (52.9)	8 (7.8)	-	-	PHQ-9 >10	7 (6.9)	-	-
Chatterjee, S. S. (2020)[28]	India	152 NR	42.0 ± 12.2	119 (78.3)	33 (21.7)	152 (100)	0	0	DASS-21 NR	60 (39.5)	DASS-21 NR	53 (34.9)	-	-

Chen, J. (2020)[29]	China	900 NR	36.4 ± 8.5	281 (31.2)	619 (68.3)	541 (60.1)	311 (34.5)	48 (5.3)	GAD-7 ≥10	150 (16.7)	PHQ-9 ≥10	164 (18.3)	-	-
Chen, X. (2020)[30]	Ecuador	252 (62.8)	NR	87 (34.5)	165 (65.5)	NR	NR	NR	GAD-7 ≥10	71 (28.2)	-	-	-	-
Cheng, F. F. (2020)[31]	China	534 NR	NR	94 (17.6)	440 (82.4)	289 (54.1)	245 (45.9)	0	SAS ≥50	75 (14.0)	-	-	PSQI >7	160 (30.0)
Chew, N. W. S. (2020)[32]	Singapore and India	906 (90.6)	29(25-35)£	323 (35.7)	583 (64.3)	268 (29.6)	355 (39.2)	283 (31.2)	DASS-21 >7	142 (15.7)	DASS-21 >9	96 (10.6)	-	190 (21.0)
Civantos, A. M. (2020)[33]	USA	349 (7.8)	NR	212 (60.7)	137 (39.3)	349 (100)	0	0	GAD-7 ≥5	167 (47.9)	PHQ-2 ≥3	37 (10.7)	-	-
Consolo, U. (2020)[34]	Italy	356 (40.7)	NR	215 (60.4)	141 (39.6)	356 (100)	0	0	GAD-7 ≥5	204 (57.3)	-	-	-	-
Croll, L. (2020)[35]	USA	130 (51)	NR	NR	NR	NR	NR	NR	NR	108 (83)	NR	49 (38)	-	-
Dal'Bosco, E. B.(2020)[36]	Brazil	88 (18.5)	NR	9 (10.2)	79 (89.8)	0	88 (100)	0	HADS >7	43 (48.9)	HADS >8	22 (25)	-	-
Dong, Z. Q. (2020)[37]	China	4,618 NR	NR	755 (16.3)	3,863 (86.7)	1,138 (24.6)	2,889 (62.6)	591 (12.8)	HEI ≥8	24.2% anxiety or/and depressive symptoms			-	-
Elbay, R. Y. (2020)[38]	Turkey	442 NR	36.0 ±8.7	191 (43.2)	251 (56.8)	442 (100)	0	0	DASS-21 NR	224 (51.6)	DASS-21 NR	286 (64.7)	-	-
Giusti, E. M. (2020)[39]	Italy	330 (41.2)	44.6 ± 13.5	124 (37.4)	206 (62.6)	140 (42.2)	86 (26.1)	105 (31.8)	DASS-21 >75th percentile	103 (31.3)	DASS-21 >75th percentile	88 (26.8)	-	-
Guo, J. (2020)[40]	China	11,118 NR	NR	2,802 (25·2)	8,316 (74.8)	3,351 (30·1)	5,900 (53·1)	1,671 (15.0)	SAS ≥50	1,940 (17.4)	SDS ≥50	3,497 (31.4)	-	-
Hassannia, L. (2020)[41]	Iran	487 NR	NR	NR	NR	127 (6.2)	105 (5.10)	255 (52.4)	HADS >11	167 (34.3)	HADS >11	121 (24.8)	-	-
He, J. (2020)[42]	China	4,403 NR	NR	1,092 (24.8)	3,311 (75.2)	905 (20.5)	746 (16.9)	2,752 (62.5)	SAS ≥50	980 (22.3)	SDS ≥52	1,222 (27.7)	-	-
Hu, D. (2020)[43]	China	2,014 (99.6)	30.9±6.1	260 (12.9)	1,754 (87.1)	0	2,014 (100)	0	SAS ≥50	833 (41.3)	SDS ≥53	878 (43.6)	-	-

