Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Some of us are most at risk: Systematic review and meta-analysis of correlates of depressive symptoms among healthcare workers during the SARS-CoV-2 outbreak

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ABSTRACT

The COVID-19 pandemic has had a severe psychosocial impact on healthcare workers (HCWs). This systematic review and meta-analysis aimed at evaluating the association between individual features and depressive symptoms reported by HCWs during the pandemic. We searched Medline, Embase, and PsycInfo up to 23 June 2020. We included cross-sectional studies testing the association between individual correlates and depressive symptoms in HCWs during the SARS-CoV-2 outbreak. Fourteen studies met inclusion criteria, involving 14,173 HCWs (3,070 with depressive symptoms). Women (OR = 1.50; 95 %CI: 1.28–1.76; $I^2 = 40.0$ %), individuals with suspected/confirmed COVID-19 (OR = 2.10; 95 %CI: 1.64–2.69; $I^2 = 0$ %), and those with an infected family member or friend (OR = 1.67; 95 %CI: 1.37–2.04; $I^2 = 0$%) were more likely to report depressive features, which, instead, were less frequent among doctors (compared with nurses) (OR = 0.80; 95 %CI: 0.66–0.98; $I^2 = 48.2$ %) and HCWs who felt adequately protected (OR = 0.48; 95 %CI: 0.32–0.72; $I^2 = 36.3$ %). Our study provided timely evidence on the correlates of depressive symptoms among HCWs during the pandemic. Early screening is crucial to develop tailored health interventions, redesigning the response to COVID-19.

1. Introduction

As of 30 January 2020, the WHO declared the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) outbreak a Public Health Emergency of International Concern. Whilst early efforts have been primarily focused on epidemiological, pathophysiological, and clinical features of the infection (Lipsitch et al., 2020), interest in its impact on mental health has quickly reached unprecedented levels, from both International institutions (World Health Organization, 2020a) and the research community (Duan and Zhu, 2020; Holmes et al., 2020). Based on the experience from previous global infectious disease outbreaks, especially the 2003 SARS epidemic, the psychosocial impact on healthcare workers' (HCWs) mental health (Maunder et al., 2003; Wu et al., 2009) seems critical for the response to the novel Coronavirus Disease (COVID-19) pandemic, particularly in terms of care needs for this special population (Xiang et al., 2020). Unfortunately, access to mental health services by HCWs is hindered by a number of factors. Their professional culture is often rooted on a strict and unforgiving work etiquette and on an envisaged tenacity and diligence that expects them to tirelessly work even if unwell. This likely reflects not the simple commitment to work but rather the stigma of mental illness within healthcare professions (Hayes et al., 2017), placing HCWs worryingly at risk of adverse mental health consequences.

However, this has likely been even truer during the COVID-19 pandemic: HCWs have been overwhelmed worldwide by the challenges of serving in outbreak-afflicted areas, where they have been exposed to a massive load of stress factors. This resulted in a growing mental health burden, with negative consequences ranging from personal issues to an increased risk of burnout, poor work performance, and resignation (Blake et al., 2020). A recent systematic review and meta-analysis showed that about one quarter of HCWs were suffering from clinically meaningful depressive symptoms during the COVID-19 outbreak, although the results were based on somehow heterogeneous data (Pappa et al., 2020). Another systematic review, while commendably paving the way for the identification of risk and protective factors, did not focus on depression among HCWs, nor benefited from data

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pooling techniques of meta-analyses for correlates of depression (Luo et al., 2020).

Nonetheless, several, more recently published studies have tried to identify the factors associated with psychological distress and vulnerability to depression among HCWs during the COVID-19 pandemic. Relevant correlates explored by this novel research include organizational factors like the increased workload, the frontline role (associated with a higher risk of exposure to the virus), the inadequacy of personal protective equipment (PPE), and the stressful challenge of facing tough decisions in the absence of clinical guidelines (Blake et al., 2020). On a more individual level, reporting COVID-19 symptoms, and thus worrying about the health of potentially infectable family members or friends, seem putative variables of interest (Walton et al., 2020). In sum, a sufficient amount of research on correlates of depressive symptoms among healthcare staff during COVID-19 outbreak is now available. Although this is work in progress, it is crucial to urgently synthesize the emerging evidence on the characteristics associated with depressive symptoms among HCWs, in order to rapidly and appropriately identify those who are most in need of tailored screening and early interventions. Thus, this systematic review and meta-analysis aims at clarifying which are the factors associated with depressive symptoms in HCWs amid the COVID-19 pandemic.

2. Methods

The current meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher et al., 2009).

2.1. Eligibility criteria

We included any observational study with data enabling us to estimate the association between individual (sociodemographic, clinical, and environmental) characteristics and depressive symptoms among HCWs during the COVID-19 outbreak. Studies providing a categorical definition of depressive symptoms according to specific cut-offs from any appropriate psychometric scale were considered. HCWs were defined as any individual engaged in actions whose primary intent is to enhance health, either directly (i.e., doctors and nurses) or indirectly (laboratory technicians, administrative professionals, or support staff) (World Health Organization, 2006).

We excluded (i) studies not providing information on depressive symptoms; (ii) those taking into account the general population without specific information on HCWs; (iii) those not providing raw data on correlates of depressive symptoms; (iv) duplicate works, based on data from the same sample, in order to avoid misleading results; and (v) unrefereed preprints and grey literature.

2.2. Search strategy and selection of studies

We searched Medline, Embase and PsycInfo electronic databases (via Ovid), for COVID-19 related articles indexed up to 23 June 2020, without language restrictions, and using the following search phrase: *(depression OR depressive OR mood OR affective) AND (COVID-19 OR SARS-CoV-2).mp.*, with 'mp' code meaning that it included title, abstract, heading words and keywords. An additional screening of the studies included in a recent, relevant meta-analysis (Pappa et al., 2020) was made. After deduplication, three authors (BB, RMC, and FM) independently completed the preliminary screening based on titles and abstracts and retrieved full texts to assess studies according to inclusion criteria for definitive eligibility. Disagreements were resolved by discussion and consensus, involving all authors.

2.3. Data extraction

We used a standardized data extraction template, deriving the following key items for all eligible studies: year of publication; study location; inclusion criteria; health worker type (e.g., medical and non-medical staff, frontline workers); sample size; mean age; female proportion; methods to assess depressive symptoms; available correlates of depressive symptoms at both individual and organizational levels. Data were independently extracted by three authors (AC, DC, and FM) and cross-checked for accuracy. In order to benefit from additional information and to reduce the risk of selective reporting bias, we contacted the corresponding authors of studies disclosing unclear or incomplete data.

