Article

JHP

Journal of Health Psychology
1–20

DOI: 10.1177/1359105320966639
journals.sagepub.com/home/hpq
SAGE

The prevalence of psychological consequences of COVID-19: A systematic review and meta-analysis of observational studies

Teresa Arora[1], Ian Grey[2], Linda Östlundh[3], Kin Bong Hubert Lam[4], Omar M Omar[5] and Danilo Arnone[3,6]

Abstract

A systematic review and a meta-analysis were conducted to examine the overall prevalence of psychological health outcomes during COVID-19. Seven databases were systematically searched to include studies reporting on at least one psychological outcome. The pooled prevalence of primary psychological outcomes was 26% (95%CI: 21–32). Pooled prevalence for symptoms of PTSD was 33% (0–86), anxiety 28% (21–36), stress 27% (14–43), and depression 22% (13–33). The prevalence of psychological outcomes was similar in healthcare workers and in the general population (34% [24–44] and 33% [27–40] respectively). High prevalence figures support the importance of ensuring adequate provision of resources for mental health.

Keywords

COVID-19, mental health, psychiatry, pandemic, meta-analysis, systematic review

Introduction

Since the initial outbreak in Wuhan, and subsequent spread to other parts of China in January 2020, COVID-19 has rapidly diffused through the World becoming a pandemic (Wu et al., 2020). Most countries have progressively implemented various forms of lockdown and mass quarantines resulting in global restrictions, profoundly affecting social and occupational functioning. Uncertainty about the future, due to the increasing number of COVID fatalities, the economic downturn, the breaking down of routine health care provision, unemployment, and limitations to personal freedom, has infused a widespread sense of

[1]Zayed University, Abu Dhabi, United Arab Emirates
[2]Lebanese American University, Beirut, Lebanon
[3]College of Medicine and Health Sciences, United Arab Emirates University, Al Ain, United Arab Emirates
[4]Nuffield Department of Population Health, University of Oxford, Oxford, Oxfordshire, UK
[5]University of Birmingham, Birmingham Clinical Trials Unit, Birmingham, UK
[6]Centre for Affective Disorders, Institute of Psychiatry, Psychology and Neuroscience, Psychological Medicine, King's College London, London, UK

Corresponding author:
Danilo Arnone, College of Medicine and Health Sciences, Department of Psychiatry and Behavioural Science, United Arab Emirates University, PO BOX 17666, Al Ain, Abu Dhabi, United Arab Emirates.
Email: danilo.arnone@uaeu.ac.ae

precarity. Older generations, at risk of infection due to pre-existing vulnerabilities, have become the centre of an ethical debate aiming at deciding whether younger generations should be preferred, in view of limited healthcare resources (Archard and Caplan, 2020). Frontline healthcare workers (HCWs) have been exposed to the absence of protective equipment (Horton, 2020), whereas intense media reporting has fostered an atmosphere of anticipation and social anxiety (Sell et al., 2017). Authority-driven guidelines such as national lockdowns, proscription of household gatherings, social distancing and self-isolation at home are inharmonious to the social needs of humans. While these measures are intended to minimize the spread of the virus, it is possible that they could manifest in unintended psychological consequences. Recently, Holmes et al. (2020) have made an urgent call for a systematic and strategic approach for research priorities to better serve the mental health needs of COVID-19 affected individuals and the likely psychological consequences of the pandemic for the general population. In this systematic review and meta-analysis, we address the fundamental first question by establishing the prevalence of a wide range of psychological outcomes originating from the global COVID-19 pandemic. The work systematically evaluates the prevalence of psychological consequences of those inflicted or suspected of COVID-19, HCWs, as well as the general population. We specifically assessed these three populations given that the reasons for psychological strain are likely to be driven by different factors. For example, the former group are most likely to fear death and experience feelings of hopelessness and panic from contracting the virus. HCWs are at high risk of depressive symptoms and fear of infection, particularly if there is an inadequate supply or limited access to personal protective equipment (PPE) (Lam et al., 2020). Conversely, the general population is more likely to suffer psychological consequences as a result of government-led restrictions such as social isolation and social distancing measures. There are currently two recent systematic reviews and meta-analyses in this area. The first specifically focused on the psychological impact of COVID-19 among HCWs (Pappa et al., 2020). The second considered HCWs as well as the general population which also included patients (Luo et al., 2020). However, it is important to note that the primary focus of these were anxiety, depression and/or insomnia. Unlike the aforementioned studies, our work collectively investigated the psychological impact of COVID-19 across all three groups and incorporates a wider range of psychological disorders, as well as negative emotional states likely to be experienced during the global pandemic. Thus, our work provides a more comprehensive representation and assessment of the wide-ranging psychological effects across all potential affected groups which is urgently needed in order to better prepare for the downstream consequences of a global pandemic. We therefore provide the first objective and collective evidence of the mental health needs during COVID-19 across these three specific populations which were intended to capture the prevalence of diverse mental health disorders as well as adverse emotional states. The prevalence of psychological distress is essential to evaluate the short to medium-term consequences of the COVID-19 pandemic to better inform healthcare systems.

Methods

Study design

Our systematic review and meta-analysis targeted the inclusion of observational studies. It is registered with PROSPERO (CRD42020177446) and follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher et al., 2009).

Search strategy

A comprehensive search of seven electronic databases (PubMed, Medline, Embase,

PsycInfo, Scopus, CINAHL and Web of Science) was conducted (LÖ) between March and April 2020 to identify observational studies, in multiple languages (English, Chinese, Italian, French, German, Spanish, Portuguese, or Italian), which reported the prevalence on psychological outcomes in the context of COVID-19 since the beginning on the pandemic. Search term variations of COVID-19 and selected psychological related conditions were systematically identified and searchers were conducted up until 17 April 2020. A combination of the search fields "title", "abstract" and "MeSH"/"thesaurus" were used to ensure the best possible search result. No filters or limitation were applied to the search. After deduplication was performed in Covidence (LÖ), blinded screening of titles and abstracts and full text was completed independently by two authors (TA & IG) throughout the selection stages to identify eligible studies. Conflicts were resolved in discussion with a third author (DA). A search log including detailed search strings, results and notes for all databases is available in appendix 1.

Eligibility criteria

Inclusion criteria were (1) human studies which reported (2) original research data and (3) at least one psychological outcome since the emergence of COVID-19 in China in HCWs, the general population and/or those with confirmed or suspected COVID-19. Primary psychological outcomes for inclusion were anxiety, depression, post-traumatic stress disorder (PTSD), and stress. Secondary outcomes were anger, panic, frustration, fear, worry, suicidal ideation, self-harm, irritability, distress, disturbances of circadian rhythms and/or sleep. Primary and secondary outcomes had to be reported as prevalence with 95% confidence intervals (CI), or equivalent. The corresponding author was contacted by email to request any prevalence rate not reported within the published paper, if the article was otherwise eligible. All articles were included in the meta-analysis, with the exception of those which had not undergone peer-review and/or were not published in a scientific journal.

Data extraction

Potential confounders were systematically extracted including country of origin of the study, differences in population type, age of the sample, sex differences, sample size, instruments used to assess psychological outcome(s), population investigated, timing of the outbreak (time from the first case of COVID-19 in the region to the start of data collection) and month of publication. All data were extracted independently by two reviewers (TA & IG) to a data extraction sheet which was created by the team statistician (OMO). Data extraction discrepancies were resolved by the statistician (OMO).

Quality assessment and risk of bias

All article deemed suitable for inclusion were assessed for quality using the Study Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies from the National Institutes of Health (National Heart, Lung and Blood Institute). This was performed by two independent reviewers (TA & IG) and discrepancies were resolved by a third reviewer (DA).