Huang, L. (2020)[44]	China	364 (96.6)	32 (27–40)£	150 (41)	214 (59)	0	119 (32.7)	245 (67.3)	SAS ≥50	85 (23.3)	-	-	-	-
Kaveh, M. (2020)[45]	Iran	1,038 NR	36.3±8.2	129 (12.4)	909 (87.6)	214 (20.6)	514 (49.5)	310 (29.9)	BAI ≥8	1,038 (100)	-	-	-	-
Labrague, L. (2020)[46]	Philippines	325 (93)	30.9±6.6	82 (25.2)	243 (74.8)	0	325 (100)	0	CDAS ≥9	123 (37.8)	-	-	-	-
Lai, J. (2020)[6]	China	1,257 (68.7)	NR	293 (23.3)	964 (76.7)	493 (39.2)	764 (60.8)	0	GAD-7 ≥5	560 (44.6)	PHQ-9 ≥5	634 (50.4)	ISI ≥8	427 (34.0)
Lin, Z. (2020)[47]	China	636 (25)	33·5 ± 8·5	99 (52·1)	91 (47·9)	190 (29·9)	297 (46·7)	149 (23·4)	DASS-21 ≥7	161 (25·3)	-	-	-	-
Liu, C. Y. (2020)[48]	China	512 (85.3)	NR	79 (15.4)	433 (84.5)	NR	NR	NR	SAS ≥50	64 (12.5)	-	-	-	-
Liu, S. (2020)[49]	China	6,588 (94.0)	NR	2,212 (33.5)	4,370 (66.4)	2,523 (38.3)	3,888 (59.0)	177 (2.7)	-	-	PHQ-9 ≥10	3,795 (57.6)	-	-
Liu, Z. (2020)[50]	China	4,679 (100)	35.9 ± 9	830 (17.7)	3,849 (82.3)	1,853 (39.6)	2,826 (60.4)	0	SAS ≥50	749 (16.0)	SDS ≥50	1,619 (34.6)	-	-
Lu, W. (2020)[51]	China	2,299 (94.8)	NR	514 (22.4)	1,785 (77.6)	2,042 (88.8)	0	257 (11.2)	HAMA ≥7	569 (24.7)	HAMD ≥7	268 (11.6)	-	-
Ma, Y. (2020)[52]	China	34 (100)	NR	10 (29.4)	24 (71)	20 (59)	14 (41)	0	GAD-7 ≥5	12 (35)	PHQ-9 ≥5	8 (24)	-	-
Magnavita, N. (2020)[53]	Italy	595 (82)	NR	175 (29.9)	417 (70.1)	NR	NR	NR	GADS ≥5	99 (16.6)	GADS ≥2	121 (20.3)	-	-
Mahendran, K. (2020)[54]	China	120 (96)	35 (19–63)£	28 (23)	87 (73)	14 (12)	60 (50)	46 (38.3)	GAD-7 NR	64 (53.3)	-	-	-	-
Naser, A. Y. (2020)[55]	Jordan	1,163 NR	NR	510 (43.8)	653 (56.2)	560 (48.2)	151 (13)	452 (38.8)	GAD-7 ≥5	823 (70.7)	PHQ-9 ≥5	907 (77.9)	-	-
Qi, J. (2020)[56]	China	1,306 (93.6)	33.1 ± 8.4	256 (19.6)	1,050 (80.4)	NR	NR	NR	-	-	-	-	PSQI >6 AIS>6	936 (71.7) 594 (45.5)
Que, J. (2020)[57]	China	2,285 (78)	31.1 ± 6.99	707 (30.9)	1,578 (69.1)	860 (37.6)	208 (9.1)	1,217 (53.2)	GAD-7 ≥5	1,233 (53.9)	PHQ-9 ≥5	1,271 (55.6)	ISI ≥8	1,628 (71.2)

Rossi, R. (2020)[58]	Italy	1,379 NR	39.0 ± 16.0	315 (22.8)	1,064 (77.2)	519 (37.4)	472 (34.2)	387 (28.1)	GAD-7 ≥15	273 (19.8)	PHQ-9 ≥15	341 (24.7)	ISI ≥22	114 (8.2)
Saddik, B. (2020)[59]	United Arab Emirates	1,385 (93.3)	20.5 ± 2.3	391 (28.2)	994 (71.8)	0	0	1,385 (100)	GAD-7 ≥5	520 (37.5)	-	-	-	-
Salman, M. (2020)[60]	Pakistan	398 NR	28.6 ± 4.1	183 (46.0)	215 (54.0)	205 (51.5)	133 (33.4)	60 (15.1)	GAD-7 ≥10	85 (21.3)	PHQ-9 ≥5	255 (64.1)	-	-
Sandesh, R. (2020)[61]	Pakistan	112 (100)	NR	64 (57.1)	48 (42.9)	NR	NR	NR	DASS-21 NR	107 (95.5)	DASS-21 NR	101 (90.2)	-	-
Savitsky, B. (2020)[62]	Israel	215 (88)	NR	NR	NR	0	0	215 (100)	GAD-7 ≥10	92 (42.8)	-	-	-	-
Sögüt, S. (2020)[63]	Turkey	972 NR	20.8 ± 1.9	0	972 (100)	0	0	972 (100)	BAI ≥22	54 (5.5)	-	-	-	-
Song, X. (2020)[64]	China	14,825 (100)	34.0 ± 8.2	5,289 (35.7)	9,536 (64.3)	6,093 (41.1)	8,732 (58.9)	0	-	-	CES-D ≥16	3,733 (25.2)	-	-
Stojanov, J. (2020)[65]	Serbia	83 (70)	39.1 ± 7.3	36 (43.37)	47 (56.6)	NR	NR	NR	GAD-7 ≥10	27 (31.8)	SDS ≥60	15 (17.6)	-	-
Sung, C. (2020)[66]	Taiwan	1,795 NR	36.7 ± 8.2	360 (20.1)	1,435 (79.9)	357 (19.9)	1,064 (59.3)	374 (20.8)	STAI-6 ≥37	1,610 (89.7)	CES-D-10 ≥10	817 (45.5)	-	-
Szepietowski, J. C. (2020)[67]	Poland	120 (97.6)	44.4 ± 11.9	26 (21.7)	94 (78.3)	58 (48.3)	62 (51.7)	0	GAD-7 ≥5 HADS-A ≥8	54 (45.0) 35 (29.1)	PHQ-9 ≥10 HADS-D ≥8	24 (20) 17 (14.1)	-	-
Tan, B. Y. Q. (2020)[68]	Singapore	470 (94)	30 (28–35)[£]	149 (31.7)	321 (68.3)	135 (28.7)	161 (34.3)	174 (37.0)	DASS-21 A>7	68 (14.5)	DASS-21 D>9	42 (8.9)	-	-
Temsah, M. H. (2020)[69]	Saudi Arabia	582 (71.8)	NR	145 (24.91)	437 (75.1)	NR	363 (62.4)	NR	GAD-7 (≥5)	185 (31.8)	-	-	-	-
Teng, Z. (2020)[70]	China	398 NR	NR	96 (24.1)	302 (75.9)	NR	NR	NR	SAS ≥50	56 (14.1)	PHQ-9 ≥5	143 (35.9)	-	-
Thapa, L. (2020)[71]	Nepal	100 NR	26.8 ± 8.17	22 (22.0)	78 (78.0)	9 (9.0)	62 (62.0)	29 (29.0)	ALI≥1 SAS≥45	98(98) 34 34)	-	-	-	-