2.4. Quality of evidence

We evaluated the quality of evidence according to standard items, including (i) the methodological issues of the included studies, (ii) the consistency of the results, (iii) the magnitude of the estimates, and (iv) the probability of publication bias (Schünemann et al., 2019).

In order to identify possible sources of selection and information bias, we assessed: HCWs population representativeness; sample size; validity of measures used for the assessment of depressive symptoms; and sampling procedures. The HCWs population representativeness was appraised evaluating whether at least two different HCW categories (doctors, nurses, and other HCWs) were included. The appropriateness of the sample size was established if no less than 200 HCWs were included, following the example of a relevant meta-analysis in a similar field (Pereira-Lima et al., 2019). As for depressive symptoms assessment, we checked if the studies used validated psychometric scales with adequate cut-offs for at least moderate depressive symptoms, rather than indistinctly including subjects who reported mild and clinically non-significant depressive symptoms only. At the same time, we evaluated if the included studies used probability instead of snowball or convenience sampling procedures. In addition, in order to appraise the consistency of findings, we assessed the statistical heterogeneity across studies, according to relevant I^2 cut-off values. To estimate the effect magnitude, we evaluated cut-offs for continuous and categorical outcomes, respectively, defining small (Standardized Mean Difference, SMD = 0.2 or Odds Ratio, OR = 1.5), medium (SMD = 0.5 or OR = 2.5), and large (SMD = 0.8 or OR = 5.0) effect sizes, respectively (Chen et al., 2010). Finally, the probability of publication bias was assessed.

2.5. Data analysis

Meta-analyses of the association between depressive symptoms and relevant correlates were based on ORs with 95 % Confidence Intervals (CIs) for categorical variables and SMDs with 95 % CIs for continuous variables. We deemed appropriate to include individual characteristics with data available from at least three different studies. The Freeman-Tukey method was used to pool prevalence data for descriptive purposes. Study weights were obtained using a random-effects model for meta-analysis. Heterogeneity between studies was evaluated using standard cut-offs for the I^2 statistic, with values of 25 %, 50 %, or 75 % defining different levels of inconsistency (low, moderate, or high). Publication bias was assessed using Egger's test with relevant p-value for correlates based on at least ten studies (Page et al., 2019). All p-values were two-sided and were considered significant when $p < 0.05$. Analyses were performed in Stata statistical software package (release 15 StataCorp).

3. Results

3.1. Study selection

Three hundred and thirty-eight, 277, and 36 articles were generated from Embase, Medline, and PsycInfo electronic databases, respectively, whilst 13 additional articles were identified from a recent review (Pappa et al., 2020). Deduplication produced 411 records. The preliminary

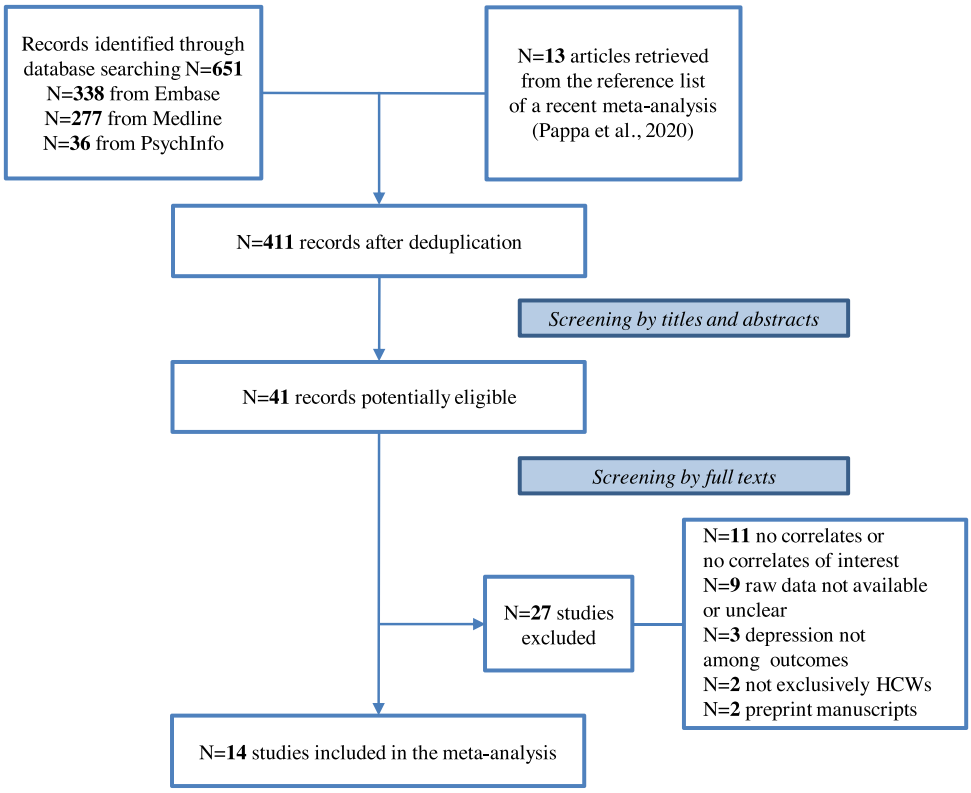

Fig. 1. Flowchart of the selection process.

screening by title and abstract identified 41 potentially eligible articles. After excluding 27 studies through the final screening by full text, we identified 14 eligible studies to be included in the meta-analyses (Amerio et al., 2020; Chatterjee et al., 2020; Civantos et al., 2020; Du et al., 2020; García-Fernández et al., 2020; Khanna et al., 2020; Lai et al., 2020; Ni et al., 2020; Sharif et al., 2020; Xiao et al., 2020; Yang et al., 2020; Zhang et al., 2020; Zhu et al., 2020a, b). We successfully contacted seven out of 17 (41.2 %) corresponding authors, allowing to include unpublished data of four additional studies in our meta-analyses, as well (García-Fernández et al., 2020; Ni et al., 2020; Zhang et al., 2020; Zhu et al., 2020a). Altogether, studies involved 14,173 HCWs, 3,070 of whom reporting depressive symptoms, with a Freeman-Tukey transformed proportion of 23.8 % (95 %CI: 16.2–32.2 %). The flowchart describing the screening, with reasons for exclusion, is reported in Fig. 1. Detailed characteristics of the included studies are displayed in Table 1.

