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Prevalence of the most common psychological problems during coronavirus epidemics: A systematic review and meta-analysis

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Abstract

Introduction: There have been so far three noteworthy epidemics caused by coronaviruses: SARS, MERS, and COVID-19. We aimed to review prevalence of the most common psychological problems during these epidemics.

Material and methods: We conducted systematic reviews and meta-analyses of studies. A comprehensive search was performed in electronic databases PubMed/MEDLINE, Web of Science, PsycINFO/ProQuest, SCOPUS, and Google Scholar. Two independent reviewers searched for all English-language articles on psychological problems during coronavirus epidemics published by February 2021. We used DerSimonion-Laird random-effects model to estimate the prevalence of psychological problems. We conducted subgroup analyses to analyze the source of heterogeneity. Meta-regression model was also used.

Results: Eighty-eight eligible papers were included. The prevalence of the most common psychological problems was insomnia (27%), depression (24.8%), stress (22%), and anxiety (12.4%), respectively. Subgroup analysis indicated that healthcare workers were more likely to have the mentioned psychological problems compared to survivors and the general population. According to meta-regression analyses, study tools and study populations were identified as the most important sources of heterogeneity. Variability in study tools and study populations was attributed to a high level of heterogeneity.

Conclusions: This study suggested that people during coronavirus epidemics were exposed to insomnia, depression, stress, and anxiety far more than other psychological problems.

Keywords: Anxiety, Depression, Coronavirus, Stress, Insomnia

Streszczenie

Wstęp: Do tej pory miały miejsce trzy godne uwagi epidemie wywołane przez koronawirusy: zespół ostrej ostrej niewydolności oddechowej (SARS) począwszy od 2002 roku, bliskowschodni zespół oddechowy (MERS) od 2012 roku oraz COVID-19 od 2019 roku. Celem naszego badania była ocena częstości występowania najczęstszych problemów psychologicznych podczas epidemii SARS, MERS i COVID-19.

Materiał i metody: Przeprowadziliśmy przegląd systematyczny i metaanalizę dostępnych badań. Przeprowadzono kompleksowe wyszukiwanie w elektronicznych bazach danych PubMed/MEDLINE, Web of Science, PsycINFO/ProQuest, SCOPUS i Google Scholar. Dwóch niezależnych recenzentów przeszukało wszystkie anglojęzyczne artykuły na temat problemów psychologicznych podczas epidemii koronawirusa opublikowane do lutego 2021 r. Do oszacowania rozpowszechnienia problemów psychologicznych wykorzystaliśmy model efektów losowych DerSimoniona-Lairda. Przeprowadziliśmy analizy podgrup, aby przeanalizować źródło niejednorodności. Wykorzystano również model meta-regresji.

Dyskusja: Uwzględniono osiemdziesiąt osiem kwalifikujących się artykułów. Najczęściej występującymi problemami psychologicznymi była bezsenność (27%), depresja (24,8%), stres (22%) i lęk (12,4%). Analiza podgrup wykazała, że pracownicy służby zdrowia częściej mieli wymienione problemy psychologiczne w porównaniu z osobami, które przeżyły i ogółem populacji. Zgodnie z analizami metaregresji narzędzia badawcze i populacje badawcze zostały zidentyfikowane jako najważniejsze źródła heterogeniczności. Zróżnicowanie narzędzi badawczych i badanych populacji przypisano wysokiemu poziomowi heterogeniczności.

Wnioski: Badanie to sugeruje, że ludzie podczas epidemii koronawirusa byli bardziej narażeni na bezsenność, depresję, stres i

lęki niż inne problemy psychologiczne. Informacje te mogą być pomocne w kryzysie COVID-19 i prawdopodobnych przyszłych epidemiach.

Słowa kluczowe: Depresja, Stres, Lęk, Koronawirus, Bezsenność

1. Introduction

In December 2019, a highly infectious respiratory syndrome caused by a new coronavirus (COVID-19) appeared in Wuhan, China. On March 11, 2020, the COVID-19 has been declared a global epidemic [1]. Several epidemics emerged over the past two decades, including severe acute respiratory syndrome (SARS) starting in 2002, Middle East respiratory syndrome (MERS) starting in 2012, and COVID-19 starting in 2019. SARS caused 8422 global cases and 916 deaths by August 2003 [2]. MERS caused 2468 global cases and 851 deaths by September 2019 [3]. There have been nearly 137 million confirmed cases of COVID-19, including approximately 2.94 million deaths, reported to the World Health Organization by April 13, 2021 [3]. During these situations, mental health consequences need to be addressed as much as physical health consequences [4]. The coronavirus epidemics have exposed individuals to multiple psychological distress including: anxiety [5], depression [6], social isolation [7], sleep disorders [8], and other psychological problems (e.g., eating behavior problems and stress) [7].

Many research showed significantly high rates of generalized anxiety disorders (GAD) and anxiety symptoms in patients with coronavirus or persons without it [9]. In a study [10], anxiety symptoms and feelings of anger were present in 7.6% and 16.6% of people who were in contact with MERS patients. Some researchers noted that nearly 50% of recovered SARS patients continued to have anxiety [11, 12]. The onset of a sudden and life-threatening disease could lead to extraordinary amounts of pressure. According to a study [13], most clinically stable patients with COVID-19 suffered from posttraumatic stress symptoms prior to discharge. Researchers recognized 8.1% moderate to severe stress levels in a survey in China during the initial stage of the COVID-19 epidemic among the general population [14]. A cohort study concluded that posttraumatic stress disorder (PTSD) occurs in 44.1% of subjects with SARS [15].

In research in Canada during the SARS outbreak, PTSD and depression were observed in 28.9% and 31.2% of participants [6]. A survey conducted throughout 194 cities in China demonstrated 16.5% of moderate to severe depressive symptoms during the COVID-19 epidemic [14]. In two cross-sectional studies among Chinese citizens, the prevalence rates of depressive symptoms were 48.3% and 20.1%, respectively [9]. During the SARS outbreak, there was a 30% increase in suicide in those aged 65 years and older [11]. In a survey study among medical staff, 29% of medical staff experienced emotional distress [12]. Furthermore, evidence reported sleep problems in public during the COVID-19 epidemic [9]. Insomnia had a 49.4% prevalence among medical staff during the SARS epidemic [16].

In the COVID-19 situation, researchers could deploy the previous studies about the psychological impacts during the coronavirus epidemics. To date, there have been some systematic reviews and meta-analyses focused separately on psychological disorders during the epidemic, however, the results are unclear. For example, the prevalence rate of psychological disorders varies across population groups, countries, and periods. To our knowledge, there is still a lack of the overall estimation of the prevalence rate of psychological problems during the coronavirus epidemics. To fill this gap, we conducted a meta-analytic review to improve our understanding of the most common mental health-related problems to coronavirus epidemics and further explored variation in prevalence by country, population group, study tools, and study quality.

2. Method

2.1 Emotional and motivational self-regulation

The protocol for this systematic review and meta-analysis was registered on PROSPERO (CRD42020192708).

2.2. Search strategy

We conducted a systematic review using PubMed/MEDLINE, Web of Science, PsycINFO/ProQuest, SCOPUS, and Google Scholar for publications in English. The searches were concluded by February 2021. Two authors independently screened the titles and abstracts of all articles retrieved to find the most common psychological problems. Then, based on the specific psychological problems extracted at the first stage, we conducted a second search; we screened the titles and abstracts and reviewed the full text of articles meeting the inclusion criteria. The search terms at the first stage were: severe acute respiratory syndrome OR SARS Virus OR SARS-COV-2 OR Coronavirus OR Middle East respiratory syndrome Coronavirus OR MERS OR COVID-19 OR 2019-nCoV AND Mental health OR Mental Disorders OR psychology OR psychological. See the published protocol for details of search terms used for each database [17].

The search terms at the second stage of searching were: severe acute respiratory syndrome OR SARS Virus OR SARS-COV-2 OR Coronavirus OR Middle East respiratory syndrome Coronavirus OR MERS OR COVID-19 OR 2019-nCoV AND Anxiety OR Anxiety Disorders OR Depression OR Depressive Disorder OR Depressive Symptom OR Stress Disorders, Traumatic, Acute OR Stress Disorders, Traumatic OR Stress, Psychological OR Stress Disorders, Post-Traumatic OR Sleep Initiation and Maintenance Disorders OR Insomnia OR Sleep.

