

Effects of different intervention methods on psychological anxiety, stress, and fatigue among healthcare workers during COVID-19 pandemic: a systematic review and meta-analysis

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Abstract. – OBJECTIVE: This study aimed to explore the treatment effects of various intervention methods on the stress, anxiety, and fatigue of medical workers during the 2019 Coronavirus Disease (COVID-19) pandemic.

MATERIALS AND METHODS: We conducted computer searches in both Chinese and English databases including China National Knowledge Infrastructure (CNKI), Wanfang Data Knowledge Service Platform (Wang Fang), VIP Chinese Journal Service Platform (VIP), Web of Science, Embase, PubMed, Cochrane Library, Scopus, and ScienceDirect to include prospective randomized controlled studies (Prospective RCT) published before September 30, 2023, regarding different treatment methods for stress, anxiety, and fatigue among healthcare workers during COVID-19. Data on anxiety, stress, and fatigue of research participants were extracted from the included studies, followed by statistical analysis of treatment effects using R software with the meta package.

RESULTS: A total of 9 articles were eventually included, involving a total of 1,466 participants, including 686 in the control group and 780 in the study group. Intervention measures included mindfulness-based therapy in 4 studies and other intervention methods in 5. The anxiety status of the health workers was assessed using the Generalized Anxiety Disorder-7 (GAD-7), and the meta-analysis revealed a pooled mean difference (MD) of -0.53 (95% CI: -1.42, 0.37). Stress status was evaluated by Perceived Stress Scale 4 (PSS-4), and the meta-analysis results showed a post-treatment MD of 0.13 (95% CI: -0.39, 0.65), with a pre- and post-treatment difference MD of -0.44 (95% CI: -2.65, 1.76). Maslach Burnout Inventory (MBI) was employed for the evaluation of fatigue. The meta-analysis results showed an MD of -6.13 (95% CI: -16.68, 4.43) for the MBI Emotional index, an MD of 5.04 (95% CI: -3.25, 13.33) for the Personal Accomplishment index, and an MD of -1.68 (95% CI: -6.50, 3.13) for the Depersonalization index.

CONCLUSIONS: Maintaining the mental health of frontline health workers is crucial during the COVID-19 pandemic, and mindfulness-based therapy is the most extensively employed psychological intervention method. However, its effectiveness requires further research confirmation.

Key Words:

COVID-19, Anxiety, Stress, Fatigue, Mindfulness.

Introduction

COVID-19, caused by the SARS-CoV-2 virus, is an infectious disease characterized by rapid onset, high transmissibility, and fast disease progression, posing a critical threat to human life and health¹. Measures to slow the spread of SARS-CoV-2 and prevent diseases and deaths resulted in a significant impact on the social interactions, work, study, and lifestyle of individuals, thus engendering a series of psychological health issues². Establish an organizational system for epidemic prevention and control, develop a work plan for epidemic prevention and control, form an epidemic prevention and control team to clarify the work profession, form vertical management, and cooperate with each other. Quickly integrate the medical treatment space, start the independent fever clinic building as soon as possible, make room for emergencies in the shortest time, set up two areas, namely, the COVID-19 fever clinic and the ordinary fever clinic, and build a residential ward with the demand of single-room isolation for suspected cases to minimize cross-infection. Adjust the inpatient ward to support closed-loop management and long-term medical staff residents with family care needs.

For young medical personnel, adopting the approach of mentoring the elderly and providing necessary training to participate in the frontline work of epidemic prevention and control. Medical workers at the frontline against the pandemic are overwhelmed by huge psychological stress due to heavy workload and risks of infections, as many of them were infected with COVID-19 and some died, making them susceptible to psychological disorders such as anxiety, depression, and fatigue³. Meanwhile, medical workers are also encountering other challenges, including shortage of medical staff, overtime work, long-time use of protective clothing, inadequate supply of protective materials, rapidly changing policies and guidelines, risks of disease infections to families and friends, and insufficient training and psychological support^{4,5}. A meta-analysis⁶ incorporating 29 studies demonstrated that frontline medical workers during the COVID-19 pandemic experienced an incidence rate of 25.8% for anxiety, 24.3% for depression, and 45% for stress. Furthermore, other psychological disorders such as insomnia, fear, and post-traumatic stress disorders have been frequently reported among medical workers^{7,8}.