3.2. Quality and risk of bias assessment

Eight studies (Du et al., 2020; García-Fernández et al., 2020; Lai et al., 2020; Ni et al., 2020; Xiao et al., 2020; Zhang et al., 2020; Zhu et al., 2020a, b) were considered sufficiently representative since they recruited at least two different HCW categories. Among the remaining studies, five were exclusively based on doctors, i.e., GPs (Amerio et al., 2020), specialist and non-specialist doctors (Chatterjee et al., 2020), otolaryngologists (Civantos et al., 2020), ophthalmologists (Khanna et al., 2020), neurosurgeons (Sharif et al., 2020), whereas one (Yang et al., 2020) focused on physical therapists. A sample size of at least 200 HCWs was available in nine studies (Civantos et al., 2020; García--Fernández et al., 2020; Khanna et al., 2020; Lai et al., 2020; Ni et al., 2020; Sharif et al., 2020; Xiao et al., 2020; Zhang et al., 2020; Zhu et al., 2020b). As regards depressive symptoms assessment, we classified ten studies as high quality (Amerio et al., 2020; Civantos et al., 2020; Du et al., 2020; Khanna et al., 2020; Lai et al., 2020; Ni et al., 2020; Xiao et al., 2020; Yang et al., 2020; Zhang et al., 2020; Zhu et al., 2020b), whereas others were based on psychometric scales with cut-offs which were either unclear (Chatterjee et al., 2020) or below the standard score for a valid assessment of clinically significant depressive symptoms (García-Fernández et al., 2020; Sharif et al., 2020; Zhu et al., 2020a). Finally, the vast majority of the included studies, based on online surveys, had low-quality or unclearly described sampling frameworks, with eight of them explicitly reporting snowball or convenience procedures (Chatterjee et al., 2020; Civantos et al., 2020; García-Fernández et al., 2020; Lai et al., 2020; Ni et al., 2020; Sharif et al., 2020; Xiao et al., 2020; Zhu et al., 2020a).

3.3. Factors associated with depressive symptoms

Nine relevant factors had data available from at least three studies and were used for meta-analyses. Three were professional/organizational variables, i.e., being a doctor (vs nurse or vs other HCWs), being a frontline worker, and feeling safe with the available PPE, whereas six were individual/interpersonal variables, i.e., age (considered both continuously and categorically <40 years), gender, being married or in a stable relationship, having at least a child, being infected or a suspected case, and having a family member or friend infected.

We found that women (OR = 1.50; 95 %CI: 1.28–1.76; I^2 = 40.0 %), infected/suspected subjects (OR = 2.10; 95 %CI: 1.64–2.69; I^2 = 0 %), and those who had had a family member or a friend infected (OR = 1.67; 95 %CI: 1.37–2.04; I^2 = 0 %) were all more likely to report clinically relevant depressive symptoms. No statistically significant effect was estimated for age, considering both the SMD between depressed and non-depressed HCWs (SMD = -0.28; 95 %CI: -0.61 to 0.06; I^2 = 84.7 %) and the odds in HCWs under 40 years of age (OR = 1.22; 95 %CI: 0.97–1.53; I^2 = 0 %). In addition, doctors – as compared with nurses –

Table 1
Characteristics of studies included in the meta-analysis.

Study	Location	Days after WHO's Global Emergency Declaration	Sample characteristics							Depressive symptoms		Explored correlates
			N overall	Age *yrs.* (mean ± SD)	Female proportion (%)	Type of HCWs	N doctors	N nurses	N other HCWs	Measure	Proportion (%)	
Amerio et al. (2020)	Genoa, Italy	45	131	52.3 ± 12.2	48.1	General Practitioners	131	0	0	PHQ-9 cut-off: ≥10	22.9	Age (mean), Gender, Being married, Having children, Feeling to have adequate protection
Chatterjee et al. (2020)	West Bengal, India	58	152	42.1 ± 12.2	21.7	Nonspecialist, Medical, Surgical, Preparaclinical and administrative doctors	152	0	0	DASS-21 cut-off: NA	34.9	Age (mean), Gender
Civantos et al. (2020)	United States of America	75	349	NA	39.3	Otolaryngologists	349	0	0	PHQ-2 cut-off: ≥3	10.6	Age <40 yrs., Gender
Du et al. (2020)	Wuhan, Hubei, China	14	134	36.0 ± 8.1	60.5	Doctors, Nurses, Support staff (all frontline)	47	55	32	BDI-II cut-off: ≥14	12.7	Gender, Doctors vs nurses, Doctors vs other HCWs, Family member or friend infected
García-Fernández et al. (2020)	Spain	59	779	39.5 (SD missing)	76.6	Doctors, Nurses, Other HCWs	392	226	161	BDI cut-off: ≥4	43.9	Age (mean), Age <40 yrs., Gender, Doctors vs nurses, Doctors vs other HCWs, Feeling to have adequate protection, Being infected or a suspected case
Khanna et al. (2020)	India	76	2350	42.5 ± 12.1	43.3	Ophthalmologists and ophthalmology trainees	2350	0	0	PHQ-9 cut-off: ≥10	32.6	Age (mean), Gender, Being married
Lai et al. (2020)	China	−1	1257	NA	76.7	Doctors, Nurses	493	764	0	PHQ-9 cut-off: ≥10	14.8	Gender, Doctors vs nurses, Frontline
Ni et al. (2020)	Wuhan, Hubei, China	19	214	NA	67.8	Doctors, Nurses, Pharmacists, Nurse assistants, Other HCWs	81	108	25	PHQ-2 cut-off: ≥3	19.2	Gender, Being married, Doctors vs nurses, Doctors vs other HCWs
Sharif et al. (2020)	Africa, Asia, Europa, North America, South America	NA	375	NA	NA	Neurosurgeons	375	0	0	SRQ-20 cut-off: ≥8	13.9	Age <40 yrs., Feeling to have adequate protection
Xiao et al. (2020)	China	−2	958	NA	67.2	Clinical doctors, Nurses, Working in CT room, Working in clinical laboratory, Other HCWs	378	359	221	HADS cut-off: ≥8	57.3	Gender, Being married, Having children, Feeling to have adequate protection, Doctors vs nurses
Yang et al. (2020)	South Korea	71	65	NA	47.7	Physical therapists	0	0	65	PHQ-9 cut-off: ≥10	18.5	Age <40, Gender, Family member or friend infected, Being infected or a suspected case
Zhang et al. (2020)	Wuhan, Hubei, China	20	2182	NA	64.2	Doctors, Nurses, Other HCWs	623	197	unclear	PHQ-2 cut-off: ≥3	10.6	Gender, Being married, Doctors vs nurses, Frontline
Zhu et al. (2020a)	Gansu, China	2	165	34.2 ± 8.6	83.0	Doctors, Nurses (all frontline)	79	86	0	SDS cut-off: ≥50	44.2	Age <40, Gender, Being married, Having children, Doctors vs nurses
Zhu et al. (2020b)	Wuhan, Hubei, China	9	5062	NA	85.0	Doctors, Nurses, Technicians	1004	3417	641	PHQ-9 cut-off: ≥10	13.5	Gender, Being married, Having children, Doctors vs nurses, Doctors vs other HCWs, Frontline, Family member or friend infected, Being infected or a suspected case

BDI = Beck Depression Inventory; BDI-II = Beck Depression Inventory-II; CT = Computerized Tomography; DASS-21 = Depression Anxiety Stress Scales-21; HADS = Hospital Anxiety and Depression Scale; NA = Not Available; HCWs = Healthcare Workers; PHQ-2 = Patient Health Questionnaire-2; PHQ-9 = Patient Health Questionnaire-9; SD = Standardized Deviation; SDS = Zung Self-Rating Depression Scale; SRQ-20 = Self-Reporting Questionnaire-20; WHO = World Health Organization.