2.3 Inclusion/exclusion criteria

At the first stage, we considered all the original peer-reviewed researches and grey literature related to psychological problems during the coronavirus epidemics. But at the second stage, the following inclusion criteria were applied: 1) prevalence of the psychological problems retrieved at the previous stage (including anxiety, depression, stress, and insomnia) in study samples in coronavirus epidemics since 2002 being surveyed and reported; 2) just articles published in the English language.

The following studies were excluded from the meta-analysis. 1) commentary, editorial, case report, or review study; 2) not reporting prevalence data; 3) articles that could not be retrieved in full-text form through online databases, library requests, or email correspondence with the authors of the researches; 4) non-English language articles.

2.4. Data extraction

Two authors screened the title and abstracts independently, and then the full text of the studies was retrieved and independently assessed based on the inclusion and exclusion criteria. The two independent authors also applied a uniform data extraction form to record data including: first author, publication year, title, countries, epidemic, study participants, measurement tools, sample size, the prevalence of anxiety, depression, stress, and insomnia, and other subgroup data.

We divided the participants in the studies into four categories: general populations, healthcare workers (HCWs), patients, and survivors of coronavirus disease. General populations referred to community samples. Healthcare workers referred to individuals who provided medical services. Patients included those infected with the coronavirus disease. Survivors included individuals who had been infected with the coronavirus disease and then survived of the disease.

2.5. Quality assessment

The quality of each study was assessed by "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE), which evaluates studies for risk of bias based on the design, participants, sample size, measurement tools, data collection methods, confounders, and statistical analyses [18]. The quality scores were shown in Table 1. The risk of bias was classified as low (study reported sufficient data for quality assessment and fulfilled the criteria for the quality item), medium risk (study reported incomplete data for the quality item were reported or had an intermediate risk of bias), or high (study reported sufficient data for quality assessment but did not fulfill the criteria for the quality item). Two investigators independently assigned the scores, and inconsistencies were resolved by discussion or the third author.

2.6. Data Synthesis and Statistical Analyses

We used the DerSimonian-Laird random-effects model to pool the mean value of prevalence and presented the forest plots for each outcome. We assessed heterogeneity between the included studies through the I2 heterogeneity statistic. We also performed subgroup analysis stratified by population groups and study tools. Furthermore, we made meta-regression models by a maximum likelihood calculation approach to discover the most important moderators responsible for the variance between studies. To assess the risk of bias in the meta-analysis stage, we used the funnel plot and Egger's test. In case of detecting a publication bias, we used trim-and-fill analysis to adjust for potential results of unpublished studies and we estimated the adjusted prevalence rate based on trim–and-filled studies (stimulating missing studies). The analyses were performed using STATA Statistical Software: Release 14. College Station, TX: Stata Corp LP.

3. Results

3.1. Study selection

The screening process is shown in Fig. 1. Based on the search terms at the main (second) stage, we found a total of 1847 non-duplicate articles. Of these, some were excluded by screening titles and abstracts, leaving a total of 173 full texts to be assessed for eligibility. After the full-text screening, 88 articles met the inclusion criteria.

3.2. Study characteristics

Insomnia data were reported by 13 studies with 66,267 participants drawn from two major population groups: Healthcare workers and General samples. Depression data were reported by 64 studies with 685,491 participants drawn from four major population groups: Healthcare workers, General samples, Survivors, and Patients with coronavirus. Stress data were reported by 38 studies with 87,403 participants drawn from four major population groups: Healthcare workers, General samples, Survivors, and Patients with coronavirus. And anxiety data were reported by 67 studies with 747,084 participants drawn from four major population groups: Healthcare workers, General samples, Survivors, and

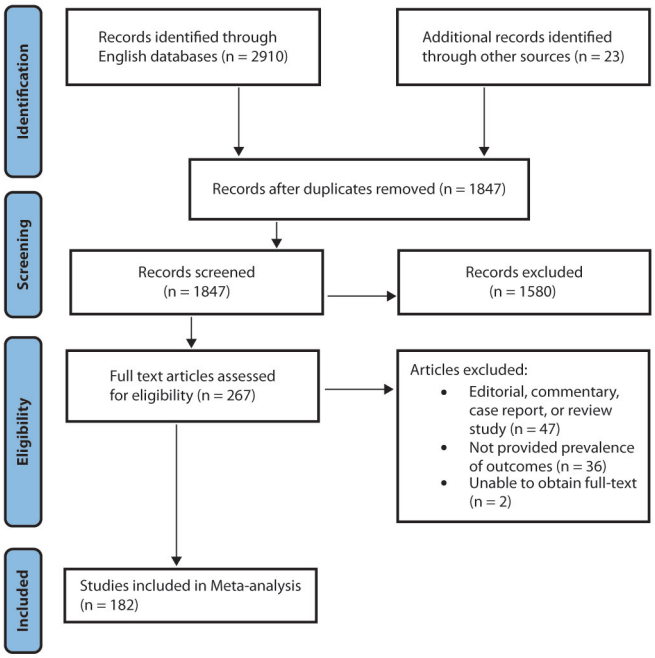

Fig. 1. PRISMA flowchart of study selection

Patients with coronavirus. Of the included studies, most were cross-sectional and online surveys. Dates of publication ranged from 2004 to 2020. The characteristics of the studies are shown in Table 1.

3.3 Prevalence of Insomnia

According to meta-analyses and using the DerSimonion-Laird random-effects model, the most common psychological problem during the coronavirus epidemics was insomnia with the pooled estimate prevalence of 27% (95% CI: 19% - 35%). According to meta-regression, sources of heterogeneity in insomnia studies were attributed to factors other than study tools, study population, and region of study. However, according to Fig 2-A, health care workers were more exposed to insomnia (prevalence = 31%; 95% CI: 16% – 47%) compared to general population (prevalence= 21%; 95% CI: 12% to 30%). The estimated pooled prevalence of insomnia sub-grouped by study tools. Based on Figure 2-B, no publication bias was detected in reporting insomnia during coronavirus epidemics (Egger's test P-value = 0.660).

Table 1. Characteristics of the included studies and the Quality score (STROBE score)

ID	First Author/ Year	Country	Epidemic	Participants	Age	Female	Sample size	Measure	Outcomes	Prevalence	Quality score
1	Alamri, H. S. 2020	Saudi Arabia	COVID-19	General	36.6±10.8	45.5%	1597	DASS-21	Depression	0.17	18
2	Alamri, H. S. 2020	Saudi Arabia	COVID-19	General	36.6±10.8	45.5%	1597	DASS-21	Anxiety	0.10	18
3	Alamri, H. S. 2020	Saudi Arabia	COVID-19	General	36.6±10.8	45.5%	1597	DASS-21	Stress	0.12	18
4	Alhalafi, A. H. 2020	Saudi Arabia	COVID-19	General	35.7±12.1	51%	651	PHQ-9	Depression	0.29	20
5	Alhalafi, A. H. 2020	Saudi Arabia	COVID-19	General	35.7±12.1	51%	651	GAD-7	Anxiety	0.26	20
6	Ali, M. 2020	Bangladesh	COVID-19	Healthcare workers	28.86±5.5	43.5%	294	ISI	Insomnia	0.44	20
7	Ali, M. 2020	Bangladesh	COVID-19	Healthcare workers	28.86± 5.5	43.5%	294	GAD-7	Anxiety	0.21	20
8	Ali, M. 2020	Bangladesh	COVID-19	Healthcare workers	28.86±5.5	43.5%	294	PHQ-9	Depression	0.27	20
9	AlNajjar, NS. 2017	Saudi Arabia	MERS	General	18-72	58.7%	358	VAS	Anxiety	0.58	18
10	Alsahafi, AJ. 2016	Saudi Arabia	MERS	Healthcare workers	-	42.5%	1216	SQ	Anxiety	0.61	16
11	Alshehri, F. 2020	Saudi Arabia	COVID-19	General	≥18	50.95%	1374	PCL	Stress	0.23	17
12	Al-Amer, R. 2020	Jordan	COVID-19	Healthcare workers	30.27±8.38	71.4%	405	DASS-21	Depression	0.58	18
13	Al-Amer, R. 2020	Jordan	COVID-19	Healthcare workers	30.27±1.69	71.4%	405	DASS-21	Anxiety	0.42	18
14	Al-Amer, R. 2020	Jordan	COVID-19	Healthcare workers	30.27±8.38	71.4%	405	DASS-21	Stress	0.50	18