Psychological stress, anxiety, and fatigue experienced by medical workers can compromise their quality of life and the medical care they provide, and effective measures to alleviate the psychological symptoms and safeguard their physical and psychological health are of great significance^{9,10}. The psychological stress of medical workers during the COVID-19 pandemic has received widespread attention, and related therapies have been introduced in studies⁵. Mindfulness-Based Intervention (MBI) is a psychological therapy performed based on mindfulness, aimed at enhancing the inner capacity of mindfulness, fostering non-judgmental present-moment attention, and reinforcing self-observation and self-regulation, thereby fortifying awareness of thoughts and emotions¹¹. Given the effectiveness in mitigating anxiety, depression, pressure, insomnia, addiction, mental illness, and post-traumatic stress disorder, MBI has been increasingly employed in the management and prevention of psychological stress and has provided discernable treatment effects during the COVID-19 pandemic¹². In addition, various interventions such as pharmacotherapy and music therapy have also garnered significant attention.

Here, we conducted a network meta-analysis to evaluate the treatment effects of different inter-

vention methods on stress, anxiety, and fatigue of health workers during the COVID-19 pandemic, providing evidence-based medicine for the management of relevant events.

Materials and Methods

Search Strategy

We systematically searched articles published in both Chinese and English databases, including China National Knowledge Infrastructure (CNKI), Wanfang Data Knowledge Service Platform, VIP Chinese Journal Service Platform (VIP), Web of Science, Embase, PubMed, Cochrane Library, Scopus, and ScienceDirect. The search was conducted up to September 30, 2023. Using medical subject headings and free text terms, we focused on the following themes: COVID-19, healthcare workers, stress, anxiety, and fatigue. This study follows the PRISMA guidelines.

Literature Screening

We employed the PICOS framework (Participants, Interventions, Comparators, Outcomes, Study design) for the literature screening process.

Inclusion criteria: (1) Participants: Healthcare workers on the frontline during the COVID-19 pandemic, aged 18 years or older. (2) Interventions: At least two types of interventions were implemented. (3) Controls: Patients received a different type of intervention or no intervention (controls). (4) Validated tools were used to assess psychological health outcomes, specifically the Generalized Anxiety Disorder-7 (GAD-7)¹³ for anxiety assessment, Perceived Stress Scale 4 (PSS-4)¹⁴ for stress, and Maslach Burnout Inventory (MBI)¹⁵ for fatigue. (5) Randomized Controlled Trials (RCTs) or quasi-randomized controlled designs were used. Studies published in any language were included.

Exclusion criteria: (1) Studies not meeting the above requirements. (2) Full text not accessible. (3) Studies that did not report mean and standard deviation values for calculating meta-analysis effect sizes, and where authors did not respond after attempts to request data or declined to provide it. (4) Studies with less than 10 patients in a single group. (5) Intervention duration was not specified.

Data Extraction

Two researchers independently extracted data from each study using a pre-specified Excel

spreadsheet. A third investigator reviewed the data for discrepancies, which were resolved through discussion. The following relevant data were extracted, including first author, publication year, type of study population, sample sizes for each study group, gender, age, control interventions, intervention measures for the study group, number of sessions, duration of intervention, measurement time (post-intervention or follow-up), type of tools used for outcome measurement (stress, anxiety, and fatigue), and mean and standard deviation for each measurement. If specific data could not be extracted or were not explicitly reported in the paper, we contacted the respective authors. For data presented as mean and 95% confidence intervals, Cochrane's tool based on Amy Drahota and Elaine Bellor¹⁶ was used to convert to mean $\pm$ standard deviation.

Literature Quality Assessment

Two researchers independently assessed methodological quality using the Risk of Bias 2 (RoB 2.0) (Cochrane, London, UK) tool from the Cochrane Collaboration. Discrepancies in judgments were resolved through discussion with a third researcher. RoB 2.0 includes 7 items, namely, (1) random sequence generation (selection bias), (2) allocation concealment (selection bias), (3) blinding of participants and personnel (performance bias), (4) blinding of outcome assessment (detection bias), (5) incomplete outcome data (attrition bias), (6) selective reporting (reporting bias), and (7) other bias. Each item was categorized as "low risk", "high risk", or "unclear risk". Additionally, a funnel plot analysis was used to assess publication bias.