Table 2
Factors associated with depressive symptoms among healthcare workers during COVID-19 outbreak.

Factor	k	Depressive symptoms by group		Effect estimate	I^2
Professional/ organizational		n/N	n/N	OR (95 %CI)	
Doctors (vs nurses)	8	680/ 3097	1038/ 5212	0.80 (0.66–0.98)*	48.2 %
Doctors (vs other HCWs)	4	311/ 1524	150/ 859	1.04 (0.79–1.37)	14.2 %
Frontline	3	356/ 2396	743/ 6105	1.32 (0.97–1.82)	69.2 %
Feeling safe with available PPE	4	79/393	894/ 1850	0.48 (0.32–0.72)***	36.3 %
Individual/ interpersonal					
Age <40 yrs.	5	324/ 1054	192/ 671	1.22 (0.97–1.53)	0.0 %
Female gender	13	2153/ 9632	865/ 4166	1.50 (1.28–1.76)***	40.0 %
Being married	7	1495/ 7735	876/ 3327	0.85 (0.59–1.23)	87.1 %
Heterogeneity-based SA	5	421/ 2390	504/ 1260	0.88 (0.70–1.10)	13.4 %
Having children	4	886/ 3939	447/ 2377	1.08 (0.83–1.41)	51.1 %
Heterogeneity-based SA	3	429/ 827	223/ 427	0.97 (0.74–1.26)	7.2 %
Being infected or a suspected case	3	142/ 338	893/ 5568	2.10 (1.64–2.69)***	0.0 %
Family member or friend infected	3	150/ 777	555/ 4410	1.67 (1.37–2.04)***	0.0 %

HCWs = Healthcare Workers; k = number of studies; n = with depressive symptoms; N = group size; SA = sensitivity analysis; PPE = personal protective equipment.
*p < 0.05; ** p < 0.01; *** p < 0.001.

(OR = 0.80; 95 %CI: 0.66 to 0.98; I^2 = 48.2 %) and those feeling to have adequate PPE (OR = 0.48; 95 %CI: 0.32 to 0.72; I^2 = 36.3 %), were both less likely to suffer from depressive symptoms. Finally, no differences were found between doctors and HCWs other than nurses (OR = 1.04; 95 %CI: 0.79–1.37; I^2 = 14.2 %), individuals with and those without children (OR = 1.08; 95 %CI: 0.83–1.41), as well as between married and non-married individuals (OR = 0.85; 95 %CI: 0.59–1.23), even though a moderate (I^2 = 51.1 %) and a high (I^2 = 87.1 %) inconsistency across studies was estimated, respectively. We were able to assess publication bias just when women and men were compared (13 studies), estimating a low probability according to Egger's test (coeff. = -0.33; p = 0.640). The summary of findings is shown in Table 2. The forest plots of the considered correlates are reported in the **Appendix** A. The summary of the quality of evidence is reported in Table 3.

4. Discussion

4.1. Summary of findings

Grounded on 14 studies involving 14,173 among doctors, nurses, and non-medical healthcare staff, our systematic review and meta-analysis provides evidence on the characteristics associated with depressive symptoms among HCWs facing the COVID-19 pandemic. Rates reported in our meta-analysis, with about one quarter of HCWs reporting depressive symptoms, are consistent with those described in a recent meta-analysis of prevalence data (Pappa et al., 2020). Besides, we uncovered a certain number of both professional/organizational and individual/interpersonal variables associated with depressive symptoms. We found that depressive features were less frequent among doctors (as compared with nurses) and among HCWs who felt safe with the available PPE. On the other hand, in terms of individual/interpersonal characteristics, a higher likelihood of depressive symptoms was observed in women, individuals with suspected/confirmed SARS-CoV-2 infection, and those with an infected family member or friend. No differences were estimated for other variables, including age, working on the frontline, being a doctor vs other HCWs, being married, and having children.

4.2. Quality of evidence and limitations

Despite promising early evidence, findings emerging from this meta-analysis should be interpreted with caution. Along with standard limitations of mental health surveys in terms of internal validity (Pierce et al., 2020), we found several factors downgrading the quality of available evidence and not allowing to draw firm conclusions (Schünemann et al., 2019). First, we appraised several quality issues of the included studies regarding (i) sampling strategies, involving non-probability sampling approaches rather than random sampling strategies; (ii) the representativeness of the target population in terms of health professionals' specialties; (iii) the reliability of the methods used to assess clinically meaningful depressive symptoms; and (iv) the sample size of the selected population. Second, the study did not allow us to consider possible confounders of the association between depression and HCWs' characteristics. In particular, no information on previous history of mental disorders among HCWs, which may favor the occurrence of depressive symptoms, was available. This is particularly important considering that, even in the pre-pandemic literature, both individual and environmental characteristics (such as the role of employee engagement in the intervention development and in the implementation process) have been associated with mental health outcomes among HCWs (Gray et al., 2019). Third, we found a high degree of inconsistency across the studies for specific correlates, including age, marital status, and working on the frontline. This possibly reflects some methodological differences across the studies, at least in terms of

Table 3
Quality of evidence.

Factor	k	N	Study limitations	Heterogeneity	Effect magnitude	Publication bias
Professional/organizational						
Doctors vs nurses	8	8,309	Yes	Moderate	Small	Not evaluable
Doctors vs other HCWs	4	2,383	Yes	Low	No effect	Not evaluable
Frontline	3	8,501	Yes	High	No effect	Not evaluable
Feeling safe with available PPE	4	2,243	Yes	Low-moderate	Small-medium	Not evaluable
Individual/interpersonal						
Age (yrs.)	4	2,798	Yes	High	No effect	Not evaluable
Age <40 yrs.	5	1,725	Yes	Absent	No effect	Not evaluable
Female gender	13	13,798	Yes	Low-moderate	Small	Absent
Being married	7	11,062	Yes	High	No effect	Not evaluable
Having children	4	6,316	Yes	Moderate	No effect	Not evaluable
Being infected or a suspected case	3	5,906	Yes	Absent	Small-medium	Not evaluable
Family member or friend infected	3	5,187	Yes	Absent	Small	Not evaluable

HCWs = Healthcare Workers; k = number of studies; N = sample size; PPE = personal protective equipment.

depressive symptoms assessment and sampling procedures, suggesting the need of further research to test the role of these correlates on depressive symptoms among HCWs, also longitudinally, to better understand the direct and indirect impact of the COVID-19 pandemic (Chamberlain et al., 2021).