Vafaei, H. (2020)[72]	Iran	575 (95.9)	NR	0	599 (100)	194 (32.4)	275 (45.9)	130 (21.7)	-	-	PHQ-9 ≥5	383 (66.6)	-	-
Wang, H. (2020)[73]	China	1,045 (80.1)	NR	148 (14.2)	897 (85.8)	149 (14.3)	773 (74.0)	123 (11.7)	HADS-A ≥8	499 (47.8)	HADS-D ≥8	412 (39.4)	ISI ≥8	521 (49.9)
Weilenmann, S. (2020)[74]	Switzerland	1,410 NR	34 (29-46)£	476 (33.7)	934 (66.2)	857 (60.8)	553 (39.2)	0	GAD-7 ≥10	365 (25.9)	PHQ-9 ≥10	292 (20.7)	-	-
Xiao, H. (2020)[75]	China	933 (87.9)	NR	279 (29.9)	654 (70.1)	NR	NR	933 (100)	GAD-7 ≥5	160 (17.1)	PHQ-9 ≥5	236 (25.3)	-	-
Xiao, X. (2020)[76]	China	958 NR	NR	314 (32.8)	644 (67.2)	378 (39.5)	359 (37.5)	221 (23.0)	HADS ≥8	518 (54.1)	HADS ≥8	549 (57.3)	-	-
Xiaoming, X. (2020)[77]	China	8817 NR	33.2 ± 8.2	1943 (22.0)	6874 (78.0)	3212 (36.4)	4685 (53.1)	920 (10.4)	GAD-7 ≥5	1825 (20.7)	PHQ-9 ≥5	2666 (30.2)	-	-
Xing, J. (2020)[78]	China	548 (97.9)	NR	153 (27.9)	395 (72.1)	137 (25.00)	411 (75.00)	0	SCL-90 NR	187 (34.1)	SCL-90 NR	163 (29.7)	-	-
Yang, S. (2020)[79]	Korea	65 (89.0)	NR	34 (52.3)	31 (47.7)	65 (100)	0	0	GAD-7 ≥5	21 (32.3)	PHQ-9 ≥10	12 (18.5)	-	-
Zhang, C. (2020)[80]	China	1,563 NR	NR	270 (17.2)	1,293 (82.7)	454 (29.0)	984 (62.9)	125 (8.0)	GAD-7 ≥5	76 (44.7)	PHQ-9 ≥5	488 (50.7)	ISI ≥8	564 (36.1)
Zhang, W. R. (2020)[81]	China	2,182 NR	NR	781 (35.8)	1,401 (64.2)	680 (31.2)	247 (11.3)	1255 (57.5)	GAD-2 ≥3	228 (10.4)	PHQ-2 ≥3	232 (10.6)	ISI >8	739 (33.9)
Zhu, J. (2020)[82]	China	165 (100)	34.1 ± 8.0	28 (17)	137 (83)	79 (47.9)	86 (52.1)	0	SAS >50	33 (20.0)	SDS >50	73 (42.2)	-	-
Zhu, Z. (2020)[83]	China	5,062 (77.1)	NR	758 (15)	4,304 (85.0)	1,004 (19.8)	3,417 (67.5)	641 (12.7)	GAD-7 ≥8	1,218 (24.1)	PHQ-9 ≥10	681 (13.5)	-	-

*****(mean ± standard deviation, year). All studies are cross-sectional. £ Median age (IQR). NR: Not report.

DASS-21: Depression, Anxiety, and Stress Scale-21 Items. PHQ-9: 9-item Patient Health Questionnaire. GAD-7: Generalized Anxiety Disorder 7- Item scale. MBI: Maslach Burnout Inventory. STAI: State-Trait Anxiety Inventory. BAI: Beck Anxiety Inventory. ISI: Insomnia Severity Index. HADS: Hospital Anxiety and Depression Scale. SAS: Self-Rating Anxiety Scale. HAMA: Hamilton Anxiety Scale. HAMD: Hamilton Depression Scale. CES-D: Center for the Epidemiological Studies of Depression. ALI: Anxiety Level Index. HEI: Huaxi Emotional-Distress Index. CDAS: COVID-19 Anxiety Scale. STAI: State-Trait Anxiety Inventory. PSQI: Pittsburgh Sleep Quality Index. AIS: Athens Insomnia Scale. SAS: Self-Rated Anxiety Scale.