15	Al-Musharaf, S. 2020	Saudi Arabia	COVID-19	General	22.0±1.9	100%	638	PHQ-9	Depression	0.43	21
16	Al-Musharaf, S. 2020	Saudi Arabia	COVID-19	General	22.0±1.9	100%	638	GAD-7	Anxiety	0.27	21
17	Al-Musharaf, S. 2020	Saudi Arabia	COVID-19	General	22.0±1.9	100%	638	PSS	Stress	0.13	21
18	AL Omari, O. 2020	Arab countries	COVID-19	General	21.01±1.69	71.5%	1057	DASS-21	Depression	0.57	19
19	AL Omari, O. 2020	Arab countries	COVID-19	General	21.01±1:69	71.5%	1057	DASS-21	Anxiety	0.41	19
20	AL Omari, O. 2020	Arab countries	COVID-19	General	21.01±1.69	71.5%	1057	DASS-21	Stress	0.38	19
21	Amerio, A. 2020	Italy	COVID-19	Healthcare workers	52.31±12.24	48.1%	131	PHQ-9	Depression	0.23	17
22	An, T. 2020	China	COVID-19	Healthcare workers	32.20±7.61	90.8%	1103	PHQ-9	Depression	0.44	18
23	Bai, Y. 2004	Taiwan	SARS	Healthcare workers	39.1±9.4	51%	338	SSQ	Stress	0.05	17
24	Bai, Y. 2004	Taiwan	SARS	Healthcare workers	39.1±9.4	51%	338	SQ	Stress	0.05	15
25	Chen, H. 2020	China	COVID-19	Healthcare workers	18-60	67.83%	171	PCL	Stress	0.21	16
26	Chen, Y. 2020	China	COVID-19	Healthcare workers	32.6±6.5	90.5%	105	SDS	Depression	0.30	16
27	Chen, Y. 2020	China	COVID-19	Healthcare workers	32.6±6.5	90.5%	105	SAS	Anxiety	0.18	16
28	Chi, X. 2020	China	COVID-19	General	20.6±1.90	63%	2038	PHQ-9	Depression	0.23	17
29	Chi, X., 2020	China	COVID-19	General	20.56±1.90	63%	2038	SAS	Anxiety	0.16	17
30	Chi, X. 2020	China	COVID-19	General	20.6±1.90	63%	2038	PCL	Stress	0.31	17
31	De Boni, R. B. 2020	Brazil & Spain	COVID-19	Healthcare workers	39.25±11.78	71.9%	3745	PHQ-2	Depression	0.08	18
32	De Boni, R. B. 2020	Brazil & Spain	COVID-19	Healthcare workers	39.25±11.7 8	71.9%	3745	GAD-7	Anxiety	0.12	18
33	Delgado-Gallegos, JL. 2020	Mexico	COVID-19	Healthcare workers	≥18	43%	104	CSS	Stress	0.08	16
34	De Lorenzo, R. 2020	Italy	COVID-19	Patients	57 (48-67)	33.5%	185	IES-R	Stress	0.22	20
35	De Lorenzo, R. 2020	Italy	COVID-19	patients	57(48-67)	33.5%	185	STAI	Anxiety	0.30	20
36	Demirjian, NL. 2020	US	COVID-19	Healthcare workers	45±11	47%	689	SQ	Anxiety	0.61	16
37	Du, J. 2020	China	COVID-19	Healthcare workers	36.92±9.83	72.3%	403	DASS-21	Depression	0.17	20
38	Du, J. 2020	China	COVID-19	General	36.92±9.83	72.3%	284	DASS-21	Depression	0.20	20
39	Du, J. 2020	China	COVID-19	Healthcare workers	36.92±9.83	72.3%	403	DASS-21	Anxiety	0.32	20

40	Du, J. 2020	China	COVID-19	General	36.92±9.83	72.3%	284	DASS-21	Anxiety	0.28	20
41	Du, J. 2020	China	COVID-19	Healthcare workers	36.92±9.83	72.3%	403	DASS-21	Stress	0.12	20
42	Du, J. 2020	China	COVID-19	General	36.92±9.83	72.3%	284	DASS-21	Stress	0.16	20
43	Estrich, CG. 2020	US	COVID-19	Healthcare workers	27-84	39%	2195	PHQ-4	Depression	0.09	17
44	Estrich, CG. 2020	US	COVID-19	Healthcare workers	27-84	39%	2195	PHQ-9	Anxiety	0.20	17
45	Ettman, CK. 2020	US	COVID-19	General	≥18	51.9%	1441	PHQ-9	Depression	0.08	19
46	Forte, G. 2020	Italy	COVID-19	General	29.61±11.42	74%	2286	COVID-19-PTSD	Stress	0.30	19
47	Gupta, AK. 2020	Nepal	COVID-19	Healthcare workers	29.5±6.1	52.7%	150	PHQ-9	Depression	0.01	17
48	Gupta, AK. 2020	Nepal	COVID-19	Healthcare workers	29.5±6.1	52.7%	150	GAD-7	Anxiety	0.28	15
49	Håkansson, A. 2020	Sweden	COVID-19	General	≥15	38%	327	PHQ-9	Depression	0.22	17
50	Håkansson, A. 2020	Sweden	COVID-19	General	≥15	38%	327	GAD-7	Anxiety	0.25	17
51	Hawryluck, L. 2004	Canada	COVID-19	General	≥18	-	129	IES-R	Stress	0.29	16
52	Hossain, M. 2020	China	COVID-19	General	26.3±7.2	30%	880	GAD-7	Anxiety	0.49	18
53	Huang, Y. 2020	China	COVID-19	General	28.39±10.5	69.3%	1172	ISI	Insomnia	0.25	18
54	Huang, Y. 2020	Bangladesh	COVID-19	General	28.39±10.5	69.3%	1172	GAD-7	Anxiety	0.33	18
55	Islam, M. 2020	Bangladesh	COVID-19	General	23.54±4.97	39.6%	1311	Panic Disorder Severity Scale	Anxiety	0.80	20
56	Islam, M. 2020	Korea	MERS	General	23.54±4.97	39.6%	1311	GAD-7	Anxiety	0.37	20
57	Jeong, H. 2016	Korea	MERS	General	43.9±19.2	57.0%	1656	GAD-7	Anxiety	0.08	18
58	Jeong, H. 2016	Korea	MERS	Patients with MERS	52.3±15.0	50.0%	36	GAD-7	Anxiety	0.47	18
59	Jeong, H. 2016	Korea	MERS	General (after 4 months)	43.9±19.2	57.0%	1656	GAD-7	Anxiety	0.03	18
60	Jeong, H. 2016	Nepal	COVID-19	Survivors (after 4 months)	52.3±15.0	50.0%	36	GAD-7	Anxiety	0.19	18
61	Khanal, P. 2020	Nepal	COVID-19	Healthcare workers	28.20±5.8	52.6%	475	ISI	Insomnia	0.34	18
62	Khanal, P. 2020	Nepal	COVID-19	Healthcare workers	28.20±5.80	52.6%	475	HADS	Anxiety	0.42	18
63	Khanal, P. 2020	China	COVID-19	Healthcare workers	28.20±5.80	52.6%	475	HADS	Depression	0.38	18
64	Lei, L. 2020	China	COVID-19	General	32.3±9.8	61.3%	1593	SDS	Depression	0.15	17
65	Lei, L. 2020	China	COVID-19	General	32.3±9.8	61.3%	1593	SAS	Anxiety	0.08	17

