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Review article

Online psychosocial interventions for improving mental health in people during the COVID-19 pandemic: A systematic review and meta-analysis

Zhiyu Ye^{a,b}, Wentian Li^{a,c,*}, Ruizi Zhu^d

^a School of Education Research, China University of Geosciences, Wuhan, China

^b Research Center for Psychological and Health Sciences, China University of Geosciences, Wuhan, China

^c Wuhan Mental Health Centre, Wuhan, China

^d Queen's University, Kingston, Canada



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ABSTRACT

Background: During the COVID-19 pandemic, interventions for public mental health were mostly delivered through online modalities. Although many studies have explored the effectiveness of online psychosocial interventions through randomized controlled trials, there is a lack of quantitative synthesis of the effectiveness of online psychosocial interventions and an examination of their overall application.

Objective: To understand the commonly used psychosocial interventions during the COVID-19 pandemic and the effectiveness of the interventions.

Methods: Risk bias was assessed in the included studies according to the Cochrane Collaboration criteria, and data from post-test and follow-up were combined for standardized mean differences using Stata 16.0 software, and sources of heterogeneity were explored by subgroup analysis, and risk bias was assessed in the included studies using Review Manager 5.4 software. The study was written in strict accordance with PRISMA specifications, and registration was completed on the PROSPERO platform (CRD42022302917).

Results: The online psychosocial intervention had an ameliorating effect on anxiety (SMD = -0.78), depression (SMD = -0.80), and insomnia (SMD = -0.19) in the public during the COVID-19 pandemic, was ineffective for the intervention on stress, and the effectiveness of the intervention on depression continued at follow-up. Subgroup analyses showed that the type of intervention, intervention form, Duration of intervention, and setting of the control group influenced the trial results to some extent, with cognitive behavioral therapy being the most effective intervention for anxiety and depressive symptoms, self-help interventions being more effective than interventions with therapist interventions, and 1–4 week interventions being more effective than 5–8 week interventions. Due to the limited number of studies included in the analysis and variability in quality, more randomized controlled trials are needed to test the findings.

Conclusion: Online psychosocial interventions can be effective in improving symptoms of anxiety, depression, stress, and insomnia in the public during the COVID-19 pandemic. However, additional randomized controlled trial studies are needed to determine which types of interventions are more appropriate for which populations and how they can be implemented to achieve better intervention outcomes.

1. Background

In December 2019, the first unusual case of a patient with pneumonia caused by a novel coronavirus was reported in Wuhan, Hubei Province, China (Bai et al., 2020). In March 2020, WHO declared the spread of the novel coronavirus pneumonia virus (COVID-19) caused by the coronavirus SARS-CoV-2 as a pandemic (Arden and Chilcot, 2020). The spread of novel coronavirus pneumonia will not only pose a risk to

public physical health, but also to public mental health, with frequent occurrence of a range of mental health problems. In a meta-analysis of the prevalence of stress, anxiety, and depression in the general population during the COVID-19 pandemic, the prevalence of anxiety was 31.9 % in 17 combined studies, depression was 33.7 % in 14 combined studies, and stress was 29.6 % in 5 combined studies (Salari et al., 2020a). The causes of mental health problems during the pandemic are complex, with some studies suggesting that the public may experience

* Corresponding author.

E-mail address: liwentian2018@163.com (W. Li).

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negative emotions such as anger, loneliness, boredom and anxiety due to isolation measures and a range of policies such as travel restrictions, while some somatic coughing, fever, myalgia and fatigue may also lead to emotional depression and fear of contracting neoconiosis (Xiang et al., 2020). Additional findings suggest that the present-day global pandemic trend of the COVID-19 pandemic can lead to fear and worry and affect mental health (Shah et al., 2020). It has also been found that the sudden outbreak and high contagiousness of the epidemic can lead to anxiety, depression and stress in the public (Wang et al., 2021).

In response to public mental health problems arising during the COVID-19 pandemic, there is a strong need for practical and effective intervention methods to regulate public mental health in a timely manner. However, at the same time, in order to contain and minimize the impact of the COVID-19 pandemic, countries around the world have adopted different degrees of physical distance, centralized isolation, and home isolation, which make face-to-face psychological interventions somewhat hindered. In this context, the Internet has become an increasingly influential medium to help address public mental health issues, and online psychological interventions through the Internet have gained more attention and online mental health services have been widely adopted in China (Talevi et al., 2020), which is a web-based online treatment approach that is very suitable for people in all countries under epidemic control and has injected new energy into health care services (Wind et al., 2020).

Based on the shift in intervention approaches during the epidemic, several studies have begun to design randomized controlled trials to evaluate the effectiveness of online psychosocial intervention approaches to improve public mental health during the epidemic in order to better guide their use in practice. In contrast, when looking at relevant reviews, most of the articles on mental health during the COVID-19 pandemic are narrative in nature, such as reviews of psychosocial interventions during the epidemic, and have not been conducted on specific topics, either focusing on a few specific psychological issues, such as anxiety, depression, and stress (Xiang et al., 2020), or on specific groups, such as healthcare workers (Salari et al., 2020b) or COVID-19 patients (Deng et al., 2021), in relation to the efficacy of the interventions. Systematic analyses have not been conducted in relation to the efficacy of interventions. In addition, there are few reviews that focus on online psychosocial interventions.

Therefore, the aim of this study was to conduct a comprehensive systematic review and meta-analysis of randomized controlled trials using online psychosocial treatments, and thus to understand the commonly used psychosocial interventions and the effectiveness during the COVID-19 pandemic. The meta-analysis was also used to systematically assess the effectiveness of online interventions for improving specific mental health problems during the COVID-19 pandemic, to explore which types of psychosocial interventions were most effective in improving which mental health problems, and which psychosocial interventions were most effective when used under what intervention conditions. A systematic approach to presenting the current status of interventions and their effectiveness will provide informative information on the practical use of psychosocial interventions to improve mental health problems during the New Coronary Pneumonia epidemic and further research efforts.

2. Methods

This study was written in strict accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) specification and was registered with PROSPERO (International Prospective Register of Systematic Reviews) with the registration number CRD42022302917.

2.1. Search strategy

A comprehensive review of relevant articles was conducted through

the following literature databases: PubMed, Embase, Cochrane library, CNKI, Wanfang Data, Web of science, PsycINFO (APA PsycNet), ClinicalTrials.gov, and gray databases: MedRxiv, ChinaXiv, and SSRN, a comprehensive review of relevant articles was conducted, and the search period was from 12 January 2021 to December 31, 2021. The subject terms used in this search included COVID-19, Psychosocial Intervention, Cognitive Behavioral Therapy, Mindfulness, Randomized controlled trial. The full search used in PubMed formula is (((("COVID-19"[Mesh]) OR (SARS?CoV?2 Infection*[Title/Abstract] OR 2019 Novel Coronavirus Disease[Title/Abstract] OR 2019 Novel Coronavirus Infection[Title/Abstract] OR 2019?nCoV Disease*[Title/Abstract] OR COVID?19 Virus Infection*[Title/Abstract] OR Coronavirus Disease?19 [Title/Abstract] OR Severe Acute Respiratory Syndrome Coronavirus 2 Infection[Title/Abstract] OR SARS Coronavirus 2 Infection[Title/Abstract] OR COVID? 19 Virus Disease*[Title/Abstract] OR 2019?nCoV Infection*[Title/Abstract] OR COVID?19 Pandemic*[Title/Abstract])) AND (((("Psychosocial Intervention"[Mesh]) OR (Psychosocial Intervention*[Title/Abstract] OR Psychological Intervention*[Title/Abstract])) OR (("Cognitive Behavioral Therapy" [Mesh]) OR (Cognitive Behavio* Therap*[Title/Abstract] OR Cogniti* Therap*[Title/Abstract] OR Cognitive Psychotherap*[Title/Abstract]))) OR ("Mindfulness" [Mesh]))) AND ("Randomized Controlled Trial" [Publication Type])). The search had no language or country restrictions and comprehensively considered all potential studies that met the criteria.