Statistical Analysis

Meta-analysis was conducted using the R language with the meta package. Mean Difference (MD) and 95% confidence intervals were used to analyze continuous variables. Heterogeneity among studies was assessed using the I^2 test, where $I^2=0\%$ indicates no observed heterogeneity. Larger values indicate greater heterogeneity. In this study, $I^2>50\%$ indicated significant heterogeneity among studies, necessitating subgroup analysis or analysis using a random-effects model. When $I^2\leq 50\%$, there was no significant heterogeneity among studies, and a fixed-effects model was used for analysis. A funnel plot was generated to assess reporting bias. The significance level was set at $p=0.05$.

Results

Literature Screening

Following the initial computer search and importation into Endnote, a cumulative total of 732 articles were obtained. After reviewing titles and abstracts, 702 articles were excluded, including 61 non-clinical studies, 597 non-randomized controlled studies, and 44 studies with unspecified intervention methods. Full-text reading was conducted for the remaining 30 articles, and 21 articles were subsequently excluded. Among these, 15 articles did not specify the outcome indicators, 3 articles had insufficient data for extraction, and 3 articles had inappropriate study designs. Finally, 9 studies⁷⁻²⁵ were included in the analysis. The flowchart for literature screening is shown in Figure 1.

Basic Information of Included Studies

A total of 9 studies were ultimately included, encompassing 1,466 participants, with 686 in the control group and 780 in the study group. In the control group, interventions primarily consisted of waiting lists or no intervention. In the study group, 4 studies^{17,18,21,25} utilized interventions based on mindfulness therapy, while 5 studies^{19,20,22-24} employed other intervention methods. The basic information of the included studies is presented in Table I. The quality assessment of included studies is illustrated in Figure 2.

Analysis of Treatment Effects on Anxiety

A total of 4 studies^{17,19,20,24} reported post-treatment GAD-7 data. The heterogeneity analysis showed significant heterogeneity among the studies ($I^2=66\%$, $p=0.03$), so a random-effects model was employed for the analysis. The meta-analysis results indicated a pooled MD of -0.53 (95% CI: -1.42, 0.37) for GAD-7. The forest plot for the GAD-7 is shown in Figure 3. Publication bias assessment using a funnel plot is presented in Figure 4.

Analysis of Treatment Effects on Stress

A total of 2 studies^{17,24} reported post-intervention PSS-4 data, while 3 studies^{17,24,25} reported the difference in PSS before and after treatment. The heterogeneity analysis for post-intervention PSS data showed no significant heterogeneity among the studies ($I^2=0\%$, $p=0.59$), and a fixed-effects model was used for the analysis. The meta-analysis results indicated a pooled MD