Nonetheless, it should be noted that characteristics showing an association with depressive symptoms had reassuringly low to moderate heterogeneity across studies. However, the size of the effect for most of the included variables was generally limited and only two factors showed a robust estimate. HCWs who had been infected or were suspected cases had twice as high odds as those non infected/suspected to report clinically meaningful depressive symptoms. Similarly, those feeling to have had adequate PPE had half the odds to suffer from depressive conditions.

Other variables, albeit significant, showed just a weak association or inconclusive results, as was the case of frontline workers. This may be due to the limited number of included studies, possibly reducing the statistical power for most of the tested variables. For similar reasons, we could not assess the risk of publication bias for the majority of the analyses since the number of the included studies was lower than ten for all tested variables, apart from gender. However, our comprehensive search on main electronic databases, complemented by the screening of the studies included in a recent meta-analysis (Pappa et al., 2020), as well as the use of additional, unpublished information from corresponding authors of some studies have, at least partially, limited the risk of reporting bias. In sum, the relatively limited quality of evidence emerging from the current meta-analysis, along with issues inherent to relevant mental health surveys (Pierce et al., 2020), all support the need of more rigorous research on the correlates of depressive symptoms among HCWs. This should also consider cross-cultural comparison issues, since most of the eligible studies sampled HCWs from China, which could limit the generalizability of these results.

4.3. Interpretation and implications of findings for occupational health

We can draw some solid conclusions from our study as regards the effect of both professional role and gender on depressive symptoms. We found that nurses were more likely to report depressive symptoms during the COVID-19 pandemic than doctors, whereas no differences between doctors and other HCWs were estimated. A certain number of conditions explaining the additional psychological burden on nurses could be hypothesized. These include both the exceptionally heavy workload with insufficient time for rest and recuperation over the past several months and the lack of any approved, reassuringly effective treatment, whereas patient care was primarily entrusted to intense nursing care for a large number of people (Sun et al., 2020). This may be related to the sense of responsibility to alleviate patients' suffering and somehow safeguard entire countries from the virus (Liu et al., 2020). Indeed, pressure at the institutional level, disrupted job tasks and roles, and impaired patterns of communication, yielding chronic fatigue and lack of energy, decreased productivity and alertness, increased reaction time, and emotional blunting or mood changes, all appear as key contributors to distress in HCWs (Chan and Huak, 2004). Advocacy for recommendations in terms of prevention of chronic fatigue needs to be fostered following WHO guidance, specifically addressing local conditions in order to ensure safe staffing levels, fair allocation of workloads, and management of working time. For instance, frequent brief rest breaks are likely to be preferred to a few longer breaks during demanding work as well as shorter shifts during evening and night are desirable, since fatigue is intensified by night work because of night-time drowsiness and inadequate daytime sleep (International Labour Organization, 2018; World Health Organization, 2021). This can be accomplished by implementing strategic health-workforce plans, support, and capacity-building, and by providing suitable surveillance measures. These may enable the detection of impaired communication and critical events in order to lighten their impact on HCWs' mental health, allowing regular screening for depression and PTSD for HCWs (Carmassi et al., 2020; Kisely et al., 2020; Puangsri et al., 2021). On the other hand, feeling safe with the available personal equipment seems to play a protective role against depressive symptoms as well. Certainly, facing a potentially fatal disease, HCWs have to deal with the uncertainty of encountering an undiagnosed COVID-19 patient, especially considering constrained protective material resources (Yahya et al., 2020). Conversely, we did not find any excess load of depressive symptoms among frontline HCWs. This is surprising since they often worked incredibly long hours under significant strain, quietly accepting risks for their own safety and the fear of potential transmission of the virus to family members (Balicer et al., 2010). Nonetheless, research on previous pandemics such as SARS also provided mixed findings on the possible role of working in high-risk environments in terms of occurrence of mental disorders, considering frontline HCWs' awareness of their positive impact on both patients and family members (Brooks et al., 2018; Sinclair et al., 2020). This might be exploited to mitigate the effects of dehumanized healthcare working conditions on HCWs, dressed up with alienating protective personal equipment, and with less time for social exchange with patients (Guessoum et al., 2020).

In addition, we found a role for gender in the odds of depressive symptoms that is about 40 % larger for women than for men. The gender distribution of health care professionals in general, with female workers, particularly nurses, composing the vast majority of the workforce, somehow hampers the possibility to distinguish the relative contribution of gender to the development of depressive symptoms in HCWs. Although it is unanimously acknowledged that depression is more prevalent in women (Kuehner, 2017), it has also been shown that nurses suffer from depression at almost twice the rate of individuals in other professions (Brandford and Reed, 2016). Thus, a cumulative gender-Xprofession burden might be considered, although the uneven gender distribution in the healthcare workforce might also explain the greater chance of suffering from depression for women in the COVID-19 pandemic. In addition, it should be noted that frontline workers across different countries may significantly differ in terms of both healthcare role and workload. This is important when assessing the possible differences between doctors and nurses in terms of vulnerability to depressive symptoms. Moreover, HCWs with an infected family member or friend, disrupting boundaries between personal and professional spheres, were more likely to report depressive symptoms. The pandemic may thus impact also HCWs' personal lives and their mental health (Brooks et al., 2018), by reducing contacts with relatives and within their social networks, with some of them even living apart as a precautionary measure (Yahya et al., 2020).

This seems actually exacerbated when HCWs themselves become COVID-19 suspected cases, since their likelihood to report depressive symptoms is twice as high as for their non-infected counterparts. People tend to stigmatize those who may have been contaminated, though HCWs obviously represent one of the most vulnerable populations in terms of contracting COVID-19 (Adams and Walls, 2020). Fearing for their own health, being unavoidably quarantined, being afraid of infecting or having infected family members, experiencing social isolation, and finally even the condition of being a COVID-19 survivor, all contribute to a significant emotional burden on HCWs which can overwhelm their coping abilities (Holmes et al., 2020). In order to maintain individual wellness and team performance over the long run and to

contribute to trust, leadership must support HCWs both as professionals and as individuals, emphasizing the importance of self-care. This can be achieved by using transparent, concise, and thoughtful communication focused on their immediate needs (Adams and Walls, 2020). Along with organizational strategies, specific preventive approaches should be implemented, prioritizing an early screening of depressive symptoms among HCWs with specific characteristics. This may be important in order to redesign the COVID-19 response in case of further pandemic waves or similar scenarios. It is critical for occupational health staff to accurately detect depression correlates, perhaps establishing cross-disciplinary organizational task-forces to improve early recognition and referrals. Building confidential, walk-in or web-based, mental health services that are easily reachable by HCWs may reduce barriers to treatment. Finally, a particular challenge is posed by the additional stigma depressed HCWs working during the COVID-19 pandemic may experience: this should be tackled at multiple levels, including governments, citizens, media, key influencers, and communities (World Health Organization, 2020b).