66	Li, Q. 2020	China	COVID-19	General	36.22±9.02	76.9%	88611	GAD-7	Anxiety	0.14	18
67	Li, X. 2020	China	COVID-19	Healthcare workers	21-60	72.0%	225	DASS-21	Depression	0.47	17
68	Li, X. 2020	China	COVID-19	Healthcare workers	21-60	72.0%	225	DASS-21	Anxiety	0.36	17
69	Li, X. 2020	China	COVID-19	Healthcare workers	21-60	72.0%	225	DASS-21	Stress	0.16	17
70	Li, X. 2020	China	COVID-19	Healthcare workers	21-60	72.0%	225	IES-R	Stress	0.32	17
71	Liu, CY. 2020	China	COVID-19	Healthcare workers	≥18	84.57%	512	SAS	Anxiety	0.13	17
72	Liu, D. 2020	China	COVID-19	Healthcare workers	35.77±8.1	81.2%	606	ISI	Insomnia	0.32	21
73	Liu, N. 2020	Taiwan	COVID-19	General	≥18	54.4%	285	PCL	Stress	0.07	18
74	Lu, WH. 2020	China	COVID-19	General	37.81±10.8	66.2%	1970	STAI	Anxiety	0.43	20
75	Ma, Y. F. 2020	Italy	COVID-19	Patients	50.43±13.12	51.9%	770	PHQ-9	Depression	0.43	19
76	Mazza, C. 2020	Italy	COVID-19	General	32.94±13.2	28.4%	2766	DASS-21	Depression	0.17	19
77	Mazza, C. 2020	Italy	COVID-19	General	32.94±13.2	28.4%	2766	DASS-21	Anxiety	0.07	19
78	Mazza, C. 2020	Canada	COVID-19	General	32.94±13.2	28.4%	2766	DASS-21	Stress	0.15	19
79	Mrklas, K. 2020	Canada	COVID-19	Healthcare workers	25-60	86.2%	8267	PHQ-9	Depression	0.44	18
80	Mrklas, K. 2020	Canada	COVID-19	Healthcare workers	25-60	86.2%	8267	GAD-7	Anxiety	0.47	19
81	Mrklas, K. 2020	Oman	COVID-19	Healthcare workers	25-60	86.2%	8267	PSS	Stress	0.86	18
82	Omari, A. O. 2020	Jordan	COVID-19	General	21.01±1.69	71.5%	155	DASS-21	Depression	0.11	19
83	Omari, A. O. 2020	Saudi Arabia	COVID-19	General	21.01±1.69	71.5%	332	DASS-21	Depression	0.07	19
84	Omari, A. O. 2020	Iraq	COVID-19	General	21.01±1.69	71.5%	121	DASS-21	Depression	0.08	19
85	Omari, A. O. 2020	United Arab Emirates	COVID-19	General	21.01±1.69	71.5%	117	DASS-21	Depression	0.12	19
86	Omari, A. O. 2020	Egypt	COVID-19	General	21.01±1.69	71.5%	147	DASS-21	Depression	0.13	19
87	Omari, A. O. 2020	Oman	COVID-19	General	21.01±1.69	71.5%	182	DASS-21	Depression	0.13	19
88	Omari, A. O. 2020	Taiwan	SARS	General	21.01±1.69	71.5%	155	DASS-21	Anxiety	0.07	19
89	Omari, A. O. 2020	Jordan	COVID-19	General	21.01±1.69	71.5%	332	DASS-21	Anxiety	0.03	19
90	Omari, A. O. 2020	Saudi Arabia	COVID-19	General	21.01±1.69	71.5%	121	DASS-21	Anxiety	0.04	19
91	Omari, A. O. 2020	Iraq	COVID-19	General	21.01±1.69	71.5%	117	DASS-21	Anxiety	0.08	19

92	Omari, A. O. 2020	United Arab Emirates	COVID-19	General	21.01±1.69	71.5%	147	DASS-21	Anxiety	0.08	19
93	Omari, A. O. 2020	Egypt	COVID-19	General	21.01±1.69	71.5%	182	DASS-21	Anxiety	0.09	19
94	Omari, A. O. 2020	Oman	COVID-19	General	21.01±1.69	71.5%	155	DASS-21	Stress	0.10	19
95	Omari, A. O. 2020	Jordan	COVID-19	General	21.01±1.69	71.5%	332	DASS-21	Stress	0.09	19
96	Omari, A. O. 2020	Saudi Arabia	COVID-19	General	21.01±1.69	71.5%	121	DASS-21	Stress	0.08	19
97	Omari, A. O. 2020	Iraq	COVID-19	General	21.01±1.69	71.5%	117	DASS-21	Stress	0.14	19
98	Omari, A. O. 2020	United Arab Emirates	COVID-19	General	21.01±1.69	71.5%	147	DASS-21	Stress	0.11	19
99	Omari, A. O. 2020	Egypt	COVID-19	General	21.01±1.69	71.5%	182	DASS-21	Stress	0.08	19
100	Pan, X. 2020	China	COVID-19	Healthcare workers	30-50	81.4%	194	PHQ-9	Depression	0.38	17
101	Pan, X. 2020	China	COVID-19	Healthcare workers	30-50	81.4%	194	GAD-7	Anxiety	0.33	17
102	Pan, Y. 2020	China	COVID-19	General	≥18	46.9%	3035	PHQ-9	Depression	0.06	18
103	Peng, S. 2020	China	COVID-19	General	27.5±11.4	66.5%	3399	CES-D	Depression	0.14	18
104	Rapisarda, F. 2020	Italy	COVID-19	General	44.2±12.3	76.8%	241	PHQ-9	Depression	0.07	18
105	Rapisarda, F. 2020	Italy	COVID-19	General	44.2±12.3	76.8%	241	GAD-7	Anxiety	0.12	18
106	Ren, Z. 2020	China	COVID-19	General	16-50	66.9%	6130	PHQ-9	Depression	0.12	17
107	Ren, Z. 2020	China	COVID-19	General	16-50	66.9%	6130	GAD-7	Anxiety	0.07	17
108	Riello, M. 2020	Italy	COVID-19	Healthcare workers	≥18	85.5%	1071	GAD-7	Anxiety	0.43	17
109	Şahin, M. K. 2020	Turkey	COVID-19	Healthcare workers	≥18	66.0%	939	ISI	Insomnia	0.02	19
110	Şahin, M. K. 2020	Turkey	COVID-19	Healthcare workers	≥18	66.0%	939	GAD-7	Anxiety	0.08	19
111	Şahin, M. 2020	Turkey	COVID-19	Healthcare workers	≥18	66.0%	939	PHQ-9	Depression	0.16	19
112	Shi, L. 2020	China	COVID-19	General	35.97±8.22	52.1%	56679	ISI	Insomnia	0.29	21
113	Shi, L. 2020	China	COVID-19	General	35.97±8.22	52.1%	56679	GAD-7	Anxiety	0.32	21
114	Shi, L. 2020	China	COVID-19	General	35.97±8.22	52.1%	56679	PHQ-9	Depression	0.28	21
115	Shi, L. 2020	China	COVID-19	General	35.97±8.22	52.1%	56679	ASDS	Stress	0.24	21
116	Shrestha, SL. 2020	Nepal	COVID-19	Healthcare workers	-	57.4%	101	GAD-7	Anxiety	0.73	16
117	Singh, S. P. 2020	India	COVID-19	General	28.59±10.47	59.4%	234	PHQ-9	Depression	0.14	18
118	Singh, S. P. 2020	India	COVID-19	General	28.59±10.47	59.4%	234	IES-R	Stress	0.28	18
119	Solomou, I. 2020	Cyprus	COVID-19	General	≥18	71.6%	1642	PHQ-9	Depression	0.09	17