2.2. Screening criteria

Studies that met the criteria were screened by reading the title and abstract of each study. Inclusion criteria were (a) randomized controlled trials; (b) comparison of psychological interventions delivered via the Internet with control conditions; (c) assessment of symptoms of common mental health problems in the general population as a primary outcome indicator during the COVID-19 pandemic; and (d) use of a standardized measurement tool. Exclusion criteria were (a) literature review; (b) study design; (c) offline psychological intervention; and (d) special/underlying somatic disease populations such as pregnant women and cancer patients.

2.3. Data extraction

This study will collect data on trial design, intervention characteristics, target group, number of treatments, control group, and outcome measures (post-test and follow-up). For outcomes with continuous variables, mean post-intervention scores for the trial and control groups and standard deviations of these values were extracted, as well as the number of patients included in these analyses; for crossover studies, only data from the first phase (pre-crossover) were extracted. When outcome data were not reported, the original authors were contacted for the missing information, and if no response was received, the study was excluded. When two different scales were used to measure the same indicator in a single study, data were extracted only for the scale used to measure the primary outcome indicator. When two subscales of the State-Trait Anxiety Scale were used simultaneously to measure anxiety symptoms, only data from the State-Anxiety subscale were extracted, depending on the purpose of the study. When more than one follow-up visit was conducted, only the data measured at the first follow-up visit were extracted. All study characteristics and outcome data were extracted independently by the two authors, and consensus was sought from another author outside the evaluation.

2.4. Risk bias assessment

The risk of bias for all included studies was assessed using the Review Manager5.4 version referring to the Cochrane Collaboration criteria for (a) Random sequence generation; (b) Allocation concealment; (c) Blinding of participants and personnel; (d) Blinding of outcome

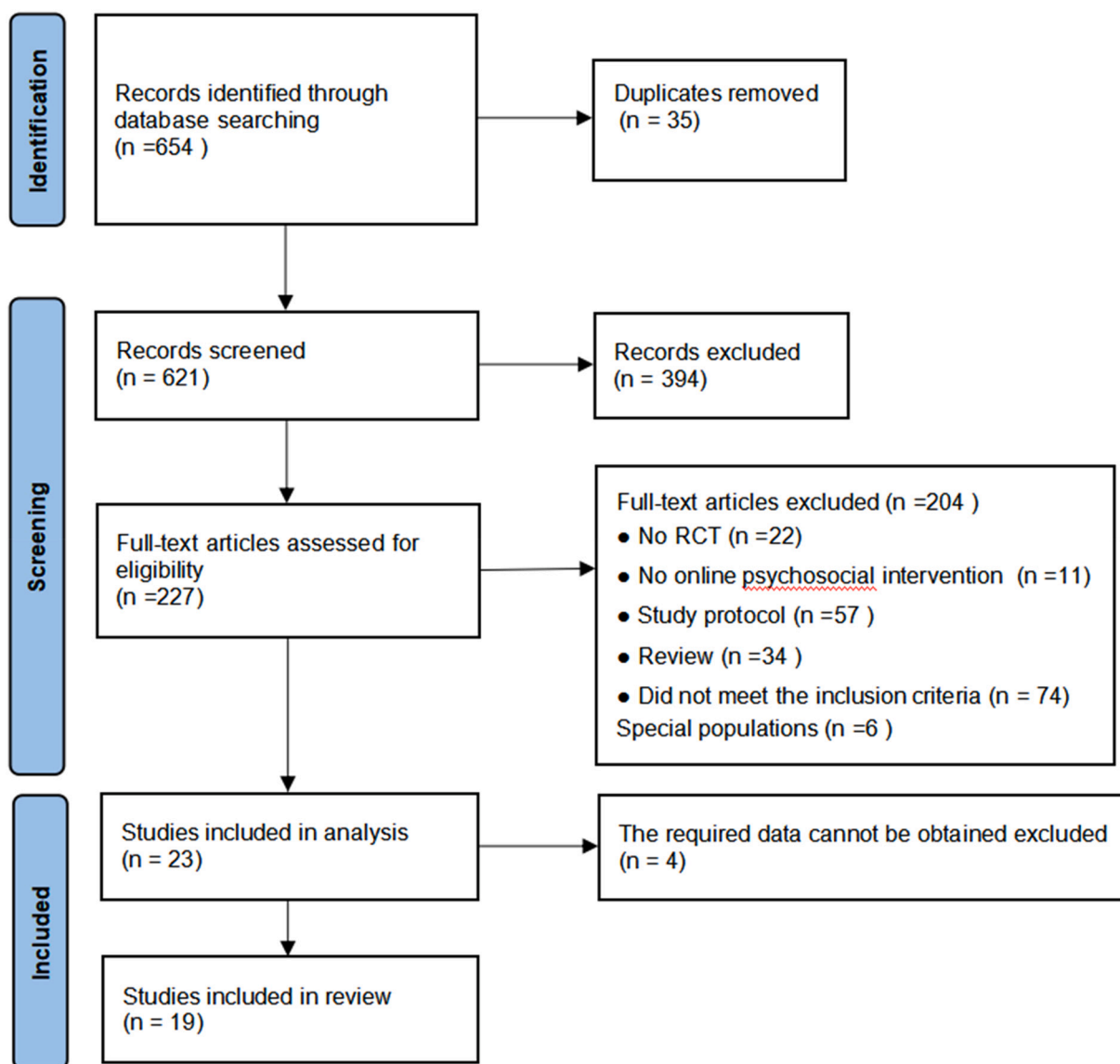


Fig. 1. Flow chart of PRISMA study.

assessment; (e) Incomplete outcome data; (f) Selective reporting; and (g) Other bias (As there were more trials of self-help interventions in the included studies, the main assessment in this case was whether the included studies reminded and confirmed that the participants completed the intervention during the intervention time period). Based on the above criteria, a comprehensive assessment was made to determine whether there was sufficient information and potential for bias. Each criterion was rated as “low risk of bias,” “high risk of bias,” or “unclear risk of bias (Higgins and Green, 2011),” and the risk of bias was assessed independently by two authors, with controversy sought from another expert outside the study. The risk bias assessment was performed independently by two authors, and in case of dispute, consensus was sought from another author outside the evaluation.

2.5. Data analysis

Meta-analysis was performed using Stata version 16.0. For outcomes of continuous variables after online psychosocial interventions, standardized mean differences (SMD) across measurement scales were combined, and 95 % confidence intervals were used for all outcomes.

Heterogeneity assessed by the I^2 statistic, the p-value of the chi-

square test for heterogeneity, and a visual inspection of the forest plot (Higgins and Thompson, 2002). When the I^2 statistic is 0 %, it indicates that dispersion does not exist, and when the value is larger, it indicates a higher degree of heterogeneity, where 25 % is low heterogeneity, 50 % is moderate heterogeneity, and 75 % is high heterogeneity (Higgins et al., 2003). When I^2 statistic is higher than 50 % or the p-value is >0.10 , it indicates that multiple studies have good homogeneity and a fixed-effects model is used; when I^2 statistic is lower than 50 % or the p-value is <0.10 , it indicates that heterogeneity between studies is apparent and a random-effects model is used.