5. Conclusions

This systematic review and meta-analysis provides first evidence focused on the characteristics of HCWs associated with depressive symptoms during the COVID-19 pandemic, allowing to preliminarily identify those most in need of tailored mental and occupational health interventions. Future higher quality research should ultimately better determine both professional/organizational and individual/interpersonal factors contributing to HCWs mental health burden.

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Declaration of Competing Interest

The authors declare that there is no conflict of interest.

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Appendix A

The forest plots of the considered correlates are reported in the **Appendix A.**

Figs. A1–A11

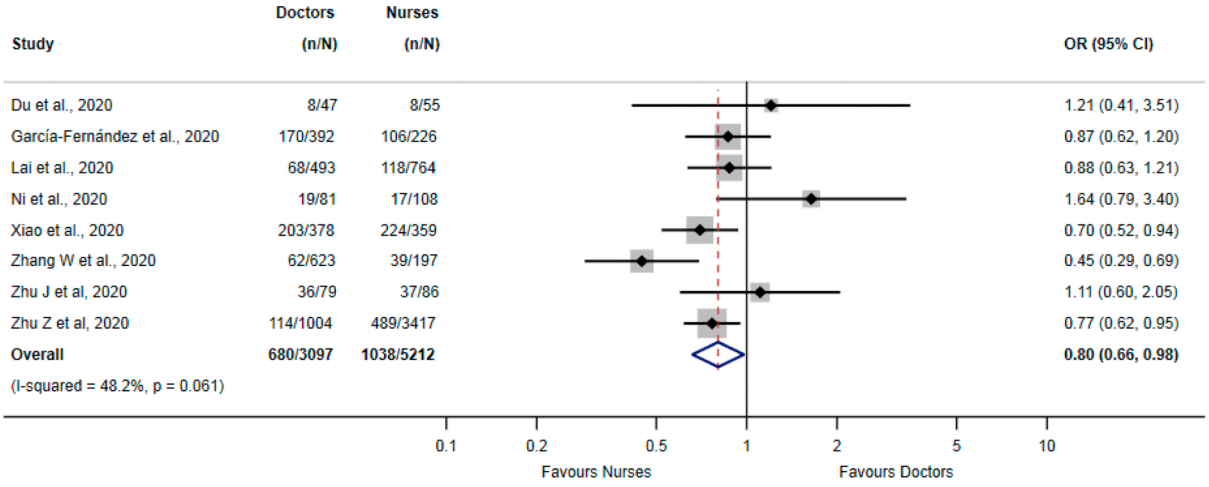

Fig. A1. Association between depressive symptoms and being a doctor as compared with being a nurse.

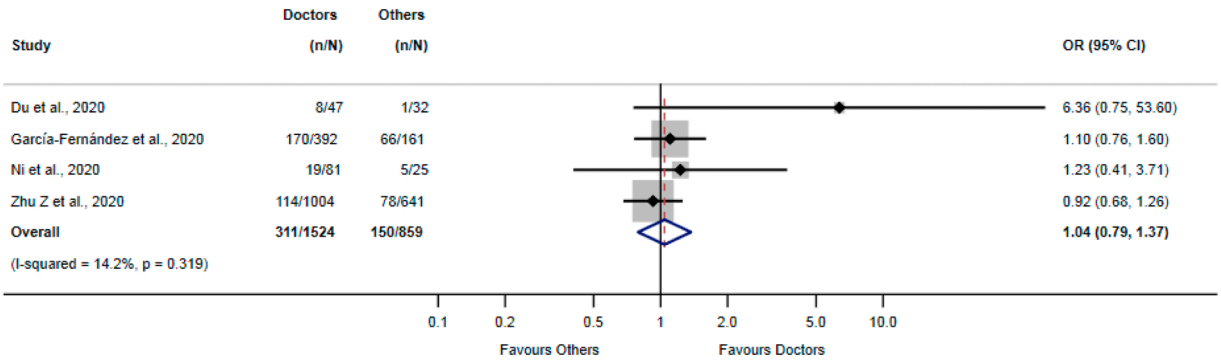

Fig. A2. Association between depressive symptoms and being a doctor as compared with other HCWs.

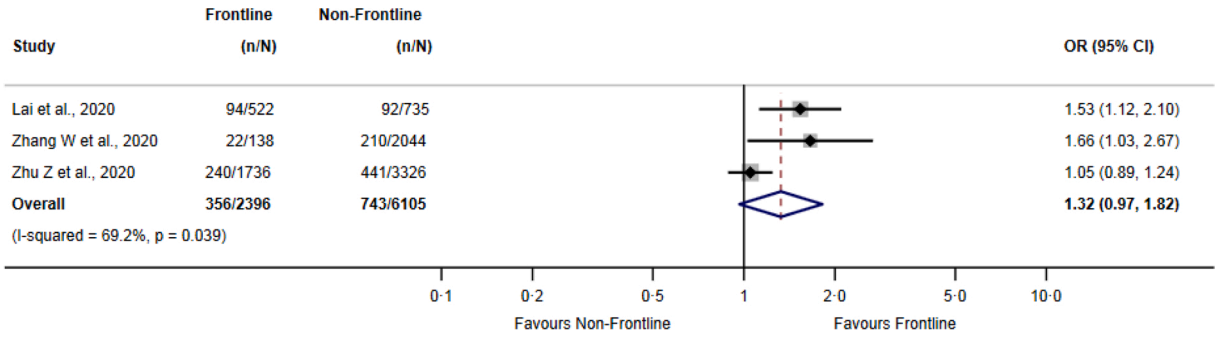

Fig. A3. Association between depressive symptoms and being a frontline HCW.