Statistical analyses

A random-effects model (DerSimonian-Laird method) was used to calculate the overall effect from effect sizes (Borenstein et al., 2010). Presence of heterogeneity between studies was evaluated by Cochrane's Q test and quantified by the I-square (I^2) statistic (Melsen et al., 2014). Analyses were carried out using Stata 16 (StataCorp LP, USA). Meta-analyses were performed by using Metaprop module, designed to perform meta-analyses of proportions in Stata (Nyaga et al., 2014). The meta-analysis was conducted with prevalence estimates that had been transformed using the double arcsine method to address the variance instability (Barendregt et al., 2013). The final pooled result and 95% CIs were back transformed for

ease of interpretation. Heterogeneity was evaluated with the idea to establish a potential relationship of the summary effect size with all the potential confounders systematically extracted. Two-sided p-values of 0.05 were considered statistically significant. Publication bias was assessed using the Doi plot and Luis Furuya-Kanamori asymmetry index (LFK index) (Furuya-Kanamori et al., 2018). Briefly, the presence of symmetry suggests no publication bias, whereas publication bias is expected in the absence of symmetry.

The primary analysis looked at prevalence rates of anxiety, depression, PTSD and stress. Secondary analyses were performed including prevalence of fear, insomnia, sleep quality, worry, anger and mixed outcomes. Mixed outcomes included the combination of more than one outcome resulting in a single prevalence rate. Subgroup analyses and meta-regressions were performed to assess potential influences on prevalence estimates. We compared prevalence estimates by identifiable confounders including region, type of workers, population, timing of COVID-19 and month of publication. Finally, to assess the impact of study quality on pooled prevalence, sensitivity analyses was performed for the primary analysis excluding low-quality studies.

Results

A total of 3233 references were captured which generated 1701 articles, of which 84 were deemed potentially eligible for inclusion. Subsequent to full-text screening, 30 studies fulfilled our pre-defined inclusion criteria, 28 of which were eligible for the meta-analysis (Figure 1).

Two studies were excluded from the meta-analysis as they were reports and not published peer-reviewed articles. Thirteen studies assessed anxiety as a primary outcome, 11 studies investigated depression. Thirteen studies were conducted in HCWs, 12 focused on psychological outcomes among the general population, and one study obtained data from both groups (Yuan et al., 2020). Two articles focused on those with suspected or infected COVID-19 patients (Bo et al., 2020; Nyaga et al., 2014). The majority of the included studies were conducted in mainland China ($n=20$; 71%). Table 1 depicts data regarding specific psychological outcomes extracted from the included studies, according to population type. A summary of all studies that met our pre-defined inclusion criteria for the systematic review can be found in Table 2.

Meta-analysis results for the primary psychological outcomes are shown in Figure 2. The overall pooled prevalence across all of the primary outcomes was 26% (95% CI: 21–32). The included studies were assessed for heterogeneity and publication bias. There was evidence of substantial heterogeneity Q test ($p<0.001$) and I^2 statistics ($I^2=99.7\%$). The Doi plot showed no symmetry, verifying the presence of bias, but no evidence of bias was detected by the asymmetry index (LFK index = –0.15), shown in Figure 3. Our analysis revealed the pooled prevalence of PTSD was 33% (95% CI: 0–86), 28% for anxiety (95% CI: 21–36), 27% for stress (95% CI: 14–43), and 22% for depression (95% CI: 13–33).

Secondary analysis of all psychological outcomes (Supplementary Figure 1) showed that fears and worries were reported most frequently, 70% (95% CI: 53–85) and 68% (95% CI: 25–98), respectively. The combined prevalence across primary and secondary psychological outcomes was 34% (95% CI: 29–40). Table 3 shows the results of the meta-regression analyses for all outcomes including pooled estimates for subgroups based on region, type of workers, population, timing of COVID and month of publication. There was little evidence of an effect of any of these factors upon prevalence. However, based on study quality assessment (good: $n=14$; fair: $n=7$; poor: $n=7$), poor quality studies were more likely to report a higher prevalence compared to good quality studies (46% vs 27%, $p=0.036$). Sensitivity analysis (Supplementary Figure 2) did not substantially alter the findings, indicating a 27% overall

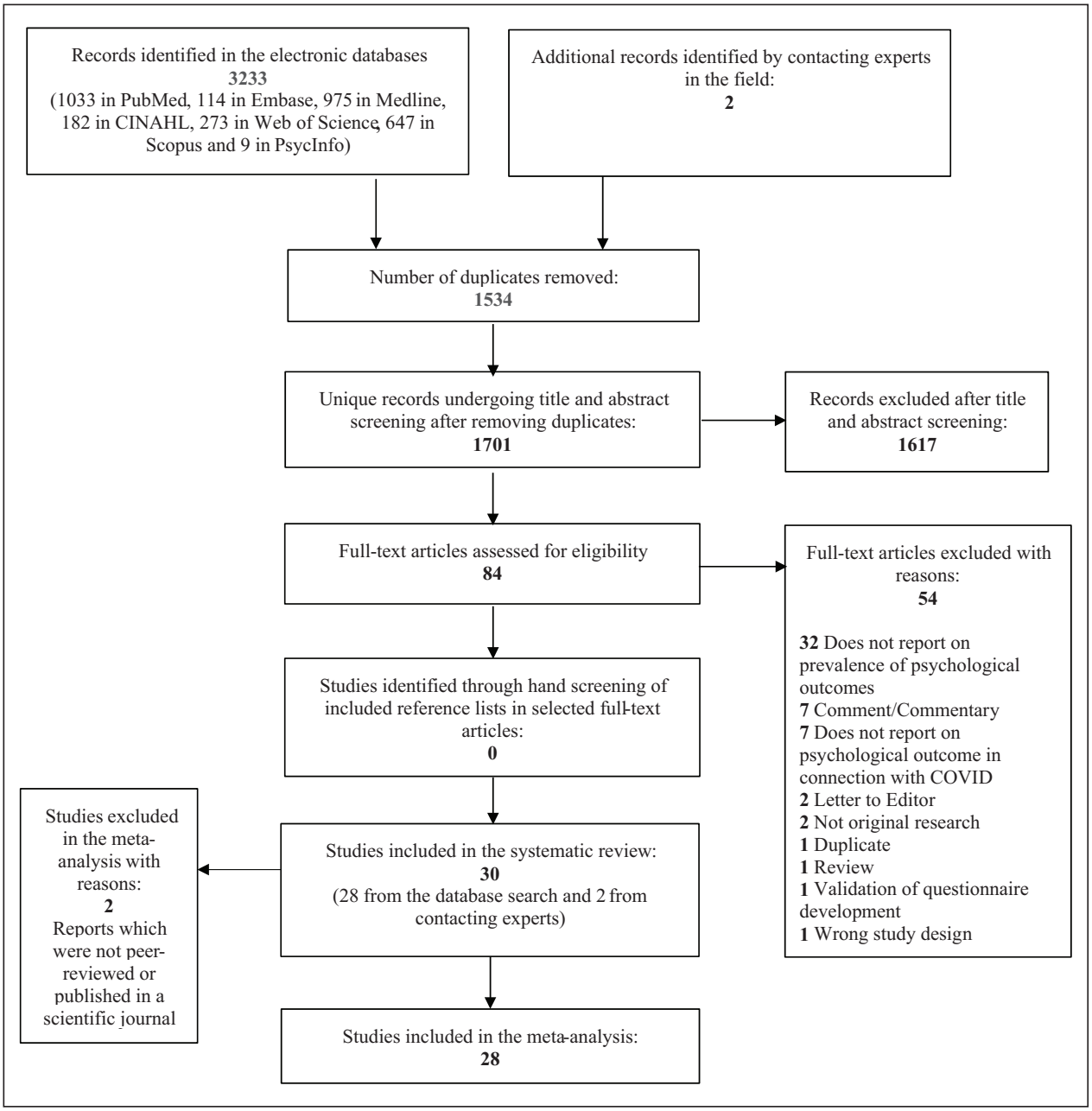

Figure 1. PRISMA 2009 flow diagram.

prevalence of primary psychological outcomes across all included studies and populations.