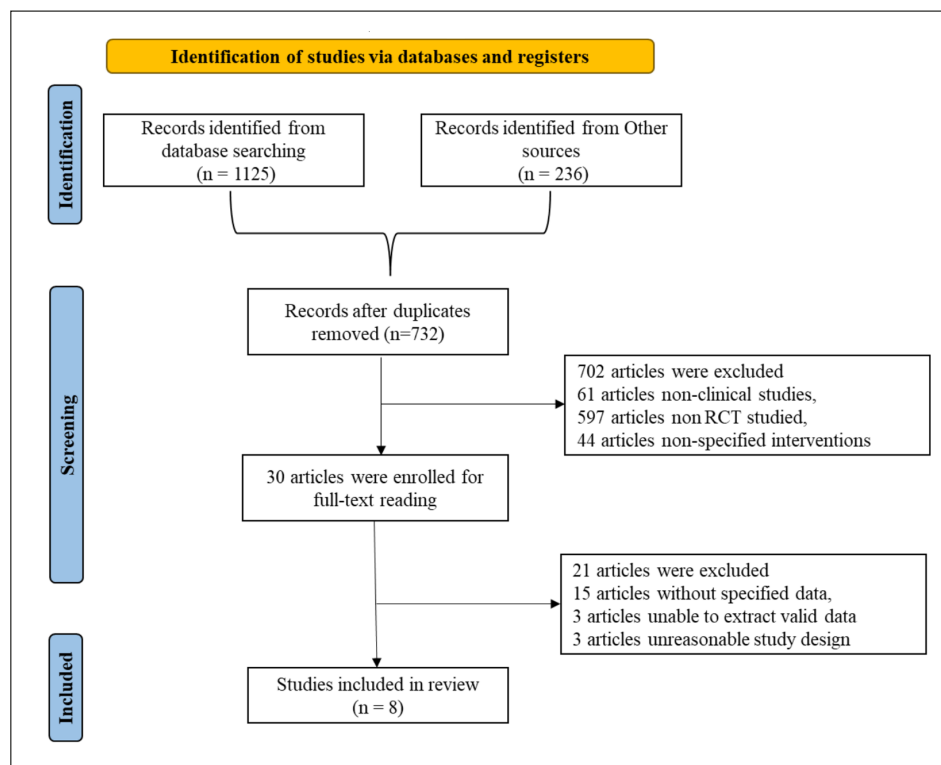


Figure 1. Flowchart for literature screening.

Table I. Basic Information of included studies.

Author	Year	Enrollments	N (c)	N (e)	Treatment (c)	Treatment (e)	Follow-up time
Pratt et al ⁷	2023	Nurses in frontline COVID-19 units	33	69	Waiting list	Mobile Mindfulness	4 weeks
Othman et al ¹⁸	2023	Critical care nurses caring or patients fwith COVID-19	30	30	No-treatment	Mindfulness-based intervention	8 weeks
Gunjiganvi et al ¹⁹	2023	Healthcare workers during the COVID-19 epidemic	40	39	No-treatment	Yoga Nidra	2-week
Sharma et al ²⁰	2022	Health care workers of tertiary care hospital during COVID-19	175	181	No-treatment	Add-on CAY intervention	12 weeks
Yıldırım et al ²¹	2022	Nurses in frontline COVID-19 units	52	52	No-treatment	Mindfulness-Based Breathing and Music Therapy Practice	Immediately
Fiol-DeRoque et al ²²	2021	Health care workers in frontline COVID-19 units	234	248	Wait list	PsyCovidApp	2 weeks
Dincer et al ²³	2021	Nurses who care for patients infected with COVID-19	37	35	No-treatment	Emotional Freedom Techniques	Immediately
Li et al ²⁴	2022	Healthcare workers in the frontline fight against COVID-19	47	87	No-treatment n	Brief mindfulness meditation	16 days
Fong et al ²⁵	2022	Nurses during COVID-19	38	39	Wait list	Mindful coloring	10 days