120	Solomou, I. 2020	Cyprus	COVID-19	General	≥18	71.6%	1642	GAD-7	Anxiety	0.23	17
121	Son, C. 2020	US	COVID-19	General	20.7±1.7	57%	195	PSS	Stress	0.71	17
122	Su, T. 2007	Taiwan	SARS	Healthcare workers-ICU	31.5±6.2	100%	26	PSQI	Insomnia	0.27	20
123	Su, T. 2007	Taiwan	SARS	Healthcare workers	29.8±7.6	100%	44	PSQI	Insomnia	0.43	20
124	Su, T. 2007	Taiwan	SARS	Healthcare workers-ICU	31.5±6.2	100%	26	BDI	Depression	0.39	20
125	Su, T. 2007	Taiwan	SARS	Healthcare workers	29.8±7.6	100%	44	BDI	Depression	0.39	20
126	Sugaya, N. 2020	Japan	COVID-19	General	46.3 ± 14.6	52.4%	11333	PHQ-9	Depression	0.18	19
127	Tam, CWC. 2004	Hong Kong	SARS	Healthcare workers	34.1±8.3	79%	652	SQ	Stress	0.68	16
128	Tang, W. 2020	China	COVID-19	General	19.81 ± 1.55	61.36%	2485	PHQ-9	Depression	0.09	18
129	Tang, W. 2020	China	COVID-19	General	19.81±1.55	61.4%	2485	PCL	Stress	0.03	18
130	Twenge, JM. 2020	US	COVID-19	General	-	-	336525	PHQ-2	Depression	0.25	16
131	Twenge, JM. 2020	US	COVID-19	General	-	-	336525	GAD-2	Anxiety	0.29	16
132	Wang, X. 2020	US	COVID-19	General	22.88 ± 5.52	61.64%	2031	PHQ-9	Depression	0.48	19
133	Wang, X. 2020	US	COVID-19	General	22.88 ± 5.5 2	61.64 %	2031	GAD-7	Anxiety	0.38	19
134	Wang, Z. 2020	China	COVID-19	General	21.0 ± 2.4	54.5%	44447	CES-D	Depression	0.12	18
135	Wang, Z. 2020	China	COVID-19	General	21.0 ± 2.4	54.5%	44447	SAS	Anxiety	0.08	18
136	Wu, M. 2020	China	COVID-19	General	20-60	46.3%	24789	HADS	Depression	0.48	20
137	Wu, M. 2020	China	COVID-19	General	20-60	46.3%	24789	HADS	Anxiety	0.52	20
138	Xiao, X. 2020	China	COVID-19	Healthcare workers	-	67.2%	958	HADS	Depression	0.58	17
139	Xiao, X. 2020	China	COVID-19	Healthcare workers	-	67.2%	958	HADS	Anxiety	0.54	17
140	Xiao, X. 2020	China	COVID-19	Healthcare workers	-	67.2%	958	PSS	Stress	0.55	17
141	Yamamoto, T. 2020	Japan	COVID-19	General	46.3 ± 14.6	52.4%	11333	PHQ-9	Depression	0.18	18
142	Yang, Y. 2020	China	COVID-19	General	36.3±9.1	49.2%	2410	PSQI	Insomnia	0.15	18
143	Yu, B. Y. 2020	China	COVID-19	General	≥18	65.6%	1138	ISI	Insomnia	0.30	17
144	Yuan, L. 2020	China	COVID-19	General	36.20±9.32	15.8%	3517	PHQ-9	Depression	0.12	18
145	Yuan, L. 2020	China	COVID-19	General	36.20±9.32	15.8%	3517	GAD-7	Anxiety	0.09	18

146	Zhang, C. 2020	China	COVID-19	Healthcare workers	≥18	82.7%	1563	ISI	Insomnia	0.36	18
147	Zhang, H. 2020	China	COVID-19	Healthcare workers	30-40	85.05%	642	PCL	Stress	0.21	18
148	Zhang, W. 2020	China	COVID-19	General	≥18	62.74	1342	PHQ-9	Depression	0.14	18
149	Zhang, X. 2020	China	COVID-19	General	30.3±6.4	29.4%	123768	SDS	Depression	0.23	19
150	Zhang, X. 2020	China	COVID-19	General	30.3±6.4	29.4%	123768	SAS	Anxiety	0.03	19
151	Zheng, R. 2020	China	COVID-19	Healthcare workers	29-50	96.7%	3228	SDS	Depression	0.34	19
152	Zheng, R. 2020	China	COVID-19	Healthcare workers-COVID	29-50	96.7%	285	SDS	Depression	0.47	19
153	Zheng, R. 2020	China	COVID-19	Healthcare workers	29-50	96.7%	3228	SAS	Anxiety	0.18	19
154	Zheng, R. 2020	China	COVID-19	Healthcare workers-COVID	29-50	96.7%	285	SAS	Anxiety	0.28	19
155	Zheng, R. 2020	China	COVID-19	Healthcare workers	≤40,>40	99.5%	617	DASS-21	Depression	0.15	17
156	Zheng, R. 2020	China	COVID-19	Healthcare workers	≤40,>40	99.5%	617	DASS-21	Anxiety	0.33	17
157	Zheng, R. 2020	China	COVID-19	Healthcare workers	≤40,>40	99.5%	617	DASS-21	Stress	0.18	17
158	Zhou, J. 2020	China	COVID-19	General	11-18	100%	4805	CES-D	Depression	0.40	17
159	Zhu, S. 2020	China	COVID-19	Survivors	≤50-≥60	-	432	SAS	Anxiety	0.29	19
160	Zhou, S. J. 2020	China	COVID-19	General	12-18	53.5%	8079	PHQ-9	Depression	0.44	18
161	Zhou, S. J. 2020	China	COVID-19	General	12-18	53.5%	8079	GAD-7	Anxiety	0.37	19
162	Zhou, Y. 2020	China	COVID-19	General	35.4±5.7	100%	315	ISI	Insomnia	0.05	18
163	Zhou, Y. 2020	China	COVID-19	General	35.4±5.7	100%	315	GAD-7	Anxiety	0.18	18
164	Zhou, Y. 2020	China	COVID-19	General	35.4±5.7	100%	315	PHQ-9	Depression	0.18	18
165	Zhou, Y. 2020	China	COVID-19	General	35.4±5.7	100%	315	PCL	Stress	0.06	18
166	Zhou, Y. 2020	China	COVID-19	Healthcare workers	35.77±8.13	81.2%	606	ISI	Insomnia	0.32	19
167	Zhou, Y. 2020	China	COVID-19	Healthcare workers	35.77±8.13	81.2%	606	GAD-7	Anxiety	0.45	19
168	Zhou, Y. 2020	China	COVID-19	Healthcare workers	35.77±8.13	81.2%	606	PHQ-9	Depression	0.58	19
169	Zhu, J. 2020	China	COVID-19	Healthcare workers-doctors	34.16±8.06	83%	79	SDS	Depression	0.46	19

170	Zhu, J. 2020	China	COVID-19	Healthcare workers-nurses	34.16±8.06	83%	86	SDS	Depression	0.43	19
171	Zhu, J. 2020	China	COVID-19	Healthcare workers-doctors	34.16±8.06	83%	79	SAS	Anxiety	0.11	19
172	Zhu, J. 2020	China	COVID-19	Healthcare workers-nurses	34.16±8.06	83%	86	SAS	Anxiety	0.28	19
173	Hawryluck, L. 2020	Canada	COVID-19	General	≥18		129	CES-D	Depression	0.31	17
174	Wu, K. K. 2005	China	SARS	Survivors (after 1 month)	41.82±14.01	56%	131	HADS	Depression	0.18	19
175	Wu, K. K. 2005	China	SARS	Survivors (after 3 months)	41.82±14.01	56%	131	HADS	Depression	0.13	19
176	Wu, K. K. 2005	China	SARS	Survivors (after 1 month)	41.82±14.0 1	56%	131	HADS	Anxiety	0.13	19
177	Wu, K. K. 2005	China	SARS	Survivors (after 3 months)	41.82±14.0 1	56%	131	HADS	Anxiety	0.14	19
178	Wu, K. K. 2005	China	SARS	Survivors (after 1 month)	41.82±14.01	56%	131	IES-R	Stress	0.04	19
179	Wu, K. K. 2005	China	SARS	Survivors (after 3 months)	41.82±14.01	56%	131	IES-R	Stress	0.05	19
180	Wu, K. K. 2005	Hong Kong	SARS	Survivors	18-88	56.92%	195	HADS	Depression	0.18	17
181	Wu, K. K. 2005	Hong Kong	SARS	Survivors	41.52±13.9 8	56.92%	195	HADS	Anxiety	0.14	18
182	Wu, K. K. 2005	Hong Kong	SARS	Survivors	41.52±13.98	56.92%	195	IES-R	Stress	0.06	18