Discussion

We set out to assess the prevalence of psychological outcomes in response to the recent COVID-19 outbreak around the peak of the pandemic. Primary and secondary psychological outcomes were systematically quantified in a meta-analysis and a summary effect size was calculated for 97,173 individuals, in the context of the COVID-19 outbreak. The analyses showed that overall, the prevalence of adverse psychological responses across all studies was 26%. For the primary outcomes, which referred to defined mental health syndromes, the highest prevalence was for PTSD (33%). The overall prevalence of anxiety and depression were 28% and 22%, respectively. Fears (70%) and worries (68%) were the commonest secondary psychological outcomes. The combined prevalence

Table 1. Number of studies according to psychological outcomes and stratified by population type.

	Population type		
	Healthcare workers	COVID-19 cases	General population
Anxiety	7	0	6
PTSD	2	1	1
Stress/distress	3	0	3
Depression	6	1	4
Anger	1	0	0
Fear	3	0	1
Worry	1	0	3
Sleep quality/insomnia	4	0	3
Mixed	1	0	1

across primary and secondary psychological outcomes was 34%. These figures are above the expected "non-epidemic" rates reported in epidemiological studies, (Holzer, 2013) and are consistent with the 2003 severe acute respiratory syndrome (Tsang et al., 2004; Yip et al., 2010) and with the predicted psychological impact of quarantine measures associated with COVID-19 (Brooks et al., 2020).

Human survival and optimal functioning in the most disparate situations, requires an intrinsic homeostatic functional balance (Marks, 2018). The disturbance of this equilibrium induced by COVID-19, and associated measures to contain its spread, will inevitably require re-adjustment for many individuals with respect to psychological and even physiological functioning which may help to explain the physiological and psychological responses measured in this study. This is consistent with the "Reset Equilibrium Function" hypothesis proposed by Marks (2018). Furthermore, COVID-19 has most likely contributed to a shift in motivational drives according to Maslow's hierarchy of needs (Maslow, 1943). For example, threats to security of basic needs and social interaction restrictions, may explain some of the emotionally driven responses such as worry, fear, distress and anxiety, that we observed. As highlighted by Matias et al. (2020), adaptations to COVID-19 has resulted in behavioral alterations such as stockpiling food and essential items, as well as an increased need for self-protection, along with reduced social contact. Thus, during the pandemic, a shift in human focus and motivation to basic needs may explain the heightened psychological consequences observed. We propose that the outcomes measured in our meta-analysis are potential manifestations of psychological mechanisms of adaptation to COVID-19. These may include changes in self-esteem, potentially affected by the rising levels of unemployment, poverty and their likely impact on social status.

From a methodological viewpoint, all studies applied a survey-based approach and data were mostly captured using online methods (18/30). However, some studies did not explicitly state if questionnaires were completed electronically or on paper ($n = 7$), and one study collected data via a telephone survey (Wolf et al., 2020). A mixed-method design was applied in one study whereby participants were interviewed and were also asked to complete a series of validated questionnaires (Cao et al., 2020a). A common concern about collecting data using online survey techniques is the risk of multiple biases (social desirability, recall, response and more) which could have influenced the overall findings. Response rates to survey-based designs were not reported for the majority (16/30), but for those that did report, the range was from 65.8% to 100%. Of note, is that some reported the completion rate (Wang et al., 2020a) rather than the response rate. However, with online surveys, unless emailed

Table 2. Details of included studies, extracted data and quality assessment.

First author	Sample size	Country & quality	Population	Age (years)	Male gender (%)	Psychological outcome & measure used	Prevalence of psychological outcome (95% CI) if reported
Bo (Bo et al., 2020)	730	China[1]	CC	50.2 ± 12.9	49.1	PCL-C (PTSD)	*PTSD*: 96.2% (94.8–97.6)
Cai (Cai et al., 2020)	534	China[3]	HCWs	18–30 (42.4%) 31–40 (60.7%)	31.3	Author-derived	*Anger*: slightly = 24.5%; moderate = 15.4%; very much = 5.8% *Fear*: slightly = 41.0%; moderate = 33.9%; very much = 6.7%
Cao, J (Cao et al., 2020a)	37	China[1]	HCWs	32.8 ± 9.6	21.6	PHQ-9 (depression)	*Depression*: 18.9%
Cao, W (Cao et al., 2020b)	7,143	China[1]	GP	Not reported	30.35	GAD-7 (anxiety)	*Anxiety*: overall = 24.9%; mild = 21.3%; moderate = 2.7%; severe = 0.9%
Chung (Chung and Yeung, 2020)	69	Hong Kong[3]	HCWs	Not reported	Not reported	PHQ-9 (depression)	*Depression*: mild = 34.8%; moderate = 14.5%
Gao (Gao et al., 2020)	4,872	China[1]	GP	32.3 ± 10.0	32.3	WHO-5 (depression) GAD-7 (anxiety)	*Depression*: 48.3% (46.9–49.7) *Anxiety*: 22.6% (21.4–23.8)
Huang, J (Huang et al., 2020)	230	China[2]	HCWs	32.6 ±6.2	18.7	SAS (anxiety) PTSD-SS (PTSD)	*Anxiety*: women = 25.64%; men = 11.63% *PTSD*: women = 29.41%; men = 18.60%
Huang, Y (Huang et al., 2019)	7,236	China[1]	GP	35.3 ± 5.6	45.4	GAD-7 (anxiety) CES-D (depression) PSQI (sleep quality)	*Anxiety*: 35.1% *Depression*: 20.1% *Sleep quality*: 18.2%
Kang (Kang et al., 2020)	994	China[1]	HCWs	18–25 (21.5%) 30 s (34.1%) 40 s (29.3%) 50 s (11.5%) >50 (3.6%)	14.5	PHQ-9 (depression) GAD-7 (anxiety) ISI (insomnia) IES-R (distress)	*Mixed*: mild = 34.4%; moderate = 22.4%; severe = 6.2%

(Continued)

Table 2. (Continued)

First author	Sample size	Country & quality	Population	Age (years)	Male gender (%)	Psychological outcome & measure used	Prevalence of psychological outcome (95% CI) if reported
Kwok (Kwok et al., 2020)	1,715	Hong Kong[2]	GP	18–24 (26%) 25–34 (33%) 35–44 (22%) 45–54 (11%) ⩾55 (8%)	31	HADS-A (anxiety) STAI (anxiety)	*Worry*: 97% *Anxiety*: borderline = 30.7% (28.1–33.4); abnormal = 33.9% (31.3–36.5)
Lai (Lai et al., 2020)	1,257	China[1]	HCWs	18–25 (15.8%) 26–30 (32.4%) 31–40 (32.3%) >40 (19.5%)	76.7	PHQ-9 (depression) ISI (Insomnia) GAD-7 (anxiety) IES-R (distress)	*Depression*: 50.4% *Anxiety*: 44.6% *Insomnia*: 34% *Stress*: 71.5%
Liu (Liu et al., 2020)	285	China[1]	GP	⩽35 (47.7%) >35 (52.3%)	45.6	PCL-5 (PTSD) PSQI (sleep)	*PTSD*: 7% *Sleep quality*: bad = 17.2%; very bad = 3.5%
Lu (Lu et al., 2020)	2,299	China[1]	HCWs		22.1	HAMA (anxiety) HAMD (depression) Numerical scale (fear)	*Fear (medics)*: none/mild = 29.4%; moderate = 43.9%; severe/extreme = 26.7% *Fear (admins)*: none/mild = 41.6%; moderate = 38.9%; severe/extreme = 19.5% *Anxiety (medics)*: mild-moderate = 22.6%; severe/extreme = 2.9% *Anxiety (admins)*: mild-moderate = 17.1%; severe/extreme = 1.6% *Depression (medics)*: mild-moderate = 11.8%; severe/extreme = 0.3%