To explore possible sources of heterogeneity, subgroup analyses ($k > 8$: depression, anxiety, and stress) were conducted on outcomes with sufficient inclusion in the study. Subgroup analyses included: type of psychosocial intervention (psycho-educational intervention, cognitive-behavioral therapy, Mindfulness Therapy, other types of interventions); form of intervention (self-help intervention, therapist intervention); length of intervention (1–4 weeks, 5–8 weeks); and control group setting (passive control, active control).

Sensitivity analyses were performed by removing three or more studies with a high risk of bias to determine the effect of risk of bias on the results. Because it was difficult to find meaningful differences among

Table 1
Characteristics of the included studies.

Author	Country	Subject Information	N	Mean age	Techniques	Form	Control group	Duration	Follow-up	Outcome measures
Al-Refae et al. (2021)	Canada	General population, of which 25 % of the sample was diagnosed with a mental health disorder	165	25.24	Psycho-educational interventions based on positive meditation, self-compassion, cognitive restructuring task-cognitive behavioral therapy, and mindfulness cognitive therapy	Self-help	Passive	Intervention 4 weeks, 1 time per day	None	DASS-21, SD-WISE, 3D-WS-12, Psychological Well-Being Scale, SCS
Aminoff et al. (2021)	Sweden	General Population	62	42.7	Cognitive Behavioral Therapy	Therapist-led	Passive	Intervention 7 weeks, 1 time per week	None	BDI-II, BBQ, PHQ-9, GAD-7, AUDIT, ISI, IES-R, PSS-14, DAR-5
Antonia Fiol-DeRoque et al. (2021)	Spain	Health Care Workers	482	41.37	Psycho-educational interventions based on cognitive-behavioral therapy and mindfulness therapy	Self-help	Active	Intervention for 2 weeks, 1 time per day	None	DASS-21, DTS, MBI-HSS, ISI, GSE, SUS
Asl (2021)	Turkey	Social Workers	49	33.06	Mindfulness therapy	Therapist-led	Passive	4 weeks of intervention, four 70-minute training sessions per week	4 weeks	DASS-21, SCS, AAQ-II
Bryant et al. (2021)	Australia	General population with psychological distress	240	36.9	Group projects based on behavioral principles	Therapist-led	Active	Intervention for 6 weeks, once a week for 60 min	2 months and 6 months	HADS-A, HADS-D, GAD-7, SII, PANAS, 6-item COVID
Cozzolino et al. (2021)	Italy	College Students	310	28.73	Brainwave modulation technology	Therapist-led	Active	Intervention for 4 weeks, 1 15-minute session per week	None	DT, PSS-14, STAI-Y, YP-CORE, PANAS
Dincer and Inangil (2021)	Turkey	Nurse, New Crown Pneumonia Unit	72	33.46	Emotional Freedom Technique	Therapist-led	Passive	Intervention 1 time 20 min	None	SUD, STAI-Y, Burnout Scale
Egan et al. (2021)	Australia, UK	General Population	225	37.79	Cognitive Behavioral Therapy	Self-help	Passive	Intervention 1 week, 1 time per day	None	MINI, GAD-7, PHQ-9
Fan et al. (2021)	China	Patients with post-traumatic stress who are about to be discharged from hospital with neocoronary pneumonia	111	46.38	Narrative Exposure Therapy + Individualized Psychotherapy	Therapist-led	Active	Intervention for 8 weeks, 1–2 times a week for 90–120 min each time	6 Months	CL-C, SDS, SAS, PQSI
Liu et al. (2021)	China	Patients with new coronary pneumonia who have mild to moderate anxiety or depression	252	42.64	Cognitive Behavioral Therapy + Conventional Treatment	Self-help	Active	Intervention 1 week, 1 time per day, 10 min each time	1 month	HAMA, HAMD, SDS, SAS, AIS
Riello et al. (2021)	Italy	Health Care Workers	238	44.37	SH+	Self-help	Active	5 weeks of intervention	14 weeks	GAD-7, IES-R, WHO-5, PSS-14, CDRISC
Shabahang et al. (2021)	Iran	College students with severe COVID-19 anxiety	150	24.7	Cognitive Behavioral Therapy	Self-help	Passive	Intervention for 3 weeks, 3 times a week for 15–20 min each time	None	CVAQ, SHAI, ASI-3, SSAS, EPSI
Shapira et al. (2021)	Israel	Seniors	82	72	Cognitive Behavioral Therapy	Therapist-led	Passive	Intervention for 3 weeks, 60–90 min twice a week	1 month	PHQ-9, Loneliness Short Scale, Duke University-University of North Carolina Functional Social Support Questionnaire
Shaygan et al. (2021)	Iran	New crown pneumonia patients	48	36.77	Psycho-educational interventions based on cognitive-behavioral techniques, stress management techniques, positive stress reduction and positive psychotherapy	Self-help	Passive	Intervention for 2 weeks, 1 time per day for 60 min	None	CD-RISC, PSS, CSQ-I
Simonsson et al. (2021)	United Kingdom	College Students	177	23.53	Mindfulness therapy	Therapist-led	Passive	Intervention for 8 weeks, 1 time per week for 90 min	1 month	PROMIS
Vukcevic Markovic et al. (2020)	Serbia	General Population	104	32.23	Expressive Writing Therapy	Self-help	Active	Intervention 2 weeks, 5 sessions of 20 min each	1 month	DASS-21, WHO-5, SQOL
Wadhen and Cartwright (2021)	United Kingdom	Home-based employees	34	42.25	Yoga Therapy	Therapist-led	Passive	Intervention for 6 weeks, 2–3 times a week for 50 min each time	None	PSS-14, Psychological Well-Being Scale, WEMWBS, DASS-21

(continued on next page)

Table 1 (continued)

Author	Country	Subject Information	N	Mean age	Techniques	Form	Control group	Duration	Follow-up	Outcome measures
Wahlund et al. (2021)	Sweden	General Population	670	46	Cognitive Behavioral Therapy	Self-help	Passive	3 weeks of intervention	1 month	WSAS, MADRS-S, ISI, IUS-12
Zhang et al. (2021)	China	General Population	57	50.12	Mindfulness therapy	Self-help	Passive	Intervention for 2 weeks, 90 min per day	None	BSI-18, Positive Attention Awareness Scale

a small number of studies, sensitivity analyses were performed only for meta-analyses with eight or more included studies.

Publication bias was assessed by reviewing the contour-enhanced funnel plot (Peters et al., 2008) and performing Egger’s intercept test (Egger et al., 1997). If publication bias was present, the cut-and-patch method (Duval and Tweedie, 2000) was used to adjust for possible bias.

3. Results

A database search identified 654 articles. After reading the titles and abstracts and excluding irrelevant or duplicate studies, a total of 227one study remained for full-text analysis. Of these studies, a total of 23 met the inclusion criteria. 5No studies showed pre- and post-intervention means and standard deviations, SDs, or 95 % confidence intervals in text, tables, or figures, and the authors did not respond to emails requesting these data, leaving19 a sample of studies from one randomized controlled trial available for preliminary analysis. A flowchart of the study selection process and reasons for exclusion is shown in Fig. 1.

3.1. Study characteristics

Overall, a total of 3528 participants were included in 19 studies with a sample size of N = 34 to 670 and a mean age of 23.53–72 years, mostly in the general population. Of these, 17 studies measured outcome indicators of anxiety symptoms, 15 studies measured depressive symptoms, 9 studies measured stress symptoms, and 4 studies measured sleep.