Notes. *Insomnia Severity Index (ISI); Pittsburgh Sleep Quality Index (PSQI); Depression Anxiety Stress Scale- 21 items (DASS-21); Patient Health Questionnaire (PHQ-9); Self-Rating Depression Scale (SDS); Hospital Anxiety and Depression Scale (HADS); Patients with COVID-19; Center for Epidemiologic Studies-Depression scale (CES-D); Beck Depression Inventory (BDI); Perceived Stress Scale (PSS); PTSD Checklist in the DSM (PCL); Impact of Events Scale-Revised (IES-R); COVID-19 stress scales (CSS); SARS-related stress reactions questionnaire (SSQ); Acute Stress Disorder Scale (ASDS); Generalized Anxiety Disorder (GAD-7); Self-Rating Anxiety Scale (SAS); State-Trait Anxiety Inventory (STAI); Visual Analogue Scale (VAS); Self-administered questionnaire (SQ).*

3.4. Prevalence of depression

Meta-analyses using the DerSimonion-Laird random effect model revealed that pooled prevalence estimation of depression during the coronavirus epidemics was 24.8% (95% CI: 22% to 27%). Pooled prevalence estimation of depression sub-grouped by study population and different study tools are presented in Fig 3-A. The study population (p = 0.003), study tools (p = 0.068), and region of the study (p = 0.085) were responsible for 16.55% of the heterogeneity (Adjusted R squared "Adj R-squared" = 16.55%). Meta-regression in the correlation between different populations study (as the most important source of heterogeneity; Adj R-squared = 10.23%) and prevalence of depression was done. Meta-regression in the correlation of different study regions (Adj R-squared = 3.35%) and prevalence of depression was also done. Egger test for small-study effects shows no publication bias in reporting the depression during coronavirus epidemics (p=0.779) (Fig 3-B).

3.5 Prevalence of stress

Meta-analyses using the DerSimonion-Laird random effect model showed that pooled prevalence estimation of stress during the coronavirus epidemics was 22% (95% CI: 13% to 31%). Pooled estimate prevalence of stress sub-grouped by study population and study tools are presented in Fig 4A. According to meta-regression analyses, study tools (p = 0.09) and study population (p = 0.05) were identified as the most important sources

of heterogeneity and were responsible for 14.3% of prevalence variation between studies (Adj R-squared = 14.37%). Meta-regression in the correlation between different populations study (as the most important source of heterogeneity; Adj R-squared = 9.58%) and prevalence of stress was done. Meta-regression in the correlation between different populations study (Adj R-squared = 6.93%) and prevalence of stress was done. According to Fig 4B, a null hypothesis for no small-study effects was accepted by the p = 0.62 in Egger's test, indicating no

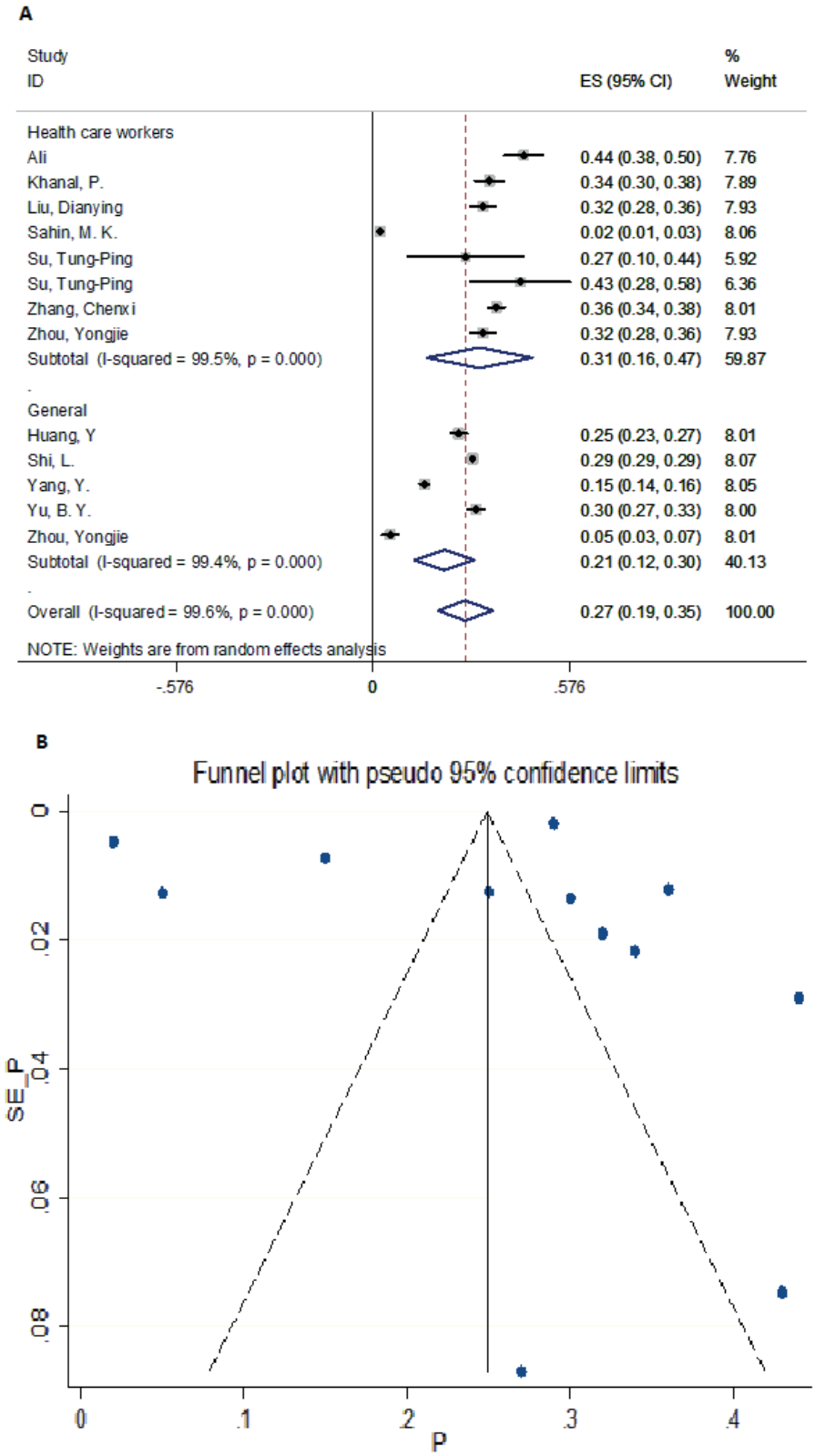

Fig 2. A: Forest plot; pooled estimate prevalence of insomnia during coronavirus epidemics sub-grouped by the study population. B: Funnel plot; no publication bias observed in studies (Egger's test p-value = 0.660)

publication bias in reporting the stress prevalence during coronavirus epidemics.

3.6 Prevalence of anxiety

According to meta-analyses using random-effect model pooled, prevalence estimation of anxiety during the coronavirus epidemics was 26.7% (95% CI: 23% to 30%). Meta-regression analyses revealed that the study population was responsible for 5.18% of heterogeneity. According to Fig 5A, subgroup analyses revealed healthcare workers were more exposed to anxiety p = 34% (95% CI: 26 – 41%) than general population p = 23 % (95% CI = 18% to 28 %) and survivors p = 22 % (95% CI = 15% to 30%). Egger test for small-study effects shows publication bias in reporting the anxiety during coronaviruses (p=0.024). Funnel plot for publication bias in reporting anxiety studies is shown in Fig 5B. Small sample studies or non-significant studies usually have less chance to be published and they may exclude from the meta-analyses. Hence, we performed trim and fill analyses to compensate for this publication bias. After trim and fill procedure (and stimulating four missing studies) using random-effect model, the pooled prevalence rate of 12.4% was estimated for anxiety during coronavirus epidemics. According to meta-regression analyses 22.78% of heterogeneity in studies was explained by study tool (p < 0.001) and study population (p = 0.012). Pooled estimate prevalence of anxiety during coronavirus epidemics was sub-grouped by study tools. The study tool was the most important source of heterogeneity in reporting anxiety (Adj R-squared = 15.39%).