(Continued)

Table 2. (Continued)

First author	Sample size	Country & quality	Population	Age (years)	Male gender (%)	Psychological outcome & measure used	Prevalence of psychological outcome (95% CI) if reported
							Depression (admins): mild-moderate = 8.2%; severe/extreme = 0% *Worry (medics)*: 26.2% *Worry (admins)*: 21.4%
Mo (Mo et al., 2020)	180	China[2]	HCWs	32.71 ± 6.52	10	SOS (stress) SAS (anxiety) Unknown sleep instrument	*Stress*: high = 22.22% *Sleep*: not good = 10%; bad = 4.44% *Anxiety*: not reported
Moghadasi* (Naser Moghadasi, 2020)	14	Iran[3]	HCWs	40.58 ± 4.44	50	BIA (anxiety)	*Anxiety*: mild = 14.3%; moderate = 0%; severe = 0%
Nguyen (Nguyen et al., 2020)	3,947	Vietnam[1]	CC	44.4 ± 17.0	44.3	PHQ-9 (depression)	*Depression*: 7.4%
Pulvirenti (Pulvirenti et al., 2020)	158	Italy[2]	GP	47.3 ± 13.8	50	GHQ-12 (anxiety & depression)	*Mixed (depression/anxiety)*: 42.3%
Qiu (Qiu et al., 2020)	52,730	China[2]	GP	Not reported	35.3	CPDI (distress, anxiety, depression)	*Distress*: mild = 29.29%; severe = 5.1%
Roy (Roy et al., 2020)	662	India[3]	GP	29.09 ± 8.83	48.6	Author-derived questions	*Worry*: 72% *Difficulty with sleep*: 12.5% *Fear*: 41%
Tan (Tan et al., 2020)	470	Singapore[1]	HCWs	31 (28–36)	31.7	DASS-21 (depression, anxiety & stress) IES-R (PTSD)	*Depression (medics)*: 8.1% *Anxiety (medics)*: 10.8% *Stress (medics)*: 6.4% *PTSD (medics)*: 5.7% *Depression (non-medics)*: 10.3% *Anxiety (non-medics)*: 20.7% *Stress (non-medics)*: 6.9% *PTSD (non-medics)*: 10.9%

(Continued)

Table 2. (Continued)

First author	Sample size	Country & quality	Population	Age (years)	Male gender (%)	Psychological outcome & measure used	Prevalence of psychological outcome (95% CI) if reported
Wang, C (Wang et al., 2020a)	1,210	China[1]	GP	12–21.4 (28.4%) 21.4–30.8 (53.1%) 30.8–40.2 (7.8%) 40.2–49.6 (7.4%) 49.6–59 (3.2%)	32.7	IES-R (psychological impact) DASS-21 (depression, anxiety & stress)	*Mixed*: minimal = 24.5%; mild = 21.7%; moderate-severe = 53.8% *Depression*: mild = 13.8%; moderate = 12.2%; severe/extremely severe = 4.3% *Anxiety*: mild = 7.5%; moderate = 20.4%; severe/extremely severe = 8.4% *Stress*: mild = 24.1%; moderate = 5.5%; severe/extremely severe = 2.6%
Wang, Y (Wang et al., 2020b)	600	China[1]	GP	34 ± 12	44.5	SAS (anxiety) SDS (depression)	*Anxiety*: mild = 5.67%; moderate = 0.67%; severe = 0% *Depression*: mild = 14.33%; moderate = 2.5%; severe = 0.33%
Wolf (Wolf et al., 2020)	630	USA[3]	GP	62.1 ± 11.3	40.3	Based on unspecified modified questionnaires	*Worry*: little = 23.4%; somewhat = 39.1%; very = 24.6%
Xiao* (Xiao et al., 2020)	180	China[2]	HCWs	Not reported	28.3	SAS (anxiety) SASR (stress reactivity) PSQI (sleep)	*Poor sleep quality*: 63.89% *Anxiety*: 58.889% *Stress*: not provided
Yuan (Yuan et al., 2020)	939	China[2]	GP & HCWs	18–24 (35.89%) 25–39 (35.57%) 40–59 (27.16%) ⩾60 (1.38%)	38	SRQ (stress) PSQI (sleep)	*Sleep quality*: became serious = 36.43%

(Continued)

Table 2. (Continued)

First author	Sample size	Country & quality	Population	Age (years)	Male gender (%)	Psychological outcome & measure used	Prevalence of psychological outcome (95% CI) if reported
Zhang, W (Zhang et al., 2020)	2,182	China[1]	HCWs	<18 (0.5%) 18–60 (96.3%) >60 (3.2%)	35.8	PHQ-4 (anxiety & depression) ISI (insomnia)	*Insomnia*: 33.9% *Anxiety*: 10.4% *Depression*: 10.6%
Zhang, Y (Zhang and Ma, 2020)	263	China[3]	GP	37.7 ± 14.0	40.3	IES (stress)	*Stress*: moderate-severe = 7.6%
Zhou (Zhou et al., 2020)	1,357	China[3]	HCWs	Not reported	46.65	Author-derived questions	*Fear*: 85%
Sheffield (The University of Sheffield, 2020)	2,000	UK	GP	⩾18	Not reported	GAD-7 (anxiety); PHQ-9 (depression); ITQ (PTSD)	*Depression*: 22% *Anxiety*: 22% *PTSD*: 17%
KCL (King's College London, 2020)	2,250	UK	GP	18–75	Not reported	Author-generated	*Anxiety/depression*: 50% *Poor sleep*: 38%

BAI: Becks Anxiety Inventory; CC: COVID Cases; CES-D: Center for Epidemiology Scale for Depression; CPDI: COVID-19 Peritraumatic Distress Index; DASS-21: Depression, Anxiety Stress Scale; GAD-7: Generalized Anxiety Disorder; GP: General Population; GHQ-12: General Health Questionnaire; HADS-A: Hospital Anxiety Depression Scale–Anxiety; HAMA: Hamilton Anxiety Scale; HAMD: Hamilton Depression Scale; HCW: Healthcare Workers; IES-R: Impact of Event Scale-Revised; ISI: Insomnia Severity Scale; ITQ: International Trauma Questionnaire; KCL: King's College London; PHQ-9: Patient Health Questionnaire; PTSD-SS: Post Traumatic Stress Disorder - Short Scale; PSQI: Pittsburgh Sleep Quality Index; SAS: Self-rating Anxiety Scale; SASR: Stanford Acute Stress Reaction; SDS: Self-rating Depression Scale; SOS: Stress Overload Scale; State-Trait Anxiety Inventory; SRQ: Stress Response Questionnaire; STAI = UK: United Kingdom; USA: United States of America; WHO-5: World Health Organization-Five Well-being Index. *article does not contain prevalence data but the information was provided by email communication. Quality assessment: [1]=good quality; [2]=fair quality; [3]=poor quality.