Regarding the type of intervention, four interventions (%) were psycho-educational interventions based on multiple therapeutic approaches, one (5.26 %) used a combination of narrative exposure therapy and individualized psychotherapy for the intervention, one (5.26 %) study used a combination of cognitive-behavioral therapy and conventional therapy for the intervention, and the remaining 13 (68.42 %) used a single psychosocial intervention. For individual intervention

modalities, nine (47.37 %) studies used directly or used intervention techniques based on cognitive-behavioral therapy, seven (36.84 %) studies used directly or used intervention techniques based on Mindfulness Therapy, and the remaining intervention techniques were brainwave modulation (k = 1, 5.26 %), emotional freedom techniques (k = 1, 5.26 %), expressive writing therapy (k = 1, 5.26 %) and yoga therapy (k = 1, 5.26 %).

Regarding the form of intervention, 10 (52.63 %) studies used a self-help intervention, Self-service intervention using the application; 9 (47.37 %) studies had a therapist-led intervention.

In terms of intervention length, 13 (68.42 %) studies had an intervention length of 1–4 weeks and 6 (31.58 %) studies had an intervention length of 5–8 weeks.

In terms of randomized controlled trial settings, 12 (63.16 %) studies compared the intervention group with a passive control group; 7 (36.84 %) studies used active control conditions.

Detailed study characteristics are shown in Table 1.

3.2. Effectiveness of psychosocial interventions

3.2.1. Test post-test

A meta-analysis of anxiety outcomes (17 studies, 3091 participants) showed that psychosocial interventions were effective in reducing anxiety symptoms compared to controls (SMD = -0.78; 95 % CI = [-1.13, -0.44]; I² = 94.99 %; 95 % CI = [93.25,96.28]; p = 0.000) (Fig. 2). Excluding the six studies with significant outlier results (Dincer and Inangil, 2021; Liu et al., 2021; Shabahang et al., 2021; Vukcevic Markovic et al., 2020; Wahlund et al., 2021; Zhang et al., 2021) the overall estimate remained significant (SMD = -0.26; 95%CI = [-0.35, -0.17]; I² = 46.58 %; 95%CI = [0.00,73.43]; p = 0.044), with inter-study heterogeneity below 50 % (Figs. 3 and 4).

A meta-analysis of depression outcomes (15 study, 2569 participant) showed that psychosocial interventions were effective in reducing depressive symptoms compared to controls (SMD = -0.80; 95 % CI =

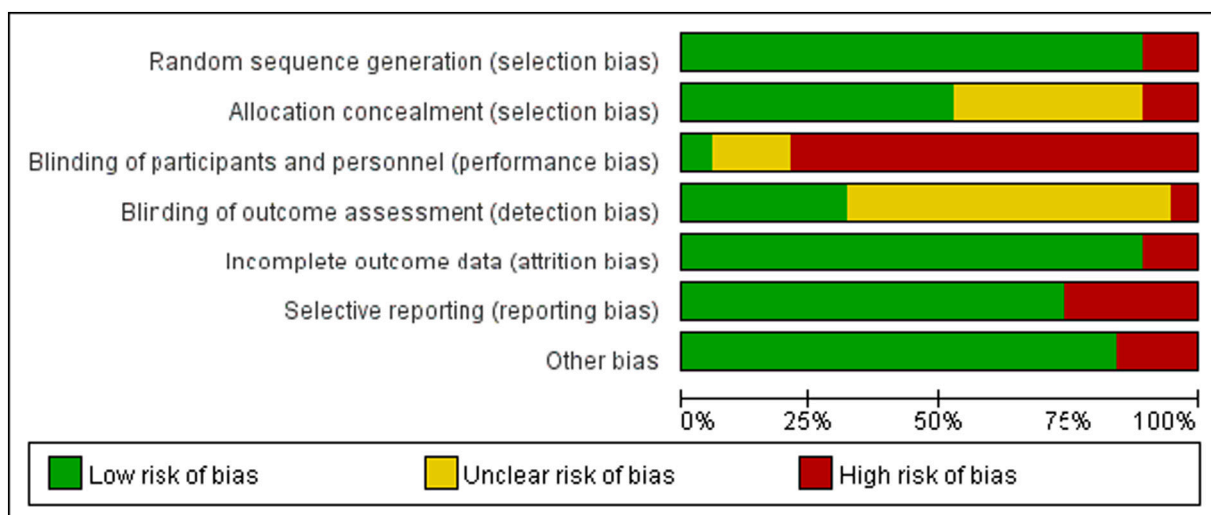


Fig. 2. Risk bias assessment chart.

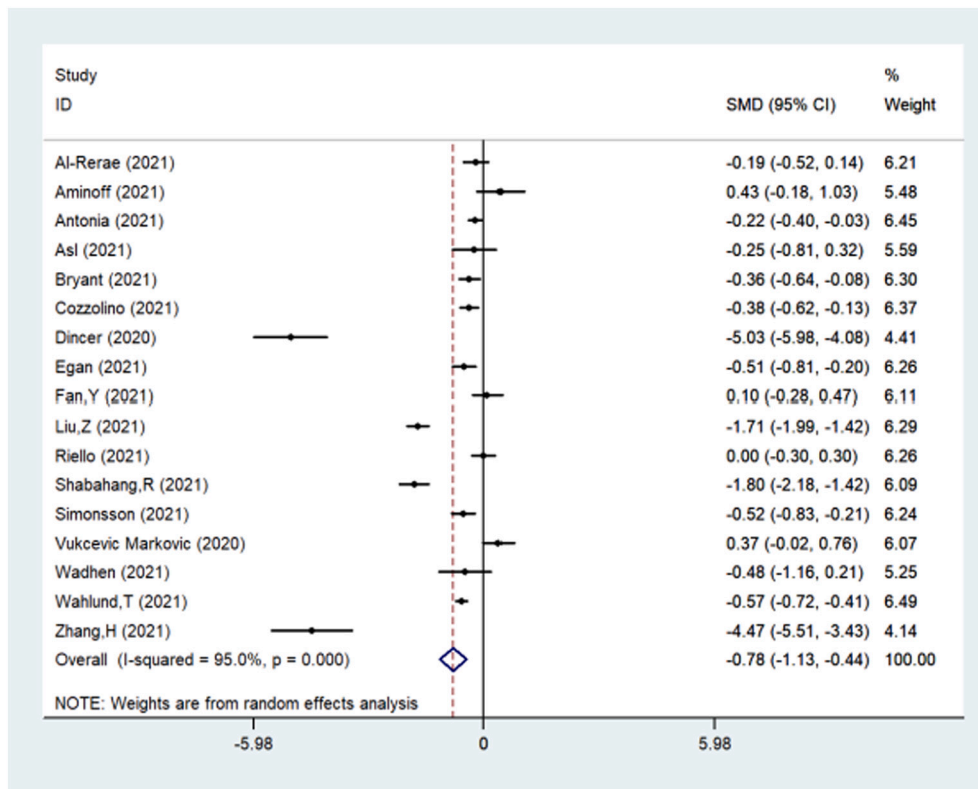


Fig. 3. Anxiety outcome.