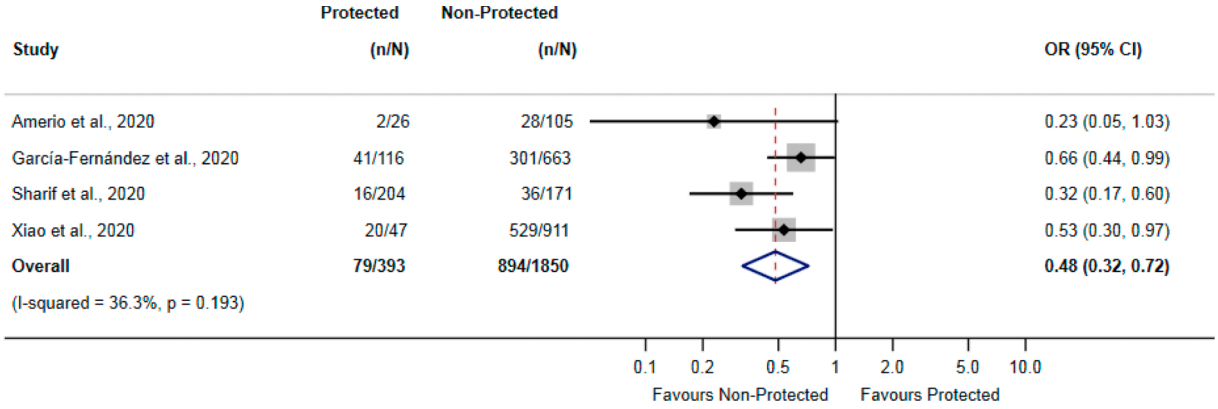

Fig. A4. Association between depressive symptoms and feeling to have adequate protection.

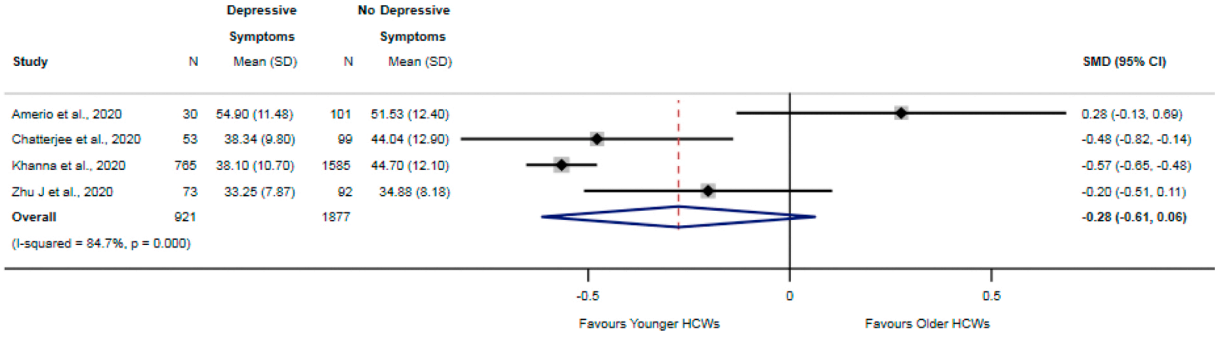

Fig. A5. Association between depressive symptoms and age (continuous).

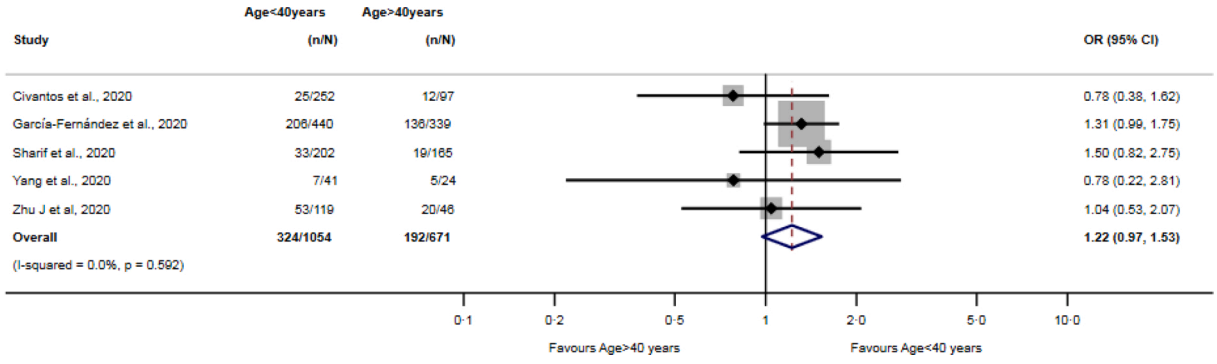

Fig. A6. Association between depressive symptoms and age <40 years old.

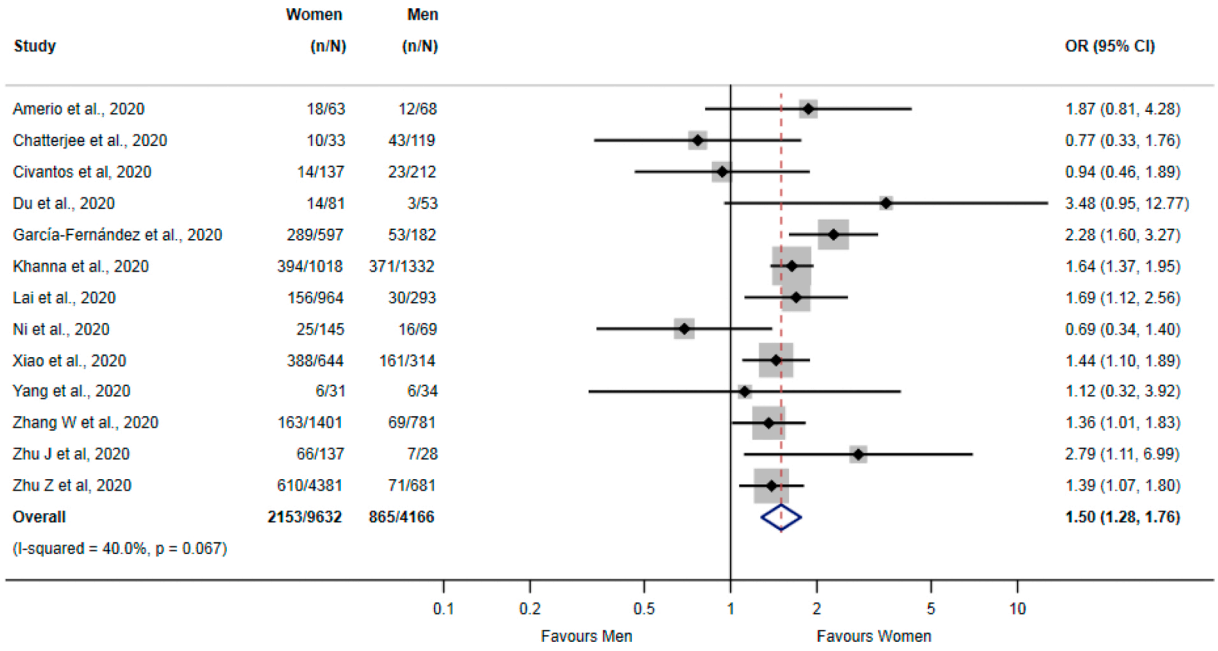

Fig. A7. Association between depressive symptoms and gender.