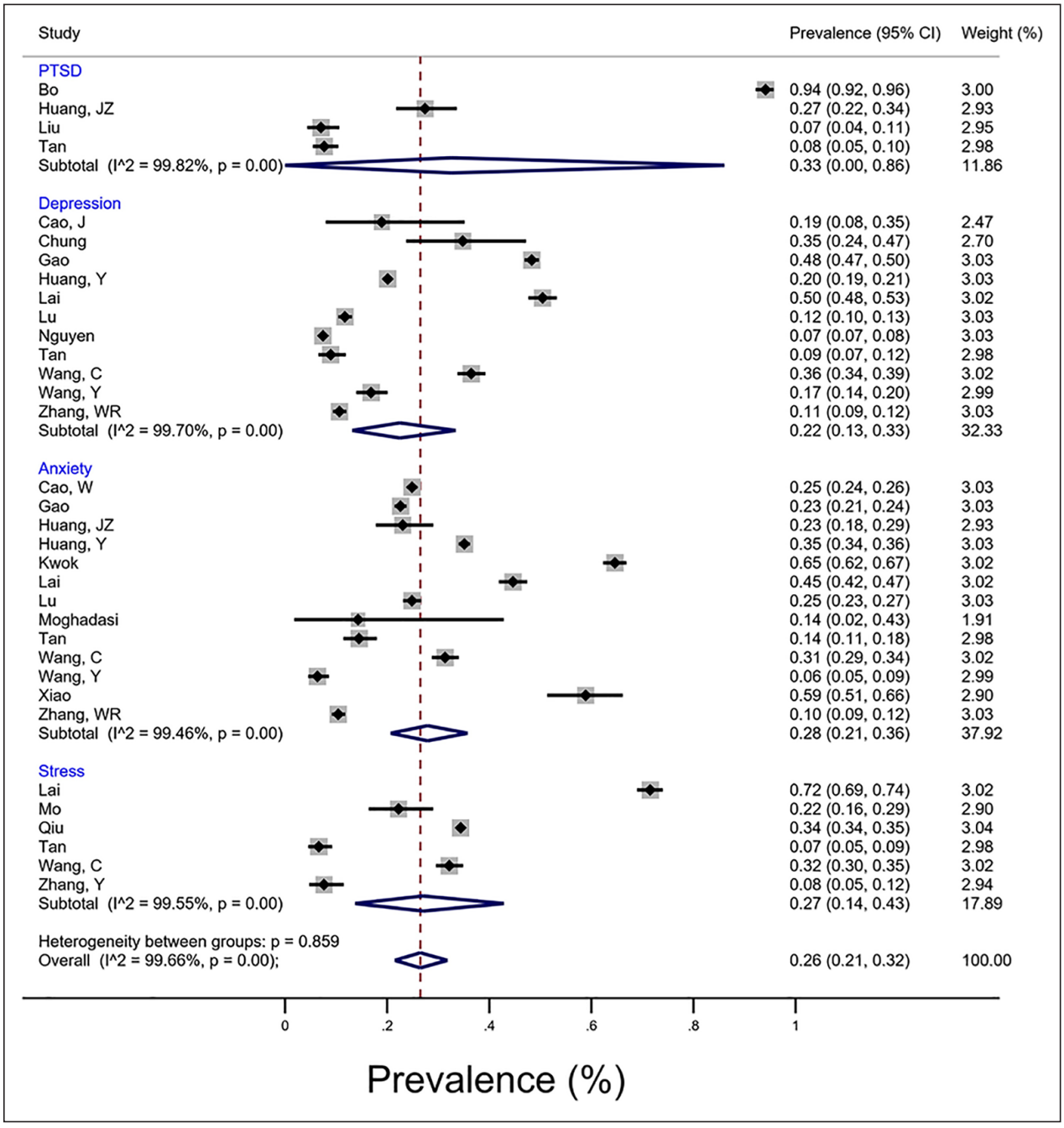

Figure 2. Forest plot for all included studies which reported on the prevalence of one or more primary psychological outcomes.

to a specific number of individuals, it is impossible to calculate the response rate when using snowball sampling methods. The majority of studies were cross-sectional ($n=29$), and one collected data across two time points, spaced 2 weeks apart (Yuan et al., 2020). The main limitation of cross-sectional studies is that causal associations cannot be assessed, although prevalence rates during COVID-19 can be compared to non-pandemic periods to draw conclusions. Most studies acquired data using validated tools to target specific outcomes of interest ($n=26$) but a small number ($n=4$) derived their own questions. The latter approach may have therefore compromised reliability of the findings and thus, weakened the quality of the study. Generally, the sample sizes were large and potentially adequate, although just

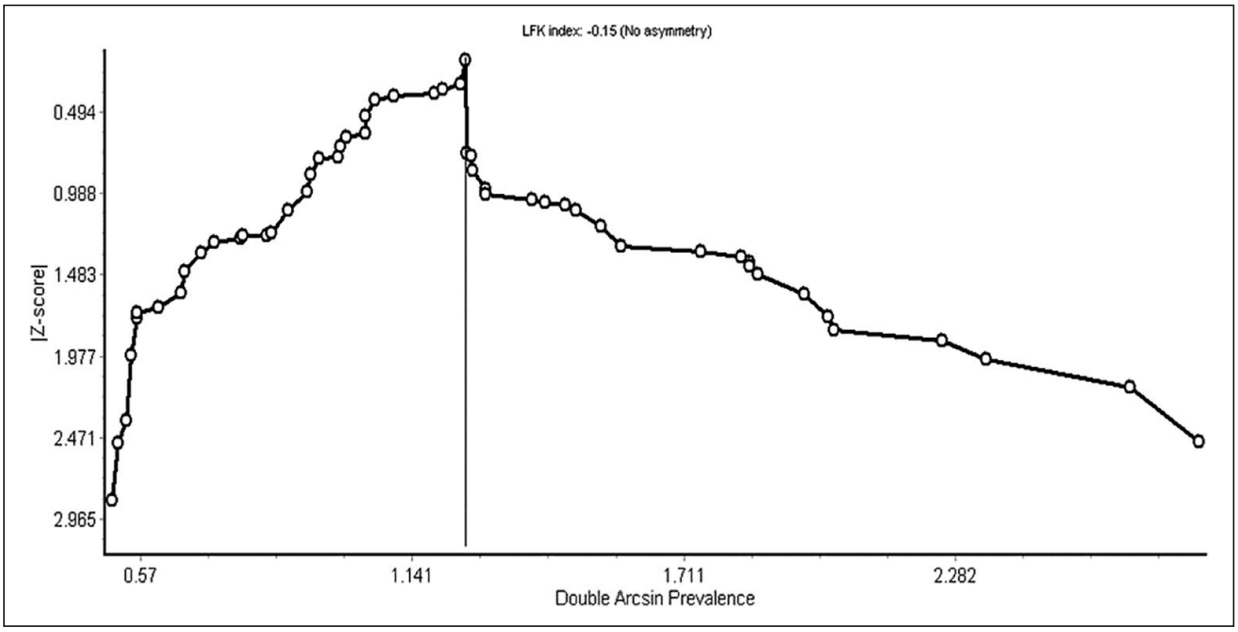

Figure 3. Doi plot analysis and LFK index of publication bias.

one reported a power calculation. A total of three studies obtained information from <100 individuals, thus representativeness and generalizability of these study findings are questionable. We also draw attention to the pooled prevalence for PTSD which should be interpreted with caution, given the wide confidence intervals. Reasons for this are due to large variability in effect sizes across the studies that measured and reported on this outcome where the range was 0.94–0.07. Moreover, only four studies were captured for this disorder from our systematic search. Thus, we recommend additional future research which focuses on this condition, particularly among HCWs and COVID-19 patients who are hospitalized, as these are the two groups are most likely to be affected by PTSD.