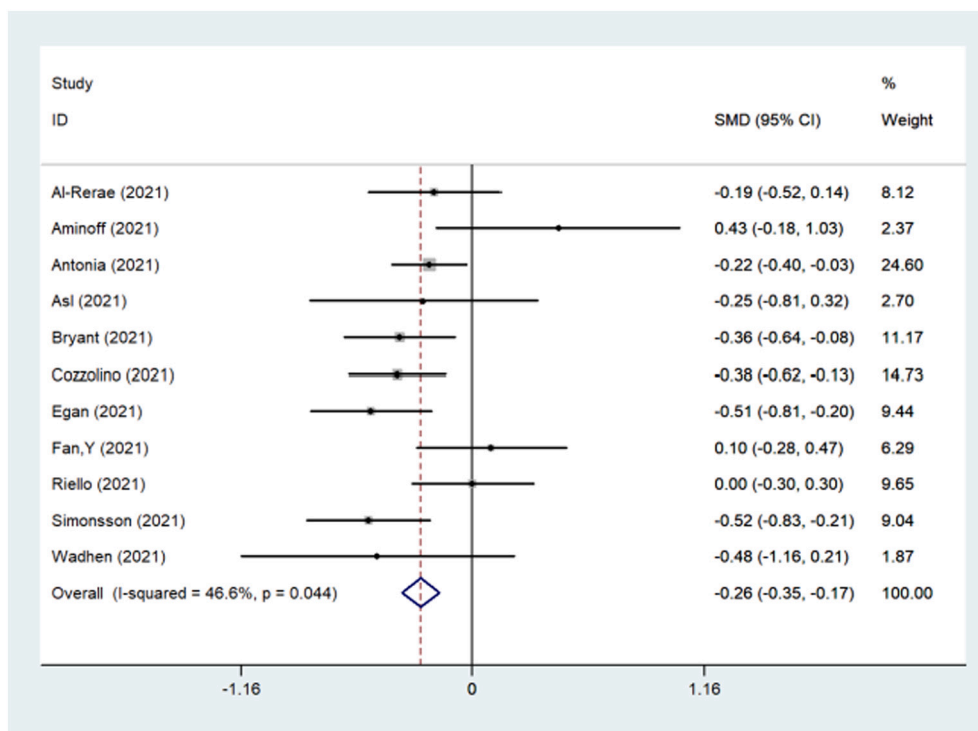


Fig. 4. Anxiety outcome (excluding outliers).

[-1.18, -0.41]; $I^2 = 94.75\%$; 95% CI = [92.75, 96.20]; $p = 0.000$). Excluding the three studies with significant outlier results (Dincer and Inangil, 2021; Liu et al., 2021; Zhang et al., 2021), the overall estimate remained significant (SMD = -0.26; 95%CI = [-0.40, -0.11]; $I^2 =$

57.18%; 95%CI = [18.55, 77.49]; $p = 0.007$), with a moderate degree of between-study heterogeneity (Figs. 5 and 6).

A meta-analysis of stress outcomes (9 study, 1294 participant) showed that psychosocial interventions were ineffective in reducing

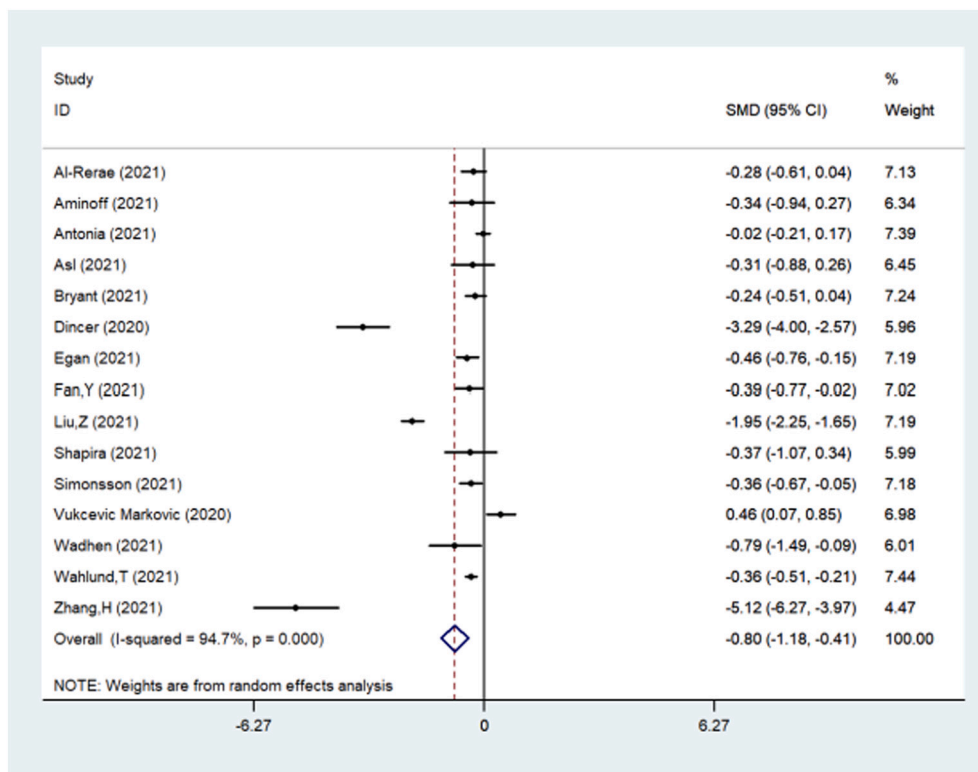


Fig. 5. Depression outcome.

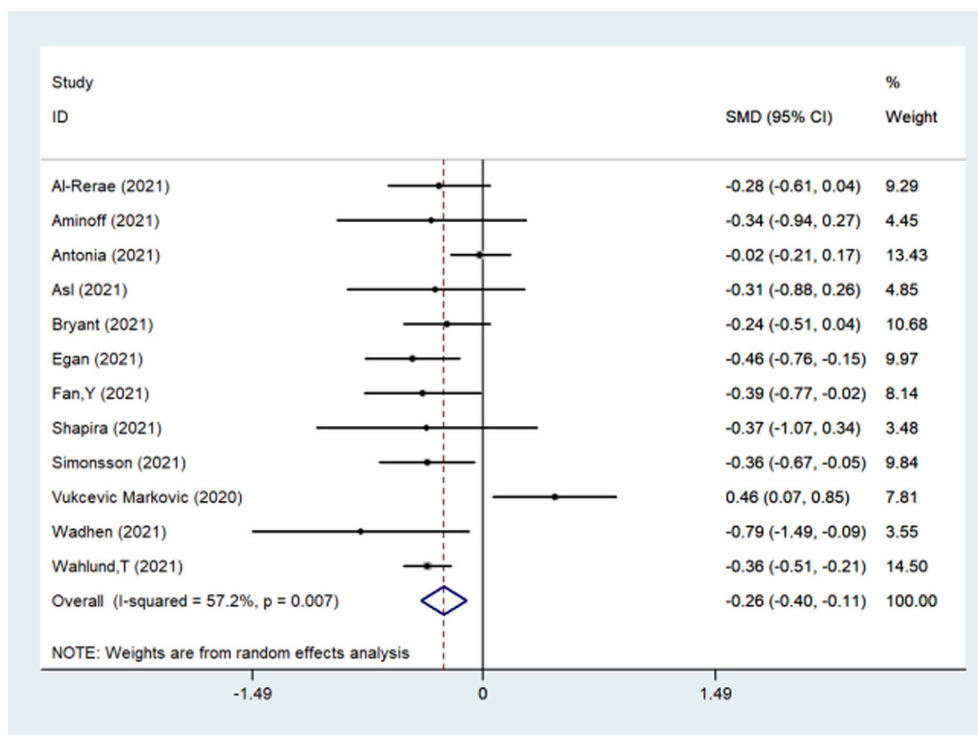


Fig. 6. Depression outcome (excluding outliers).

stress symptoms compared to controls (SMD = -0.22; 95 % CI = [-0.49,0.04]; I² = 78.28 %; 95 % CI = [59.01,88.50]; p = 0.000). Excluding one study with significant outlier results (Vukcevic Markovic et al., 2020), the overall estimate remained invalid (SMD = -0.30; 95 % CI = [-0.45,-0.14]; I² = 32.63 %; 95 % CI = [0.00,70.10]; p = 0.168),

which was more homogeneous between studies (Figs. 7 and 8).