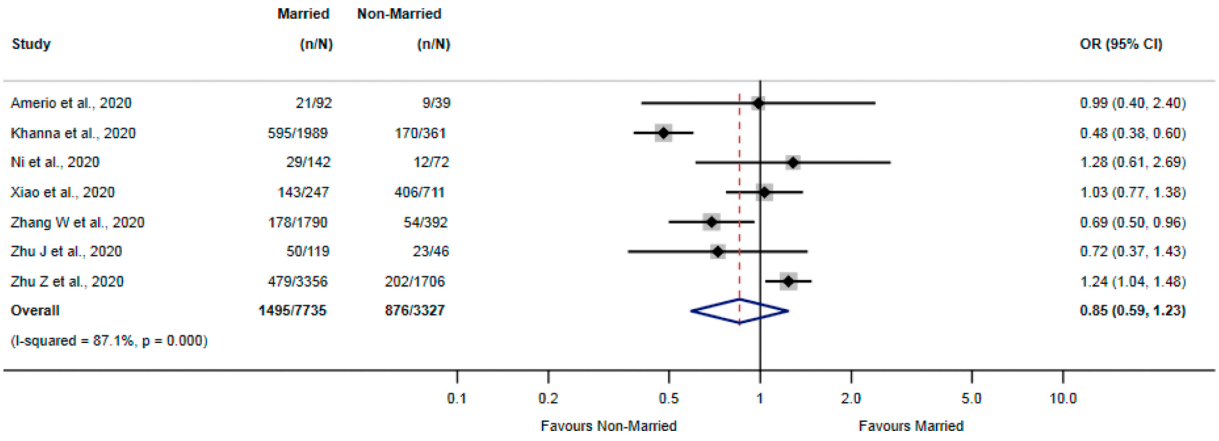

Fig. A8. Association between depressive symptoms and being married.

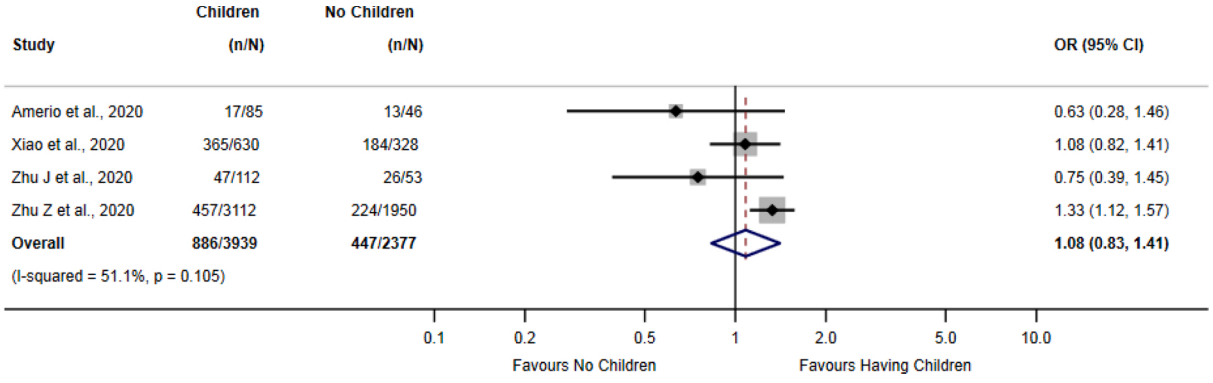

Fig. A9. Association between depressive symptoms and having children.

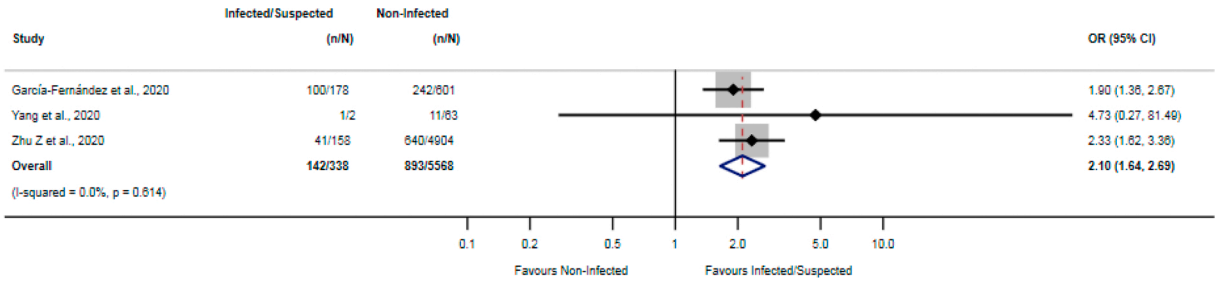

Fig. A10. Association between depressive symptoms and being infected or a suspected case.

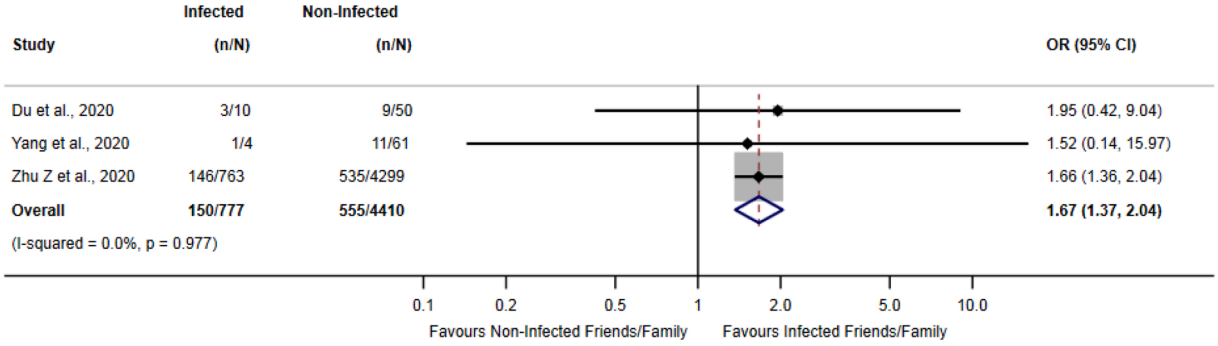

Fig. A11. Association between depressive symptoms and having a family member or a friend infected.

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