It is likely that the cause for the increase in prevalence of mental health related symptoms in the context of COVID-19 is multifactorial. Holmes and colleagues have provided a detailed insight into the many reasons, which could play a role in this context, ranging from fear of contracting the infection to the social and economic consequences of the pandemic (Holmes et al., 2020). Fear of contracting the infection, quarantine measures for infected individuals, and self-isolation/social distancing for the general population are however likely to have played a major role in the acute phase of the pandemic, which is the time of execution of most studies included in this meta-analysis. This is in agreement with the notion that quarantine measures can affect a third of the population under the condition of an epidemic (Brooks et al., 2020). Twenty of the studies included in this meta-analysis (71%, equivalent to 85,088 subjects), were conducted in China. We carried out a sub-analysis of the data from these 20 studies. Results suggest a pooled prevalence of all psychological outcomes of 27% (95% CI: 21–33). This prevalence figure is much higher than what reported by a recent epidemiological study conducted in China in 2019 prior to the pandemic. The work included 32,552 residents and found that the weighted prevalence of any psychological disorder (excluding dementia) was 9.3% (95% CI: 5.4–13.3) (Huang et al., 2019). Our prevalence figures are instead much closer to 22.9%, which is generated in the context of a psychiatric morbidity survey carried out 16 weeks post-SARS outbreak (Sim et al., 2010). However, a precise estimation of changes in prevalence attributable to COVID-19 is not possible with the cross-sectional studies included in this work. This evaluation

Table 3. Results of subgroup analyses and meta-regression analyses based on region, type of workers, population, timing of COVID and month of publication *Time from first case of COVID in the region to start of data collection.

	Subgroup analyses			Meta- regression	
	Number of estimates	Pooled estimate (95% CI)	I^2, (%)	Mean difference (95% CI)	*p*-value
All estimates	53	34 (29–40)	99.7		
Region					
China and south-east Asia	47	33 (28–39)	99.8	ref.	
Other	6	41 (20–64)	99.3	9 (–14 to 31)	0.435
Type of workers					
Medics	46	36 (30–42)	99.7	ref.	
Medics and non-medics	7	25 (12–41)	99.8	–10 (–30 to 9)	0.296
Population					
General population	22	33 (27–40)	99.8	ref.	
Healthcare workers	28	34 (24–44)	99.7	1 (–13 to 15)	0.870
Timing of COVID*					
1 month	9	27 (4–60)	99.9	ref.	
2 months	5	46 (23–70)	99.4	17 (–11 to 45)	0.234
3 months +	39	35 (29–40)	99.7	6 (–13 to 25)	0.513
Month of publication					
March	27	34 (27–41)	99.7	ref.	
April	26	35 (25–45)	99.8	1 (–13 to 15)	0.855
Quality of study					
Poor	10	46 (26–66)	99.5	ref.	
Fair	11	45 (26–64)	99.8	–4 (–25 to 18)	0.728
Good	32	27 (22–34)	99.7	–19 (–40 to –2)	0.036

would require longitudinal studies carried out before and after the pandemic.

The effect size of overall psychological issues between HCWs and the general population differed by just 1%, (34% vs 33%). The psychological outcomes across these two groups are likely to be driven by different factors. For example, frontline HCWs, most likely exposed every day to infected patients, might have been under considerable pressure to meet increased demands of healthcare systems during this unprecedented time. Indeed, some have suggested that this can leave HCWs prone to higher-than-normal levels of perceived stress, burnout, fear of being infected and of infecting their own family members, as well as of experiencing sleep and emotional disturbances (Kang et al., 2020). Moreover, medical staff treating seriously ill COVID-infected patients, could also be affected by the numerous patients' deaths. It is perhaps unsurprising that very high prevalence of depression (50.4%) and anxiety (64.6%) symptoms have been reported in HCWs (Kwok et al., 2020; Lai et al., 2020). On the other hand, data by Tan et al. (2020) indicate that medical staff have generally more capacity for resilience than non-medical staff. This is reflected in the reduced prevalence, by almost half in medical staff versus non-medical staff, of symptoms of anxiety (10.8% vs 20.7%, respectively) and PTSD (5.7% vs 10.9%) in some studies (Tan et al., 2020). It is clear that several factors could have affected the results in HCWs, including level of training, experience or even the timing of when respondents completed the survey in relation to the rise or fall of COVID-treated patients. Given that there were just two studies with COVID-19 confirmed/

suspected cases, and that these measured different outcomes (PTSD and depression), we did not conduct an overall pooled prevalence for this group.

Psychological issues among the general population are likely to be propelled by government-imposed restrictions. These include self-isolation, lockdown and social distancing, all of which limit social interaction with others. Social interaction and social support are known factors that influence both health behaviors and health outcomes, (Johnson and Acabchuk, 2018) thus the impact of social isolation upon psychological health outcomes are not unexpected. Moreover, tasks which were previously incorporated into daily lives such as shopping, sporting and social activities, are now limited and might affect psychological health in the general population. Such restrictions, paired with media and social media exposure, are likely to increase fear, worries and anxiety about becoming infected. This notion was reflected by the data presented by Kwok et al. (2020) who found that 97% of 1715 participants reported being worried about the virus. This is also consistent with Gao and colleagues who found that increased social media use was associated with a 91% increased risk of depression and anxiety and a 72% increased risk of anxiety alone, after adjustment for a range of demographics (Gao et al., 2020). Nevertheless, it is unclear whether those living alone during anti-pandemic measures experience higher rates of mental health difficulties and the extent to which perceived social support mitigates these outcomes. This is important as loneliness is known to affect both cardiovascular and mental health outcomes (Courtin and Knapp, 2017). The potential impact of the interaction between quarantine measures and a host of other factors as infection of a family member, financial difficulties, unemployment and relationship breakdown is also unknown. Research on these issues is critical as many of these are risk factors for the onset and maintenance of mental health issues (Holmes et al., 2020).

One strength of many of the studies included in this review is the use of measures with well-established indices of reliability and validity, which allows for direct comparison and the calculation of a cumulative effect size. For example, in relation to depression, several studies utilized the PHQ-9 which has been extensively validated in different populations and multiple languages. The PHQ-9 was the mostly commonly used instrument to detect the presence of depressive symptoms depression +/– severity (utilized in >50% of the studies). In relation to the assessment of anxiety, a similar pattern emerged with six of the 13 studies relying on the seven-item Generalized Anxiety Disorder Scale (GAD-7). The GAD-7 is one of the most frequently used self-report scales, and severity assessment tool for generalised anxiety symptoms. It has also been subject to repeated investigations of its psychometric properties across different contexts and in multiple languages. Although both instrument are not a substitute for a clinical assessment, they do benefit from established sensitivity and specificity which reduces the possibility of an inflationary effect compared to a formal assessment (Johnson et al., 2019). For example, in a large comparative study of clinical assessment versus the use of the GAD-7 in a sample of 956 patients, there was a convergence of scores in 89% of cases (Spitzer et al., 2006). Similar results have been reported in respect of the PHQ-9 for the assessment of depression (Levis et al., 2019). Other measures used (WHO-5, PCL-C, Self-Rating Depression Scale) also have established validity and reliability (Conybeare et al., 2012; Jokelainen et al., 2019; Topp et al., 2015). The widespread use in the studies included in this meta-analysis of well-established measures to assess symptoms of depression, anxiety and other disorders is reassuring.