4. Discussion

This systematic meta-analysis of 88 studies involving 1,586,245 participants was conducted to analyze the prevalence of the most common psychological problems during the coronavirus epidemics in different populations. Insomnia, depression, stress, and anxiety were the most common problems in the different populations. The overall pooled prevalence of insomnia, depression, and stress were 27% (95% CI: 19% - 35%), 24.8% (95% CI: 22% to 27%), and 22% (95% CI: 13% to 31%), respectively. The pooled estimate prevalence of anxiety was 26.7% (95% CI: 23% to 30%), however, Egger test for small-study effects shows publication bias in reporting the anxiety during coronavirus epidemics (p=0.024). After trim and fill procedure (and stimulating four missing studies) using random-effect model, the pooled prevalence rate of 12.4% was estimated for anxiety. Subgroup comparisons showed that healthcare workers had the highest prevalence of insomnia, depression, stress, and anxiety.

During the coronavirus epidemics, especially the COVID-19 epidemic, higher than previous levels of insomnia, depression, stress, and anxiety were reported in the different countries [19-21]. That is: all of the rates were much lower than those of all of the populations included in our analysis during the epidemics. For instance, a previous study found 6.6% major depression in the general population of the US [19]. Moreover, before the COVID-19 epidemic, the prevalence of insomnia in the general population of Turkey was 12.2% [20], and a meta-analysis reported a prevalence of insomnia among the general population of China of 15.0% [21]: that were much lower than the prevalence rate in our study. A research in the US reported a prevalence of 27.3% insomnia among the adult population [22], however, this did not exceed the prevalence of 31% for the healthcare workers in our study. Consequently, a higher prevalence of psychological problems has resulted from the COVID-19 epidemic, as seen previously after other coronavirus epidemics. All major emergencies, not just the COVID- 19 crisis, create mental health problems [23]. Studies of previous epidemics showed that nearly 35% of SARS survivors in Hong Kong, and 31.2% of persons quarantined due to SARS in Toronto reported anxiety and/or depression [6, 24]. During the spread of COVID-19 and even after that, more attention should be paid to its potentially detrimental impacts on the mental health of the different populations [25].

Our results suggest that the healthcare workers had the highest prevalence of insomnia, depression, stress, and anxiety. The medical staff experienced the fear of new infectious diseases and close contact with infected/uninfected patients and had to work under excessive pressure to diagnose, treat, and care for the patients. Therefore, such conditions would put them at high risk of developing psychological problems [26, 27]. Psychological interventions should be implemented to protect the mental well-being of all populations, particularly healthcare workers, during the COVID-19 epidemic and even after that [23].

The estimated prevalence of the psychological problems in the current study was comparable to other systematic reviews that reported the prevalence of insomnia, depression, stress, and anxiety during the coronavirus epidemics. For example, healthcare workers also showed a significantly high prevalence of the mentioned psychological problems [23]. It is worth mentioning that there was a lack of enough evidence related to the prevalence rate of psychological problems after the epidemics. The presence of mental problems could be delayed relative to the occurrence of a traumatic event [28]. Meanwhile, mental problems could exist for a long time after the trauma [29, 30]. To more precisely determine the longitudinal trajectory of psychological problems related to the COVID-19 epidemic, future studies should conduct follow-up studies and also examine the protective and risk factors towards the psychological

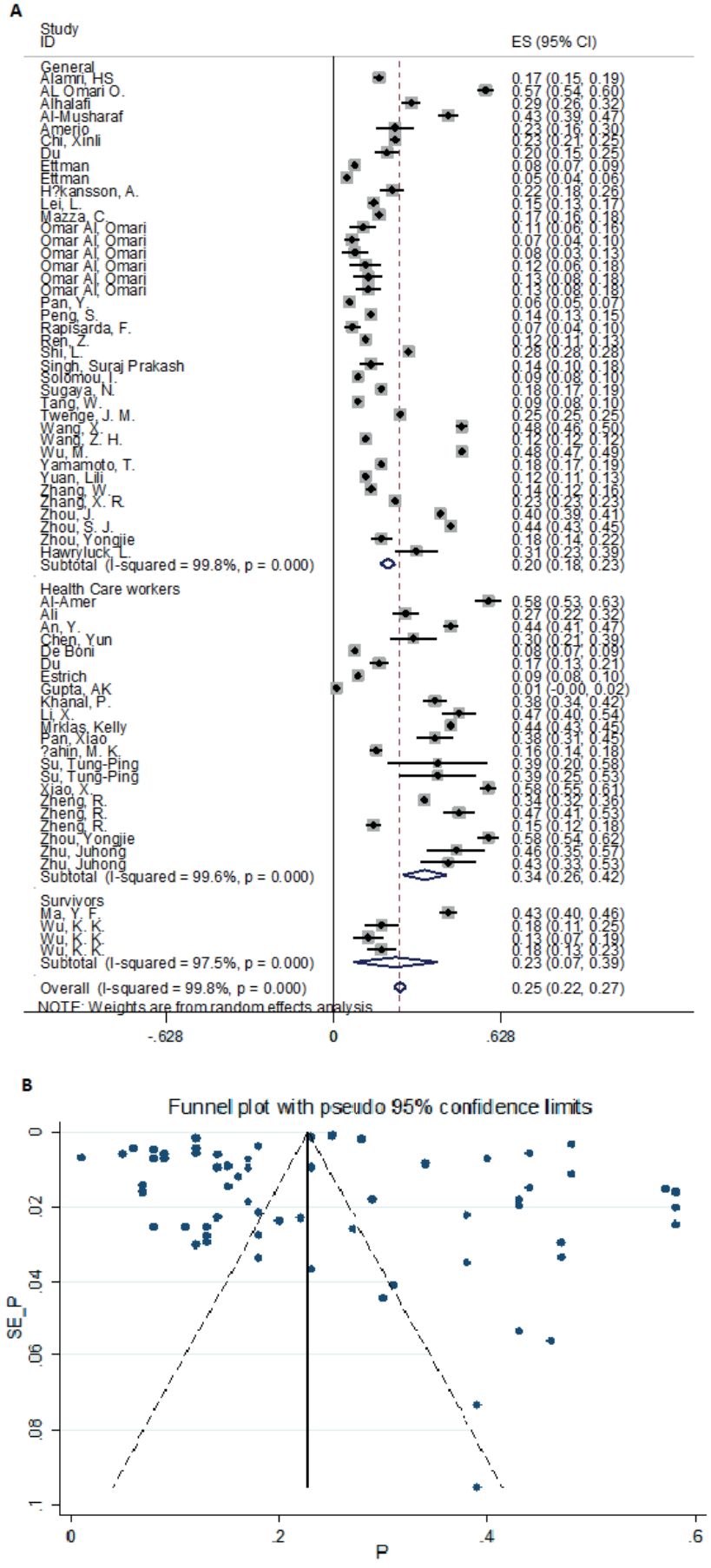

Figure-3 A: Forest plot; pooled estimate prevalence of depression during coronavirus epidemics sub-grouped by the study population. B: Funnel plot; no publication bias detected in reporting depression during coronavirus epidemics (Egger's test P-value = 0.779).