A meta-analysis of sleep outcomes (4 studies, 1469 participants) showed that psychosocial interventions were effective in reducing insomnia symptoms compared to controls (SMD = -0.19; 95 % CI = [-0.29,-0.08]; I² = 12.02 %; 95 % CI = [0.00,86.53]; p = 0.332), with

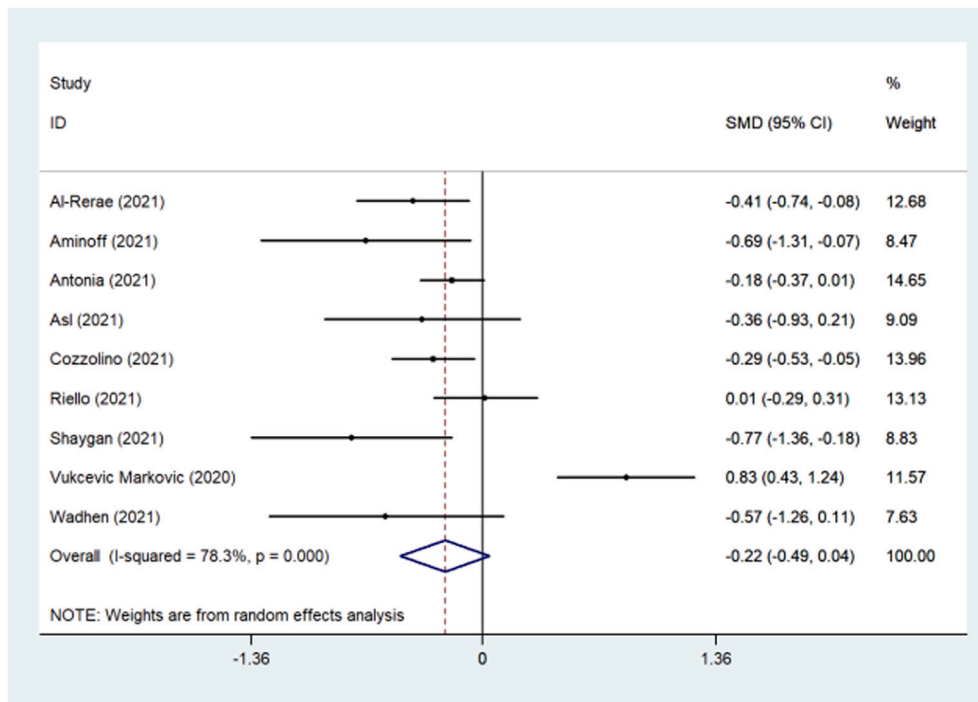


Fig. 7. Stress outcome.

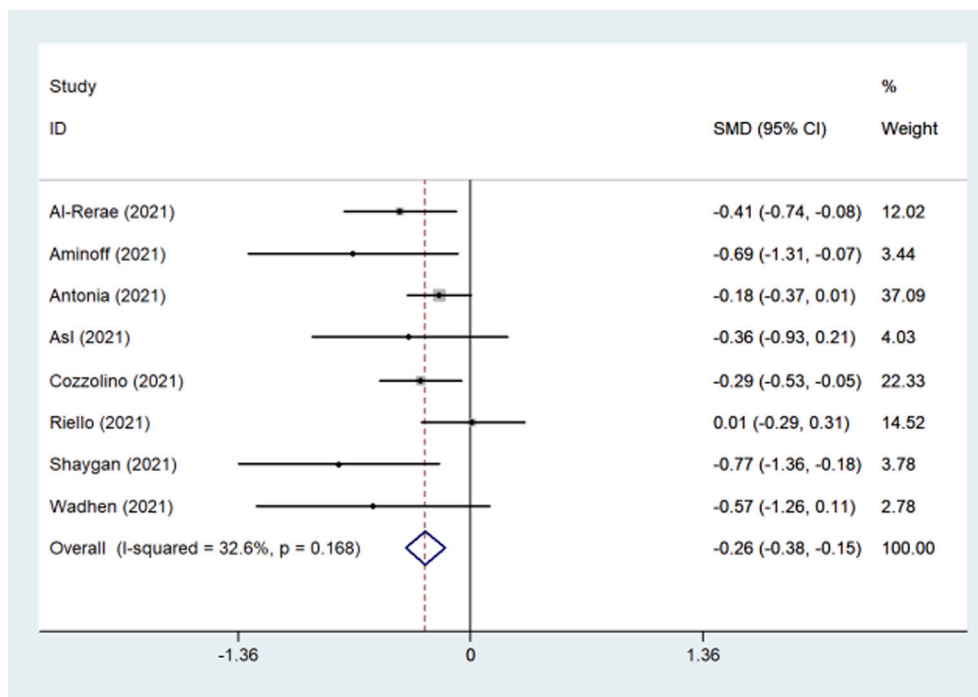


Fig. 8. Stress outcome (excluding outliers).

more homogeneity between studies (Fig. 9).

3.2.2. Trial follow-up

The effectiveness of psychosocial interventions was maintained in the follow-up assessment of depression outcomes (5 study, 726 participants; SMD = -0.21; 95 % CI = [-0.35, -0.06]; I² = 0.00 %; 95 % CI = [0.00, 79.2]; p = 0.715) and was no longer effective in the follow-up assessment of anxiety outcomes (6 study, 857 participants; SMD = -0.14; 95 % CI = [-0.39, 0.12]; I² = 69.4 %; 95 % CI = [28.10, 86.98]; p

= 0.006) (Figs. 10 and 11).

3.3. Publication bias

By visual inspection of the funnel plot and Egger’s test, there was no significant publication bias among studies with anxiety as an outcome indicator (p = 0.19), depression as an outcome indicator (p = 0.10), and stress as an outcome indicator (p = 0.64); and sleep as an outcome indicator (p = 0.48).

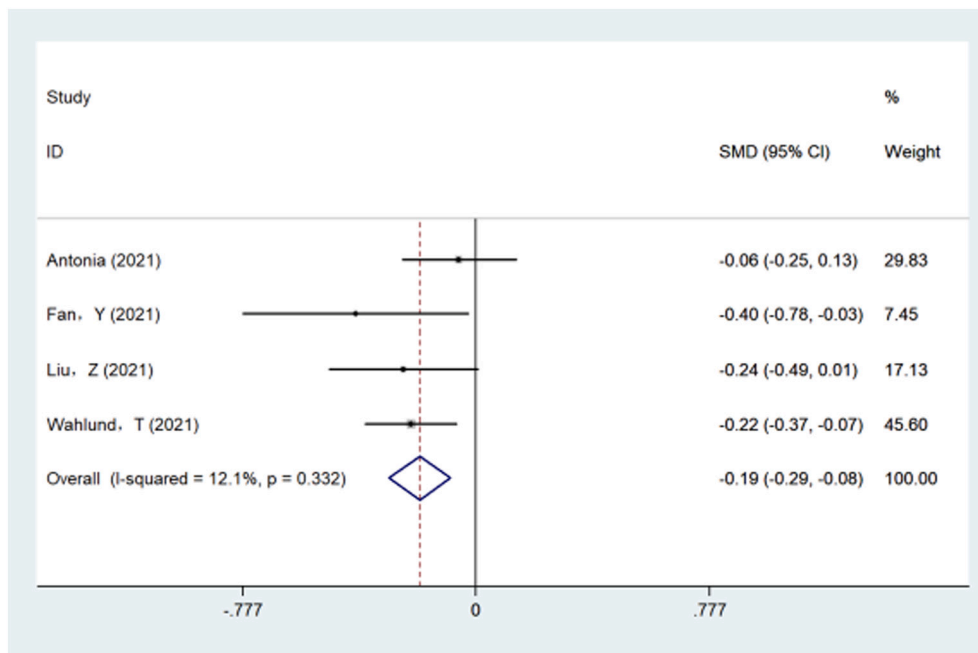


Fig. 9. Sleep outcome.