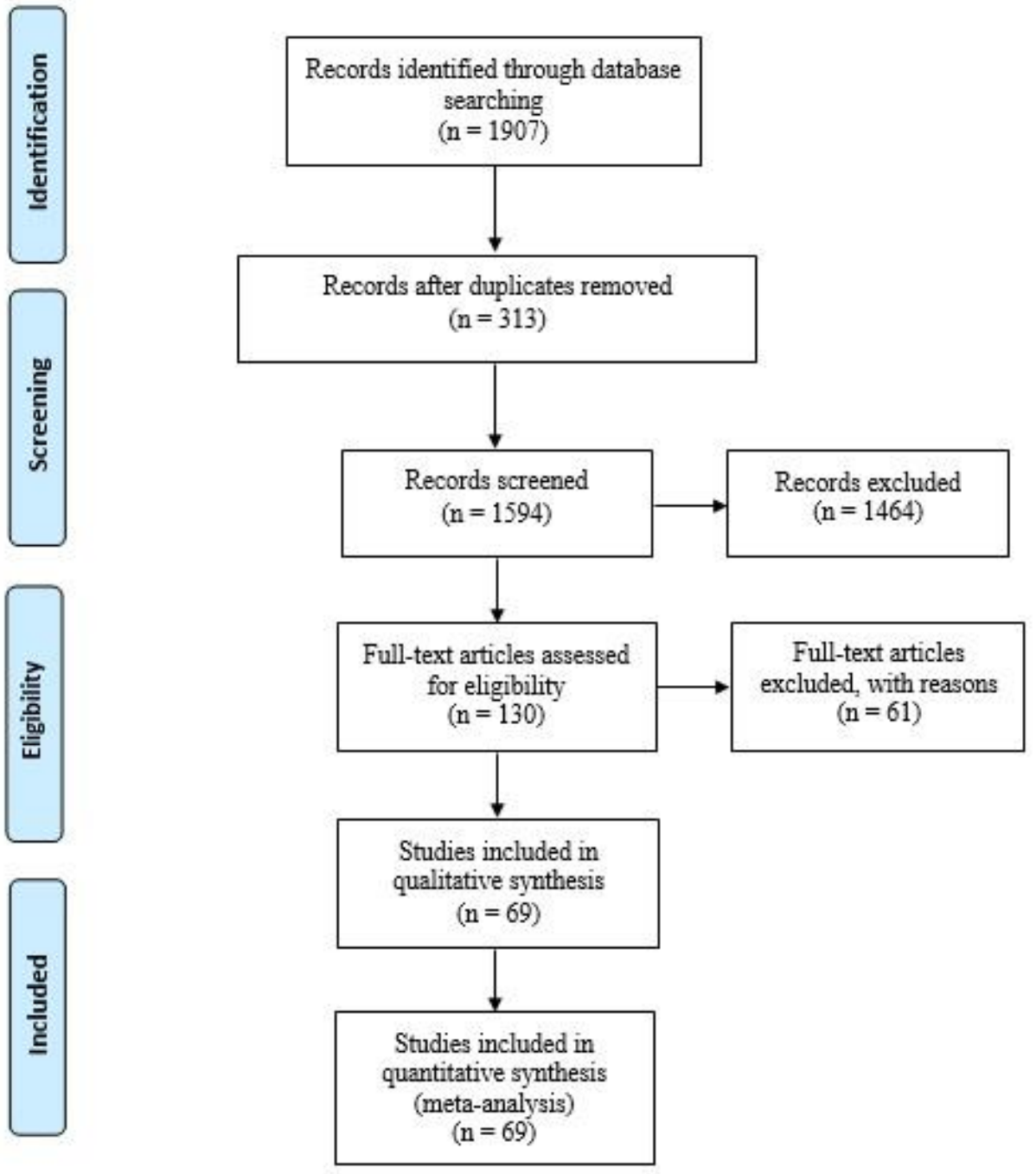

Fig. 1. PRISMA flowchart of different phases in searching the relevant publications