Our work has several strengths. First, to our knowledge we are the first group to conduct a systematic review and meta-analysis to assess the full psychological impact of COVID-19. Second, we assessed the psychological impact across three different populations. Third, we examined a wide range of psychological outcomes including specific disorders as well as

other emotional reactions such as worry and fear surrounding the pandemic. There are also some important considerations and limitations. First, the time point at which respondents completed the surveys is likely to have influenced the overall findings. For example, online questionnaires completed before, during or after the first peak in the affected country, would have allowed to estimate changes in prevalence. We did, however, attempt to overcome this aspect within our meta-regression analyses. Second, the majority of studies (20/28) were conducted in China, thus the findings may not be generalizable to other countries. Third, the studies included had varied methodological differences (seven of the 28 were deemed poor quality), hence the pooled estimate should be interpreted with caution. Although most studies used validated instruments to assess the outcomes, there was still high heterogeneity between the studies. This could have been due to data collection methods or bias introduced by study methods. The impact of study quality on pooled prevalence was assessed by conducting a meta-regression comparing "low quality" studies with those rated as "fair or good" quality. We performed a sub-group analysis excluding the "low" quality studies as meta-regressions showed some evidence of higher prevalence reporting in "lower" quality studies compared to "fair or good" quality studies. Fourth, there may be potential overlaps in sampling groups. For example, studies that recruited the general population may have included a small proportion of HCWs. This is likely to bias the observations and potentially result in higher prevalence rates of psychological outcomes being reported. In our sample, only one study (Yuan et al., 2020) presented data which included medical workers drawn from the general population (26.5% of the overall sample) and results were not dichotomized. Hence, only general population data, including the majority of the sample were accounted for in the analyses. Finally, while we did not include articles written in all possible languages but captured the majority of the epicentres where COVID was highly prevalent. Moreover, we demonstrate in our PRISMA flow diagram that no full-text articles were excluded based on language.

This research explores mental health related issues in the context of COVID-19. We have demonstrated the presence of psychological effects associated with the pandemic and the measures taken to control the spread of the virus. The work highlights the importance of addressing mental health needs while fulfilling the physical health necessities of suspected cases.

Through the epidemic at least until the virus is under control, the provision of mental health services can include telephonic and on-line consultations aside clinical interactions to reach those quarantined or in self-isolation more effectively, while facilitating the engagement of individuals not able to undertake face-to-face consultations for a myriad of different reasons (Ju et al., 2020). Other valid tools to facilitate consultations related to mental health issues include online self-assessment resources to screen for psychopathology and help recognize patients most likely to require a more in-depth assessment. This approach can improve time management, rationalize resources and save costs. It is estimated that approximately 10,000 mental health "digital" apps are currently available (Marshall et al., 2019). These instruments can provide essential information, deliver simple interventions during the pandemic and personalize mental health care delivery during COVID-19 pandemic (Arnone, 2020; Wilkinson, 2020).

In the medium to long-term, although the psychological effects of COVID-19 are currently unknown, in view of the prevalence rates detected in this meta-analysis in the acute phase, it is advisable that healthcare systems are proportionally prepared to meet the possible rise in demand for mental health services. Based on our findings during the early stages of the pandemic, there is a clear need to identify the long-term psychological consequences to ensure that there is an adequate provision of services. Should there be sustained demand, it is fundamental that resources are in place to provide necessary support to HCWs, the

general population as well as to those directly affected by COVID-19. It is also important to ensure that frontline HCWs, whose psychological health may be directly and/or indirectly affected, are protected not just from the risk of contagion but also from psychological adversity and possible burnout.

Acknowledgements

We thank Mariam Al Ahbabi for her strategic support in retrieving the relevant literature. We are also grateful to Dr Marilia Raquel Bettencourt Silva Paulo and Ms. Mariana Wieske for their assistance in translating articles from Portuguese and German into English language which supported inclusion of additional articles during the screening process.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: DA has received travel grants from Jansen-Cilag and Servier and sponsorship from Lundbeck. The other authors report no conflict of interest.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Data sharing statement

All studies and data are accessible and publicly available.

ORCID iDs

Teresa Arora https://orcid.org/0000-0001-8360-7358
Danilo Arnone https://orcid.org/0000-0003-3831-2301

Supplemental material

Supplemental material for this article is available online.

References

Archard D and Caplan A (2020) Is it wrong to prioritise younger patients with covid-19? *BMJ* 369: m1509.

Arnone D (2020, in press) Mental health services in the wake of COVID-19 and opportunities for change. *British Journal of Psychiatry*.

Barendregt JJ, Doi SA, Lee YY, et al. (2013) Meta-analysis of prevalence. *Journal of Epidemiology and Community Health* 67: 974–978.

Bo HX, Li W, Yang Y, et al. (2020) Posttraumatic stress symptoms and attitude toward crisis mental health services among clinically stable patients with COVID-19 in China. *Psychological Medicine* 27: 1–2.

Borenstein M, Hedges LV, Higgins JP, et al. (2010) A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods* 1: 97–111.

Brooks SK, Webster RK, Smith LE, et al. (2020) The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The Lancet* 395: 912–920.

Cai H, Tu B, Ma J, et al. (2020) Psychological impact and coping strategies of frontline medical staff in Hunan between January and March 2020 during the outbreak of coronavirus disease 2019 (COVID-19) in Hubei, China. *Medical Science Monitor* 26: e924171.

Cao J, Wei J, Zhu H, et al. (2020a) A study of basic needs and psychological wellbeing of medical workers in the fever clinic of a Tertiary General Hospital in Beijing during the COVID-19 Outbreak. *Psychotherapy and Psychosomatics* 89: 252–254.

Cao W, Fang Z, Hou G, et al. (2020b) The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research* 287: 112934.

Chung JPY and Yeung WS (2020) Staff mental health self-assessment during the COVID-19 outbreak. *East Asian Archives of Psychiatry* 30: 34.

Conybeare D, Behar E, Solomon A, et al. (2012) The PTSD Checklist-civilian version: Reliability, validity, and factor structure in a nonclinical sample. *Journal of Clinical Psychology* 68: 699–713.

Courtin E and Knapp M (2017) Social isolation, loneliness and health in old age: A scoping review. *Health & Social Care in the Community* 25: 799–812.

Furuya-Kanamori L, Barendregt JJ and Doi SAR (2018) A new improved graphical and quantitative method for detecting bias in meta-analysis. *International Journal of Evidence-Based Healthcare* 16: 195–203.

Gao J, Zheng P, Jia Y, et al. (2020) Mental health problems and social media exposure during COVID-19 outbreak. *PLoS ONE* 15: e0231924.

Holmes EA, O'Connor RC, Perry VH, et al. (2020) Multidisciplinary research priorities for the COVID-19 pandemic: A call for action for mental health science. *The Lancet Psychiatry* 7: 547–560.

Holzer CEC 3rd (2013) Race, ethnicity, and the epidemiology of mental disorders in adults. In: Paniagua FA and Yamada A-M (eds) *Handbook of Multicultural Mental Health: Assessment and Treatment of Diverse Populations* (2nd ed.). Cambridge, Massachusetts, US: Academic Press, pp. 89–109.

Horton R (2020) Offline: COVID-19 and the NHS-"a national scandal". *The Lancet* 395: 1022.

Huang JZ, Han MF, Luo TD, et al. (2020) Mental health survey of 230 medical staff in a tertiary infectious disease hospital for COVID-19. *Zhonghua lao dong wei sheng zhi ye bing za zhi = Zhonghua laodong weisheng zhiyebing zazhi = Chinese Journal of Industrial Hygiene and Occupational Diseases* 38: 192–195.

Huang Y, Wang Y, Wang H, et al. (2019) Prevalence of mental disorders in China: A cross-sectional epidemiological study. *The Lancet Psychiatry* 6: 211–224.

Johnson BT and Acabchuk RL (2018) What are the keys to a longer, happier life? Answers from five decades of health psychology research. *Social Science & Medicine* 196: 218–226.

Johnson SU, Ulvenes PG, Oktedalen T, et al. (2019) Psychometric properties of the general anxiety disorder 7-item (GAD-7) scale in a heterogeneous psychiatric sample. *Frontiers in Psychology* 10: 1713.

Jokelainen J, Timonen M, Keinanen-Kiukaanniemi S, et al. (2019) Validation of the Zung self-rating depression scale (SDS) in older adults. *Scandinavian Journal of Primary Health Care* 37: 353–357.

Ju Y, Ng RMK, Zhang Y, et al. (2020) Mental health support in Wuhan in response to covid-19 pandemic. *The BMJ Opinion*. Available at: https://blogs.bmj.com/bmj/2020/04/28/mental-health-support-in-wuhan-in-response-to-covid-19-pandemic/

Kang L, Ma S, Chen M, et al. (2020) Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak: A cross-sectional study. *Brain, Behavior, and Immunity* 87: 11–17.