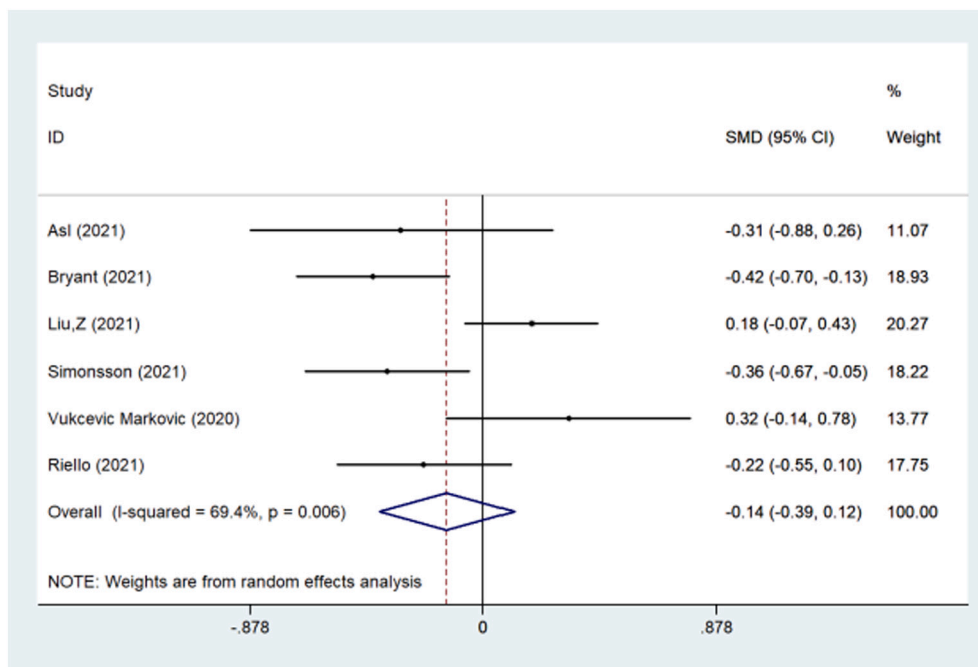


Fig. 10. Anxiety follow-up.

3.4. Subgroup analysis

The results of the subgroup analysis are shown in Table 2. The intervention efficacy using cognitive behavioral therapy was slightly better than other types of methods and psycho-educational interventions in reducing anxiety symptoms during the new crown epidemic. Only cognitive-behavioral therapy had better intervention efficacy in reducing depressive symptoms during the new crown epidemic. Only psycho-educational interventions had better intervention efficacy in reducing stress symptoms during the new crown epidemic. Secondly, the self-help intervention format, the length of the intervention of 1–4 weeks and was more effective in reducing anxiety and depression in the

public during the new crown epidemic; while for stress symptoms, the intervention with therapist intervention was more effective. In addition, the passive control group trial setting showed better intervention efficacy in the trials for alleviating anxiety symptoms, depressive symptoms, and stress symptoms during the New Coronation epidemic.

4. Discussion

4.1. Main findings

This study conducted a systematic literature search and a meta-analysis of the 19 included articles to synthesize the effectiveness of

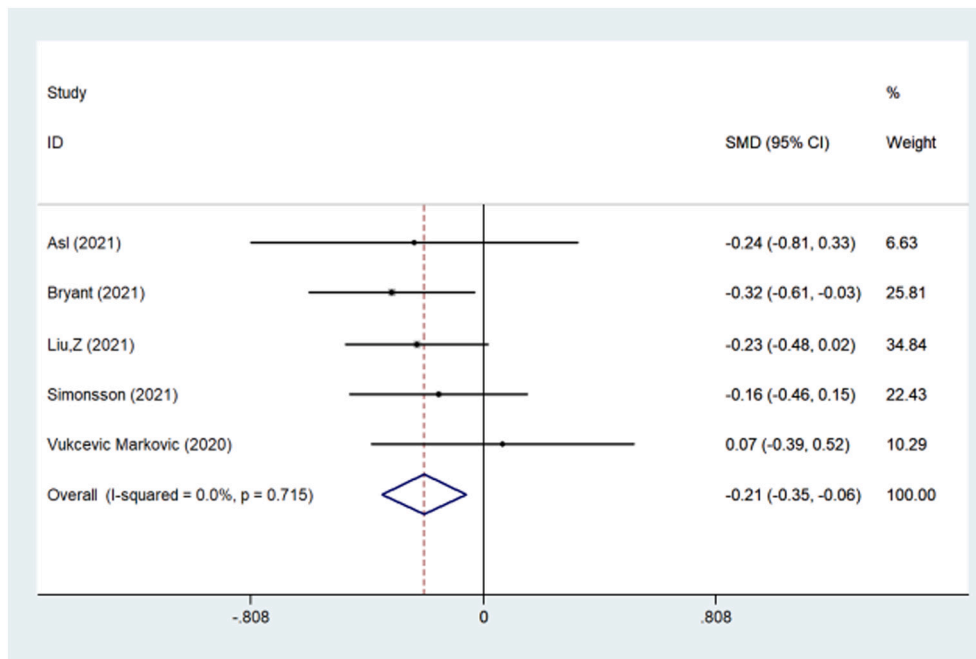


Fig. 11. Depression follow-up.

online psychosocial interventions. The results indicated that online psychosocial interventions improved symptoms of anxiety, depression, and insomnia among the public during the new crown epidemic. In addition, the effectiveness of the intervention for depressive symptoms was found to be well maintained over a range of follow-ups.

In addition, the study further conducted a subgroup analysis of factors that may influence the effectiveness of online psychosocial interventions. Regarding the types of psychosocial interventions, it was observed that the current online interventions mostly adopted cognitive-behavioral therapy and Mindfulness Therapy, followed by the use of integrated psycho-educational interventions and various types of other interventions. Among them, cognitive-behavioral therapy was more effective for alleviating anxiety and depression symptoms during the COVID-19 pandemic, which is consistent with previous studies (Etzelmueller et al., 2020). In contrast, for the intervention of stress symptoms, the form of psycho-educational intervention was more effective, which is consistent with the results of previous studies (Van Daele et al., 2012). In terms of online interventions, self-help interventions and interventions with a therapist were widely adopted, with interventions with a therapist usually conducted through a videoconferencing platform, while self-help interventions during the epidemic were conducted through the use of apps developed in addition to the traditional video and document media (Al-Refae et al., 2021; Antonia Fiol-DeRoque et al., 2021; Liu et al., 2021). Comparing the two approaches, it was found that self-help interventions were more effective for anxiety and depression symptoms, often achieving the same results as offline face-to-face interventions, while for stress, interventions with a therapist were more effective (Cuijpers et al., 2010). However, individual compliance tends to be lower in Internet-based interventions, a factor that has an impact on the effectiveness of the intervention (Christensen et al., 2009). Therefore, exploring individualized self-help/therapist interventions tailored to the different needs of individuals could be considered in order to help individuals actively participate and adhere to the intervention, thus improving the effectiveness of Internet-based psychosocial interventions. In terms of intervention duration, the results of this subgroup analysis showed that online psychosocial interventions of <1 month were more effective, whereas the results of previous Internet-based psychosocial intervention studies mostly indicated that interventions of 1–2 months were more effective (Harrer et al., 2019;

Heber et al., 2017; Richards and Richardson, 2012), which may be due to the limited number of existing studies and some bias in the trials, or inconsistency due to different contexts of interventions; therefore, further exploration is needed to obtain more precise results.