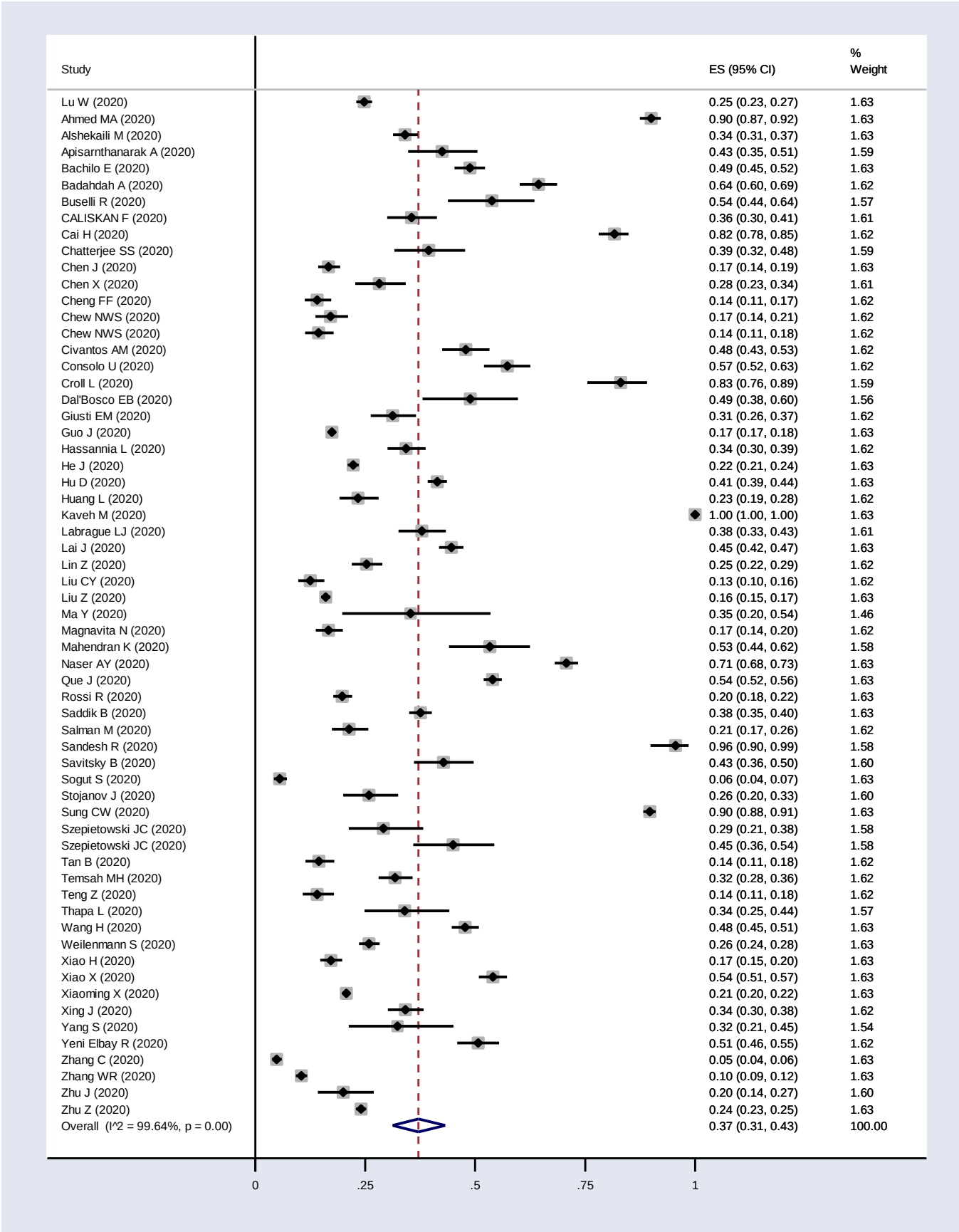

Fig. 2. Forest plot of pooled prevalence of anxiety in healthcare workers

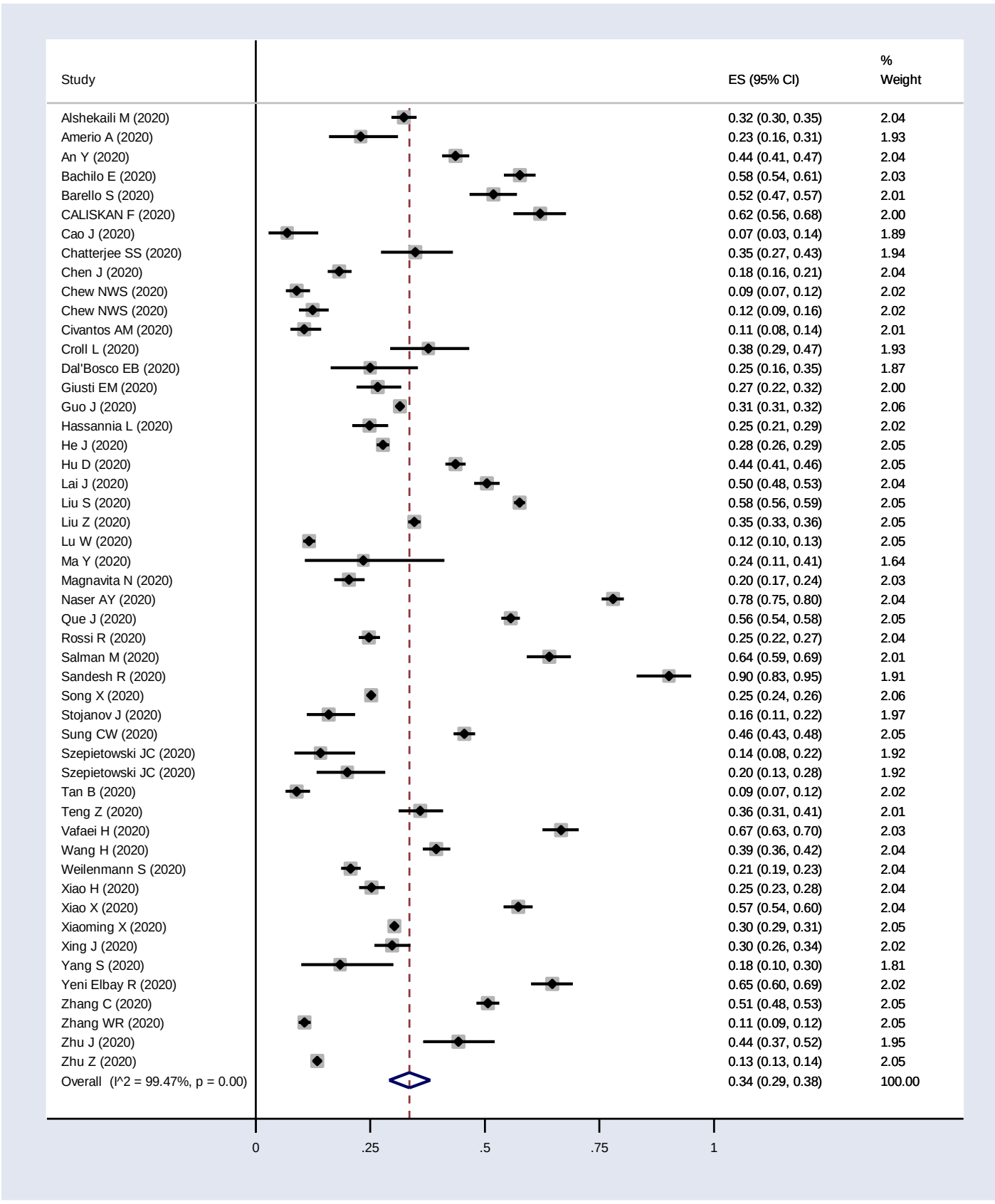

Fig. 3. Forest plot of pooled prevalence of depression in healthcare workers

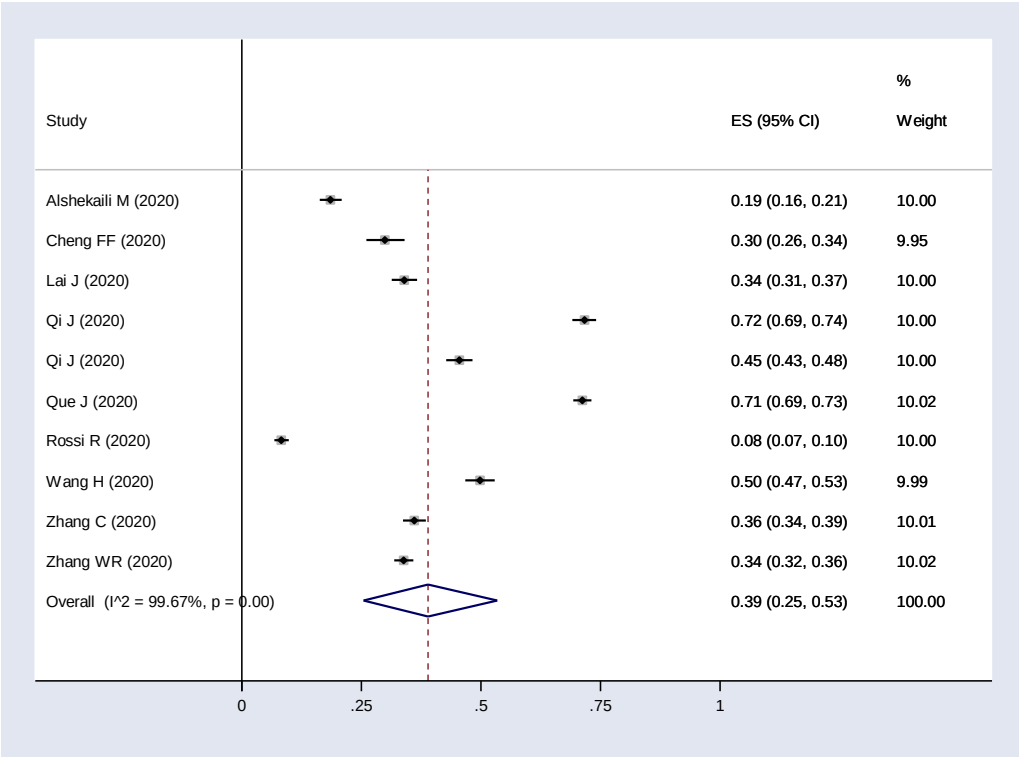

Fig. 4. Forest plot of pooled prevalence of insomnia in healthcare workers

The results of the subgroup analysis are presented in Table 2. The pooled prevalence of anxiety in male and female subgroups was 36% (95%CI: 23 to 50%) and 39% (95%CI: 30 to 49%), respectively. In addition, the pooled prevalence of anxiety by occupation type was 37% (95%CI: 27 to 47%) among doctors, 42% (95%CI: 34 to 50%) among nurses, and 35% (95%CI: 21 to 50%) in other groups. Also, a subgroup analysis was conducted according to the assessment tool; accordingly, the pooled prevalence of anxiety by scales such as BAI, DASS-21, GAD-7, HADS, SAS, and STAI were 63% (95%CI: 61 to 65%), 35% (95%CI: 24 to 48%), 33% (95%CI: 28 to 46%), 42% (95%CI: 34 to 50%), 21% (95%CI: 16 to 26%), and 88% (95%CI: 87 to 90%), respectively.

The pooled prevalence of depression in male and female subgroups was 32% (95%CI: 20 to 45%) and 36% (95%CI: 25 to 48%), respectively. The pooled prevalence of depression was 30% (95%CI: 20 to 42%) in doctors, 33% (95%CI: 24 to 42%) in nurse, and 27% (95%CI: 12 to 45%) in other groups. The pooled prevalence of depression by the assessment tool was 27% (95%CI: 27 to 28%), 33% (95%CI: 18 to 51%), 37% (95%CI: 24 to 50%), 37% (95%CI: 27 to 44%), 11% (95%CI: 9 to 12%), and 36% (95%CI: 31 to 41%) in subgroups of CES-D, DASS-21, HADS, PHQ-9, PHQ-2, and SDS, respectively.