King's College London (2020) Life under lockdown: Coronavirus. Available at: https://www.kcl.ac.uk/policy-institute/assets/coronavirus-in-the-uk.pdf (Accessed 23 April 2020).

Kwok KO, Li KK, Chan HHH, et al. (2020) Community responses during early phase of COVID-19 epidemic, Hong Kong. *Emerging Infectious Diseases* 26(7): 1575–1579.

Lai J, Ma S, Wang Y, et al. (2020) Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Network Open* 3: e203976.

Lam SC, Arora T, Grey I, et al. (2020) Perceived risk and protection from infection and depressive symptoms among healthcare workers in Mainland China and Hong Kong during COVID-19. *Frontiers in Psychiatry* 11: 686.

Levis B, Benedetti A, Thombs BD, et al. (2019) Accuracy of Patient Health Questionnaire-9 (PHQ-9) for screening to detect major depression: Individual participant data meta-analysis. *BMJ* 365: l1476.

Liu N, Zhang F, Wei C, et al. (2020) Prevalence and predictors of PTSS during COVID-19 outbreak in China hardest-hit areas: Gender differences matter. *Psychiatry Research* 287: 112921.

Lu W, Wang H, Lin Y, et al. (2020) Psychological status of medical workforce during the COVID-19 pandemic: A cross-sectional study. *Psychiatry Research* 288: 112936.

Luo M, Guo L, Yu M, et al. (2020) The psychological and mental impact of coronavirus disease 2019 (COVID-19) on medical staff and general public – A systematic review and meta-analysis. *Psychiatry Research* 291: 113190.

Marks DF (2018) *A General Theory of Behaviour*. London: SAGE.

Marshall JM, Dunsan DA and Bartik W. (2019) The digital psychiatrist: In search of evidence-based apps for anxiety and depression. *Frontiers in Psychiatry* 10: 831.

Maslow AH (1943) The theory of human motivation. *Psychological Review* 50: 370–396.

Matias T, Dominski FH and Marks DF (2020) Human needs in COVID-19 isolation. *Journal of Health Psychology* 25: 871–882.

Melsen WG, Bootsma MC, Rovers MM, et al. (2014) The effects of clinical and statistical heterogeneity on the predictive values of results from meta-analyses. *Clinical Microbiology and Infection* 20: 123–129.

Mo Y, Deng L, Zhang L, et al. (2020) Work stress among Chinese nurses to support Wuhan for

fighting against the COVID-19 epidemic. *Journal of Nursing Management* 28: 1002–1009.

Moher D, Liberati A, Tetzlaff J, et al. (2009) Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine* 6: e1000097.

Naser Moghadasi A (2020) Evaluation of the level of anxiety among Iranian multiple sclerosis fellowships during the outbreak of COVID-19. *Archives of Iranian Medicine* 23: 283.

National Heart, Lung and Blood Institute (n.d.) Study quality assessment tools. Available at: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools (Accessed 5 April 2020).

Nguyen HC, Nguyen MH, Do BN, et al. (2020) People with suspected COVID-19 symptoms were more likely depressed and had lower health-related quality of life: The potential benefit of health literacy. *Journal of Clinical Medicine* 9: 965.

Nyaga VN, Arbyn M and Aerts M (2014) Metaprop: A Stata command to perform meta-analysis of binomial data. *Archives of Public Health* 72: 39.

Pappa S, Ntella V, Giannakas T, et al. (2020) Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. *Brain, Behavior, and Immunity* 88: 901–907.

Pulvirenti F, Cinetto F, Milito C, et al. (2020) Health-related quality of life in common variable immunodeficiency Italian patients switched to remote assistance during the COVID-19 pandemic. *The Journal of Allergy and Clinical Immunology. In Practice* 8: 1894–1899.

Qiu J, Shen B, Zhao M, et al. (2020) A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: Implications and policy recommendations. *General Psychiatry* 33: e100213.

Roy D, Tripathy S, Kar SK, et al. (2020) Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian Journal of Psychiatry* 51: 102083.

Sell TK, Boddie C, Mcginty EE, et al. (2017) Media messages and perception of risk for Ebola virus infection, United States. *Emerging Infectious Diseases* 23: 108–111.

Sim K, Huak Chan Y, Chong PN, et al. (2010) Psychosocial and coping responses within the community health care setting towards a national outbreak of an infectious disease. *Journal of Psychosomatic Research* 68: 195–202.

Spitzer RL, Kroenke K, Williams JB, et al. (2006) A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine* 166: 1092–1097.

Tan BYQ, Chew NWS, Lee GKH, et al. (2020) Psychological Impact of the COVID-19 pandemic on health care workers in Singapore. *Annals of Internal Medicine* 173(4): 317–320.

The University of Sheffield (2020) Depression and anxiety spiked after lockdown announcement, coronavirus mental health study shows. Available at: https://www.sheffield.ac.uk/news/nr/depression-anxiety-spiked-after-lockdown-announcement-coronavirus-mental-health-psychology-study-1.885549 (Accessed 23 April 2020).

Topp CW, Ostergaard SD, Sondergaard S, et al. (2015) The WHO-5 well-being index: A systematic review of the literature. *Psychotherapy and Psychosomatics* 84: 167–176.

Tsang HW, Scudds RJ and Chan EY (2004) Psychosocial impact of SARS. *Emerging Infectious Diseases* 10: 1326–1327.

Wang C, Pan R, Wan X, et al. (2020a) Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International Journal of Environmental Research and Public Health* 17: 1729.

Wang Y, Di Y, Ye J, et al. (2020b) Study on the public psychological states and its related factors during the outbreak of coronavirus disease 2019 (COVID-19) in some regions of China. *Psychology, Health & Medicine* 30: 1–10.

Wilkinson E (2020) How mental health services are adapting to provide care in the pandemic. *BMJ* 369: m2106.

Wolf MS, Serper M, Opsasnick L, et al. (2020) Awareness, attitudes, and actions related to COVID-19 among adults with chronic conditions at the onset of the U.S. outbreak: A cross-sectional survey. *Annals of Internal Medicine*. Epub ahead of print 9 April 2020.

Wu JT, Leung K and Leung GM (2020) Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: A modelling study. *The Lancet* 395: 689–697.

Xiao H, Zhang Y, Kong D, et al. (2020) The effects of social support on sleep quality of medical staff treating patients with coronavirus disease 2019 (COVID-19) in January and February 2020 in China. *Medical Science Monitor* 26: e923549.

Yip PS, Cheung YT, Chau PH, et al. (2010) The impact of epidemic outbreak: The case of severe acute respiratory syndrome (SARS) and suicide among older adults in Hong Kong. *Crisis* 31: 86–92.

Yuan S, Liao Z, Huang H, et al. (2020) Comparison of the indicators of psychological stress in the population of Hubei Province and non-endemic provinces in China during two weeks during the coronavirus disease 2019 (COVID-19) outbreak in February 2020. *Medical Science Monitor* 26: e923767.

Zhang WR, Wang K, Yin L, et al. (2020) Mental health and psychosocial problems of medical health workers during the COVID-19 epidemic in China. *Psychotherapy and Psychosomatics* 89: 242–250.

Zhang Y and Ma ZF (2020) Impact of the COVID-19 pandemic on mental health and quality of life among local residents in Liaoning Province, China: A cross-sectional study. *International Journal of Environmental Research and Public Health* 17: 2381.

Zhou M, Tang F, Wang Y, et al. (2020) Knowledge, attitude and practice regarding COVID-19 among health care workers in Henan, China. *The Journal of Hospital Infection* 105: 183–187.