Considering the above factors and the proven effectiveness of online personalized cognitive behavioral therapy in previous studies (Johansson et al., 2012), in practice, it is recommended that the public adopt online cognitive behavioral therapy and personalized self-help therapy to deal with anxiety and depression symptoms during the COVID-19 pandemic, as well as adopt online psychological education intervention and receive intervention with therapists to deal with the public stress symptoms during the COVID-19 pandemic.

4.2. Recommendations for future research

Given that the current study has revealed the potential of online psychosocial intervention approaches to improve public mental health during the epidemic, but further exploration is needed in terms of intervention length and interventions for insomnia symptoms, more and higher quality randomized controlled trials can be conducted in the future, applying different intervention approaches and setting different intervention lengths for different populations, in order to explore how to better design and implement online interventions, and to understand which interventions are more effective for which groups of people in order to better guide practice. Second, little is known about the predictors of acceptability of online psychosocial interventions, and exploring this direction would also be useful for targeting specific treatments to specific populations. In addition, trials of individualized online psychosocial interventions have been conducted mostly during routine periods, and their adaptability and effectiveness during the COVID-19 pandemic needs to be further explored.

4.3. Limitations

First, in terms of inclusion, the accuracy of the relevant results is questionable due to the limited number of available articles that met the criteria of the current study, resulting in limited combined analyses, and low data in subgroup analyses as well as follow-up assessments. Second, the randomization procedures of some studies were unclear, and many

Table 2
Results of subgroup analysis.

Outcome measure	Subgroup type	Subgroup	Number of studies	Number of subjects	SMD	95 % CI	I ²	95 % CI	P
Anxiety	Intervention type	Psychological education	4	887	-0.25	[-0.39,-0.11]	0.00 %	[0.00,89.60]	0.642
		Cognitive behavioral therapy	5	1359	-0.86	[-1.49,-0.22]	95.67 %	[92.41,97.53]	0.000
		Mindfulness therapy	3	223	-1.66	[-3.38,0.06]	96.30 %	[92.21,98.25]	0.000
		Others	6	869	-0.77	[-1.54,-0.01]	95.61 %	[92.71,97.35]	0.000
	Intervention form	Self-help	9	2343	-0.88	[-1.36,-0.39]	96.17 %	[94.37,97.40]	0.000
		Therapist-led	8	1055	-0.69	[-1.25,-0.14]	93.37 %	[89.22,95.93]	0.000
	Intervention duration	1–4 weeks	11	2536	-1.17	[-1.66,-0.68]	96.46 %	[95.03,97.47]	0.000
		5–8 weeks	6	862	-0.16	[-0.43,0.10]	64.91 %	[15.60,85.41]	0.014
	Control group	Passive	10	1661	-1.20	[-1.76,-0.64]	95.33 %	[93.12,96.83]	0.000
		Active	7	1737	-0.32	[-0.77,0.13]	94.58 %	[91.11,96.69]	0.000
Depression	Intervention type	Psychological education	3	887	-0.14	[-0.31,0.03]	24.81 %	[0.00,92.18]	0.265
		Cognitive behavioral therapy	5	1291	-0.71	[-1.40,-0.03]	95.51 %	[92.08,97.46]	0.000
		Mindfulness therapy	3	283	-1.82	[-3.71,0.06]	96.79 %	[93.44,98.43]	0.000
		Others	4	321	-0.98	[-2.30,0.34]	96.36 %	[93.28,98.03]	0.000
	Intervention form	Self-help	7	1841	-0.90	[-1.51,-0.30]	97.03 %	[95.51,98.03]	0.000
		Therapist-led	8	827	-0.72	[-1.22,-0.22]	89.15 %	[80.98,93.81]	0.000
	Intervention duration	1–4 weeks	10	2158	-1.03	[-1.59,-0.48]	96.58 %	[95.13,97.59]	0.000
		5–8 weeks	5	624	-0.34	[-0.51,-0.18]	0.00 %	[0.00,79.20]	0.692
	Control group	Passive	10	1593	-1.00	[-1.48,-0.52]	92.93 %	[89.04,95.44]	0.000
		Active	5	1189	-0.43	[-1.19,0.33]	97.10 %	[95.23,98.24]	0.000
Pressure	Intervention type	Psychological education	3	695	-0.36	[-0.65,-0.08]	54.23 %	[0.00,86.90]	0.112
		Cognitive behavioral therapy	1	62	-0.69	[-1.31,-0.07]	/	/	/
		Mindfulness therapy	1	49	-0.36	[-0.93,0.21]	/	/	/
		Others	4	686	0.02	[-0.50,0.54]	87.84 %	[71.19,94.87]	0.000
	Intervention form	Self-help	5	1037	-0.09	[-0.49,0.32]	86.85 %	[71.55,93.92]	0.000
		Therapist-led	4	455	-0.37	[-0.57,-0.17]	0.00 %	[0.00,84.69]	0.624
	Intervention duration	1–4 weeks	6	1158	-0.18	[0.52,0.16]	84.08 %	[66.93,92.34]	0.000
		5–8 weeks	3	334	-0.35	[-0.84,0.15]	63.17 %	[0.00,89.47]	0.066
	Control group	Passive	5	358	-0.51	[-0.73,-0.29]	0.00 %	[0.00,79.20]	0.788
		Active	4	1134	0.06	[-0.32,0.44]	87.62 %	[70.55,94.79]	0.000

studies adopted a single-blind setting, making the trials potentially at risk of implementation bias, and the quality of the studies was subsequently compromised. Further, heterogeneity among included studies was very high, possibly due to differences between studies in various aspects such as trial area, participant characteristics, outcome measures, manner of delivering psychosocial interventions, and trial procedures, and these differences further contributed to the high heterogeneity shown when combined analyses were conducted, which also makes interpretation of the results need to be treated with caution. Finally, it is difficult to determine the extent to which the effectiveness of online psychosocial interventions for certain mental health problems is maintained because many studies did not follow up on the effects of the interventions or did not obtain data on the control group at follow-up.

Second, in the subgroup analysis, the variables were not considered thoroughly enough, and different populations were not analyzed

separately as subgroups, so it was not possible to know which intervention was more effective for which group of people, and cultural and social backgrounds were not taken into account (Harper et al., 2016).

5. Conclusion

Online psychosocial interventions were found to be effective in improving symptoms of anxiety, depression, stress, and insomnia in the public during the outbreak. However, additional randomized controlled trial studies are needed to determine which types of interventions are more appropriate for which populations and how implementation can optimize intervention outcomes to fully exploit the potential of online psychosocial interventions to improve public mental health during the COVID-19 pandemic.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CRedit authorship contribution statement

Ye Zhiyu: Conceptualization, Methodology, Software, Investigation, Formal analysis, Data curation, Writing – original draft. **Li Wentian:** Conceptualization, Investigation, Formal analysis, Data curation. **Zhu Ruizi:** Supervision, Validation, Writing – review & editing.

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