Table 2. The pooled prevalence of mental health disorders in various subgroups

		No. of studies	Prevalence of anxiety (%) (95%CI)	No. of studies	Prevalence of depression (%) (95%CI)	No. of studies	Prevalence of insomnia (%) (95%CI)
Total		60	37 (31-43)	48	34 (29-38)	9	39 (25-53)
Gender	**Male**	11	30 (23-50)	10	32 (20-45)	3	22 (12-34)
	Female	12	39 (30-49)	12	36 (25-48)	3	27 (11-46)
Occupation	**Doctor**	16	37 (27-47)	14	30 (20-42)	3	34 (6-71)
	Nurse	16	42 (34-50)	13	33 (24-42)	3	37 (11-68)
	Other medical staff	11	35 (21-50)	6	27 (12-45)	3	34 (6-71)
Assessment Scale	**BAI**	2	63 (61-65)	-	-	-	-
	GAD-7	25	33 (26-40)	-	-	-	-
	SAS	10	21 (16-26)	-	-	-	-
	STAI-6	2	88 (87-90)	-	-	-	-
	DASS-21	9	35 (24-48)	8	33 (18-51)	-	-
	HADS	6	42 (34-50)	6	37 (24-50)	-	-
	CES-D	-	-	2	27 (27-28)	-	-
	PHQ-9	-	-	21	37 (28-46)	-	-
	PHQ-2	-	-	2	11 (9-12)	-	-
	SDS	-	-	5	36 (31-40)	-	-
	ISI	-	-	-	-	6	29 (0.18-0.41)
	PSQI	-	-	-	-	2	60 (0.58-0.62)

The pooled prevalence of insomnia in medical staff was 22% (95%CI: 12 to 34%) and 27% (95%CI: 11 to 46%) among males and females, respectively. Furthermore, the pooled prevalence of insomnia according to the assessment tools of ISI and PSQI was 29% (95%CI: 18 to 41%) and 60% (95%CI: 58 to 62%), respectively.

According to the univariate and multivariate meta-regression analysis, as given in Table 3, only the country of the study had a significant association with the prevalence of anxiety (P<0.05). One reason for the high heterogeneity in this study was the different prevalence reported in each country. However, there was no significant association for other variables (P>0.05).

Table 3. Meta-regression analysis for the effect of the suspected variables on the pooled prevalence of anxiety, depression, insomnia in medical staff

Pooled prevalence	Variable	Univariate model			Multivariable model		
		β	SE	P-Value	β	SE	P-Value
Anxiety	Gender	1.08	3.01	0.72	0.78	2.9	0.7
	Occupation	-1.1	4.3	0.79	-1.5	4.3	0.7
	Country	9.9	3.8	0.01	9.9	3.8	0.01
Depression	Gender	0.34	2.7	0.9	-0.02	2.8	0.9
	Occupation	-1.5	4.1	0.7	-1.4	4.2	0.7
	Country	-3.02	3.8	0.4	-2.9	3.9	0.4
Insomnia	Gender	11.1	7.6	0.1	12.3	7.5	0.1
	Occupation	-1.01	11.5	0.3	-3.4	11.2	0.7
	Country	-27.1	16.1	0.1	-29.6	16.1	0.08

SE: standard error, β: regression coefficient

Discussion

This systematic review and meta-analysis showed a high prevalence of psychiatric disorders among healthcare personnel during the COVID-19 crisis. Based on its results, the pooled prevalence rates of anxiety, depression, and insomnia were 37%, 34%, and 39%, respectively.

The findings showed that a high proportion of HCWs experienced considerable mental health disorders during the COVID-19 pandemic. This work, similar to many previous ones, implies the importance and urgency of attention to the mental health of medical staff.

Compared with the original systematic review (87), a higher prevalence of mental disorders was found (23.21% vs. 37% for anxiety, 22.8% vs. 34% for depression, 34.32% vs. 39% for insomnia in the original and present review, respectively). The pandemic of the new coronavirus is associated with many potential stressors that can lead to psychological problems and adverse consequences, especially among medical staff directly dealing with the crisis. Therefore, a high burden of mental health disorders is expected among them. In addition, the current review includes studies conducted over a longer period from the beginning of the epidemic. The fact that some countries have failed to control the disease despite many efforts and the number of disease cases is increasing worldwide may have caused more anxiety and fear among the medical staff.

Anxiety related to COVID-19: Anxiety disorders are defined as excess worries and fears that debilitate and cause a loss of quality of life [84, 85]. The present review findings showed that a large number of HCWs felt anxious about the prevalence of the COVID-19 pandemic. Anxiety in healthcare providers during the COVID-19 pandemic can be caused by factors such as shortage of PPE, fear of contact with infected people, getting infected and spreading the disease to families and friends, and fear of death [86, 87]. Healthcare professionals might be at a higher risk for developing anxiety disorder because of the emerging and life-threatening nature of the new coronavirus, increased workload and fatigue, lack of self-efficacy, and insufficiency of social support [88]. In this regard, social and economic consequences can result in more concerns [86]. In a survey conducted in Wuhan City in China, 63.2% and 28.0% of the frontline nurses reported moderate and severe levels of fear, respectively. Additionally, 11.0% and 3.3% of these nurses had moderate and severe anxiety levels [88].

In this review, the prevalence of anxiety was higher in female HCWs than in males (39% vs. 30%). In the same line, a previous study indicated that the Self-Rating Anxiety Scale for female nurses was higher than for males, indicating a higher level of anxiety among females [88]. A previous systematic review and meta-analysis among HCWs showed anxiety disorder to be more prevalent in females than males (29.06% vs. 20.92%, respectively) [89].