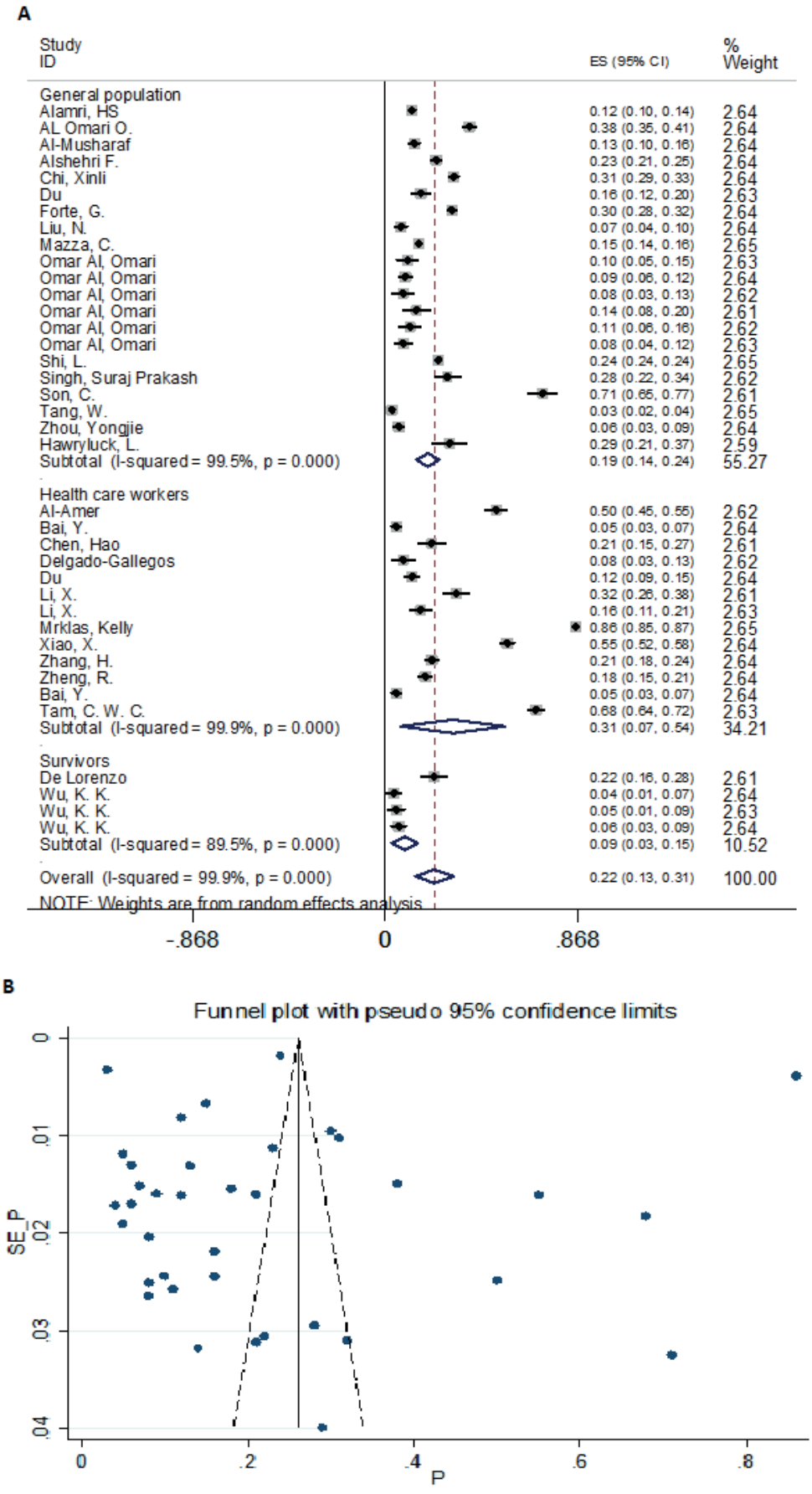

Fig 4. A: Forest plot; Pooled estimate prevalence of stress during coronavirus epidemics sub-grouped by the study population. B: Funnel plot; no publication bias observed in studies (Egger's test p-value = 0.62)

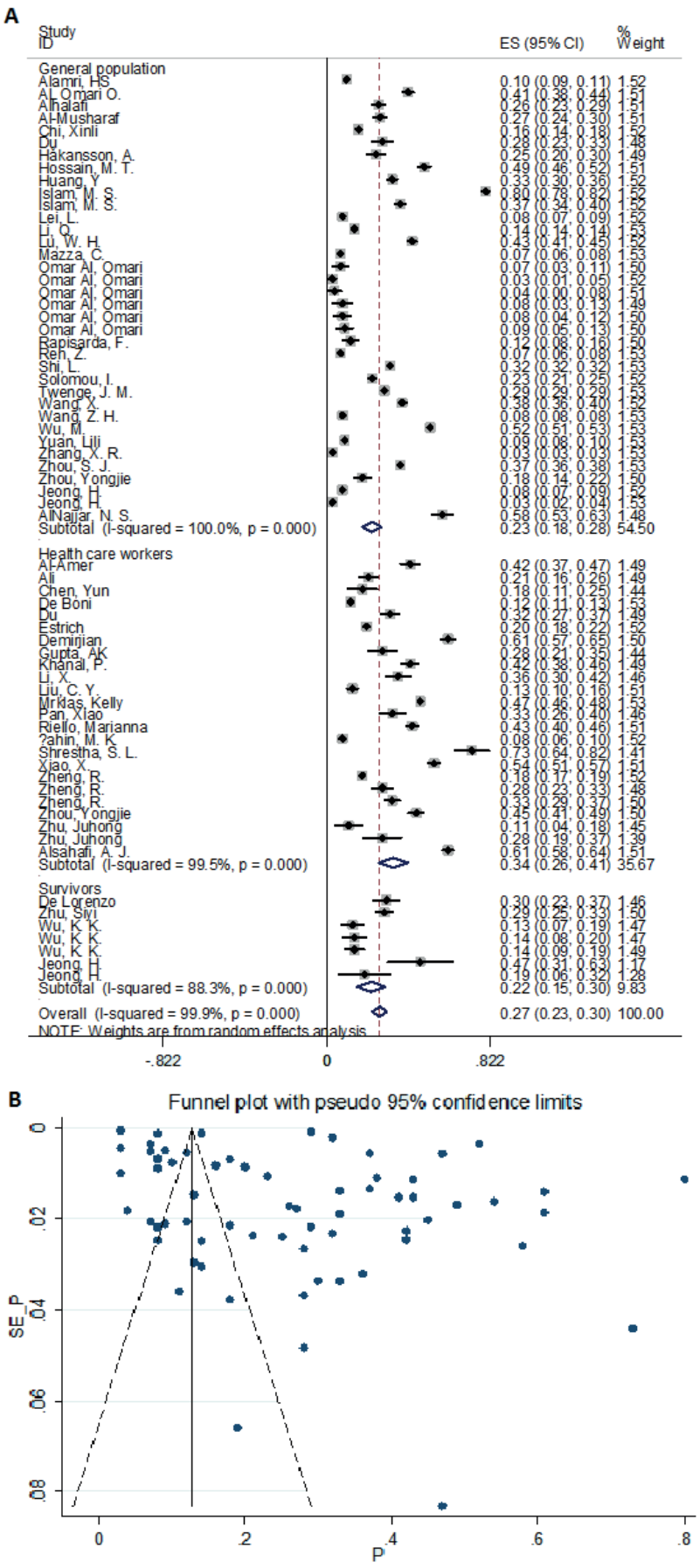

Fig 5. A: Forest plot; Pooled estimate prevalence of anxiety during coronavirus epidemics sub-grouped by the study population. B: Funnel plot; publication bias detected in reporting anxiety during coronavirus epidemics (Egger's test P-value = p=0.024).

problems. Consequently, our results suggested that insomnia, depression, stress, and anxiety were more common during the coronavirus epidemics rather than the other psychological problems. Of these problems, the prevalence rate was higher for insomnia in the different populations. Besides, healthcare workers were more at risk for mental health problems. Therefore, this study showed the crucial need for consistent intervention and care towards different populations especially healthcare workers during the epidemic and even after that.

Limitation

This study thoroughly reviewed the manuscripts that examined the most common psychological problems related to coronavirus epidemics among different populations. It also applied a meta-regression model to investigate variances explained by subgroup moderators. Notwithstanding, some limitations should be noted. First of all, there was a relative risk of bias in the included studies, with only a few studies using probability sampling. Furthermore, there was insufficient evidence related to the prevalence rate of psychological problems after the epidemics. Therefore, the results should be cautiously interpreted.

5. Conclusions

In a nutshell, our study suggests that psychological problems including insomnia, depression, stress, and anxiety are frequently experienced by various populations during coronavirus epidemics. Such crises have imposed mental health burdens on different populations, such as the general community, patients, healthcare workers, and survivors. Several measures could be taken to increase the accuracy of the estimated prevalence rate. For instance, future studies can include large-scale samples by using probability sampling, use measurement tools with good psychometric properties, and conducting follow-up studies. Randomized controlled trials are needed as well to examine effective prevention, intervention, or treatment on the psychological problems related to the epidemic.

Acknowledgments

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Conflict of interest

The authors have declared no conflict of interest.

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