Nurses working in different units also noted that anxiety was more likely among women than men [90, 91]. Sex differences in the occurrence of anxiety can be due to genetic, neurodevelopmental, environmental, and neurobiological factors. Brain structural and functional differences, as well as hormonal differences between men and women, may have a critical role in the neurobiology of anxiety disorders. There are differences between the brain of men and women in areas dependent on anxiety, including the prefrontal cortex, hippocampus, and extended amygdala complex. Moreover, estrogen and progesterone, as female reproductive hormones, can play a key role in the neurobiology of anxiety disorder. Periodic fluctuations in these hormones throughout a woman's life can also precipitate Hypothalamic-Pituitary-Adrenal axis responses. These large fluctuations in sex hormone levels may contribute to changes in the severity of anxiety symptoms at different stages of reproduction in women [91]. Thus, female medical staff are assumed to be a more vulnerable group affected more severally by anxiety; accordingly, this disorder may be a much more important issue in women.

Depressive disorders: Depression is characterized by slow psychic processes, depressed and/or irritable mood, reduced energy, sad feelings, disinterest, apathy or psychomotor agitation, difficulty in concentrating, negative thoughts, loss of planning capacity, and altered judgment of the situation [36].

During the COVID-19 pandemic, a high frequency of depressive cases was reported among HCWs worldwide. For example, in a systematic review of 59 studies, the prevalence of depression was reported within the range of 5% to 51% [92]. In another systematic review and meta-analysis, the pooled prevalence of depression was 36% among the health professionals, based on a random-effects model (95%CI: 0.19 to 0.58) [93].

Furthermore, witnessing the suffering of patients with COVID-19 and being incapable of saving the lives of some patients make the medical staff upset. In the long run, this issue can make HCWs prone to depression and other psychological diseases since depression is often comorbid with anxiety [94]. Consequently, causative factors of anxiety in HCWs, such as insufficient understanding of the disease, lack of prevention knowledge, fear of getting infected, and transmission of the infection to family members, predispose the staff to depression.

In a survey in China, the researchers found that insufficient PPE and a history of contact with diagnosed COVID-19 patients were two independent risk factors for developing depression among HCWs. In this regard, having no contact with the COVID-19 patients was found as a protective factor [76]. In a cross-sectional survey in China, gender (male) was considered a protective factor for depression among doctors [82]. This finding was consistent with the present review results; the prevalence of depression in female HCWs was higher than the males (36% vs. 32%).

Given the confirmed findings that depression is generally more common in females [95, 96], authorities are required to take measures to prevent and control depression in female HCWs.

Insomnia related to COVID-19: Insomnia disorder refers to the difficulty in falling or staying asleep, poor sleep quality, or less sleep duration. This disorder often co-occurs with other mental illnesses, such as depression. Insomnia also may lead to physical and mental morbidities and reduce the quality of life [97].

In the critical situation caused by the COVID-19 outbreak, HCWs experience different levels of insomnia [92, 98]. In the present review, a high prevalence of insomnia was reported among the medical staff. This disorder was especially more common among nurses and women. These findings were in line with a previous systematic review and meta-analysis indicating that the pooled prevalence of sleep disturbances was significantly lower among male HCWs than the females (33.8% vs. 46.4% $p < 0.001$). Additionally, the prevalence of sleep disturbances among nurses was higher than among doctors [99].

In general, gonadal steroid effects are a potential reason for the increased prevalence of insomnia among females compared with males [100]. Considering the direct association of depression with insomnia and the high prevalence of depression among women in this study, a high frequency of insomnia is also expected.

Nurses responsible for taking care of patients with COVID-19 are at a higher risk of infection because they are in close and frequent contact with such patients and should work longer hours than usual [6]. Consequently, such a situation may play a role in causing insomnia. Furthermore, anxiety, depression, and insomnia are closely related to their risk factors. In a study carried out among the medical health workers in China, the history of organic diseases, residence in rural areas, risk of contact with COVID-19 patients, and female gender were among the independent risk factors for insomnia, anxiety, and depression [81]. Shift working, increased workload, education level, and worrying about getting infection were also among the other risk factors for developing insomnia [98, 101].

The strength of this systematic review is that it includes a wide range of published articles covering a large sample size. In the case of the study limitations, the following issues can be mentioned: an inherent and considerable heterogeneity was observed in the pooled prevalence of anxiety, depression, and insomnia. Hence, a random-effects model was applied to calculate the pooled prevalence of outcomes. Subsequently, subgroup analysis and a meta-regression model were conducted. Moreover, since the included articles used different tools to measure the participants' mental health disorders, the pooled prevalence of outcomes may be questionable. In this vein, a subgroup analysis was conducted based on the assessment tools. Another limitation of this review was the low quality of some included studies.

To the best of the authors' knowledge, this study is the most comprehensive systematic review and meta-analysis of primary studies on the prevalence of anxiety, depression, and insomnia in HCWs during the Coronavirus pandemic. However, one of the limitations of this study was the unavailability of the full text of some articles, ultimately leading to the exclusion of such articles from the meta-analysis. In addition, the low quality of some included articles was another limitation.

Conclusion

The findings indicate a high impact of the COVID-19 pandemic on the mental health of HCWs involved in the crisis in various territories and occupations among both genders. The medical staff's mental health is as crucial as their physical health. Moreover, mental health is important not only for the medical professionals' well-being but also for their work efficacy, improving the quality of medical services and patients' health. To reduce the staff fear of the new epidemic, adequate training is required to shed light on the disease's nature and supply adequate resources such as PPE. Furthermore, special attention should be paid to providing HCWs with appropriate levels of social and psychosocial support. In order to improve sleep quality among the staff, the following measures can be taken: decreasing anxiety and depression, applying relaxation techniques, using medications, and providing an opportunity for adequate rest.

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