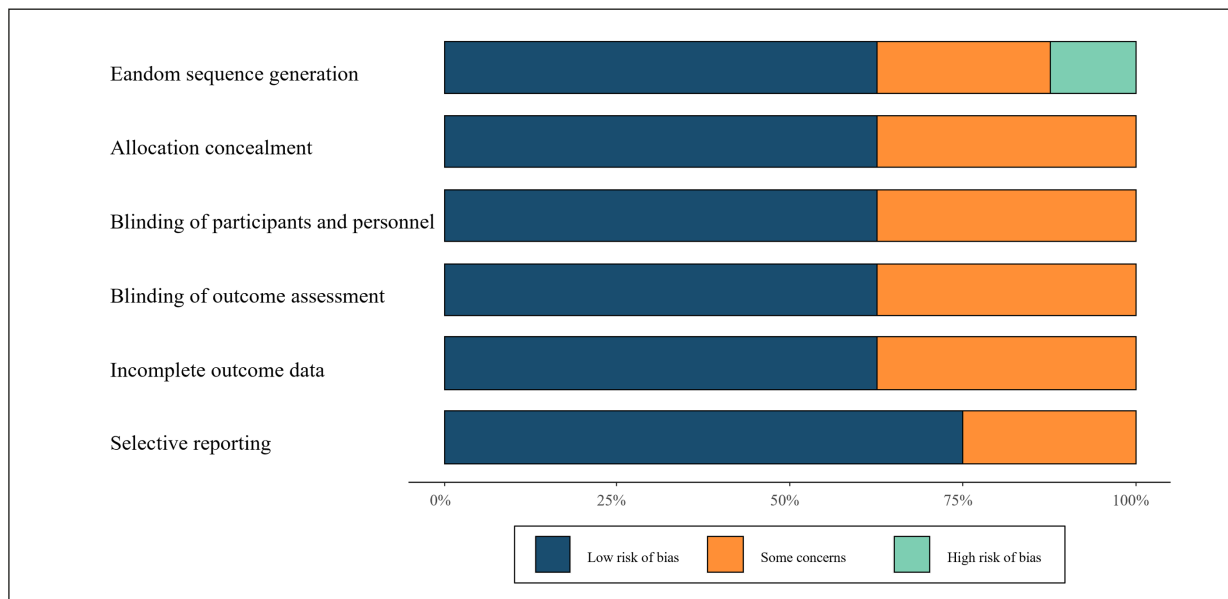


Figure 2. Quality assessment of included studies.

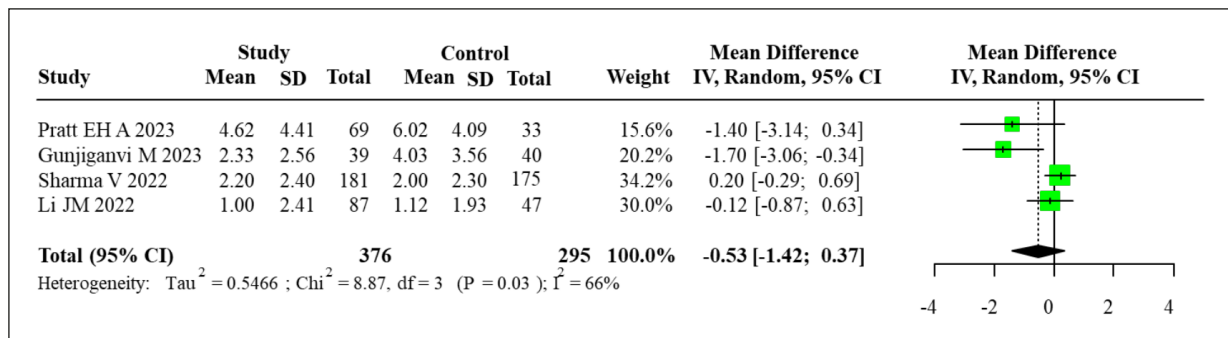


Figure 3. Forest plot of post-treatment GAD-7.

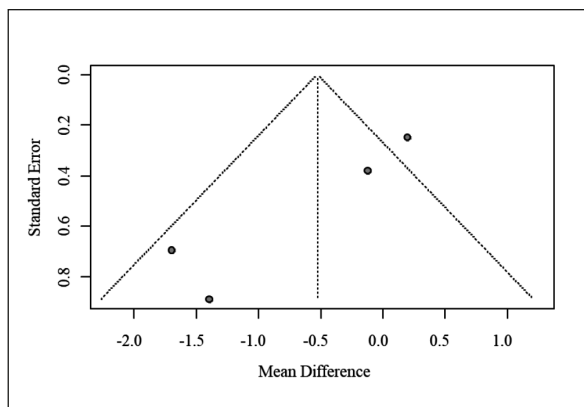


Figure 4. Funnel plot for publication bias of GAD-7.

of 0.13 (95% CI: -0.39, 0.65) for post-intervention PSS-4. The forest plot for post-intervention PSS-4 is shown in Figure 5. For the difference in PSS before and after the intervention, the heterogeneity analysis showed significant heterogeneity among the studies ($I^2=85\%$, $p<0.01$), so a random-effects model was employed for the analysis. The meta-analysis results indicated a pooled MD of -0.44 (95% CI: -2.65, 1.76) for the difference in PSS before and after intervention. The forest plot for the difference in PSS before and after intervention is shown in Figure 6. Publication bias assessment for the above indicators was conducted using a funnel plot, and the results are presented in Figure 7.

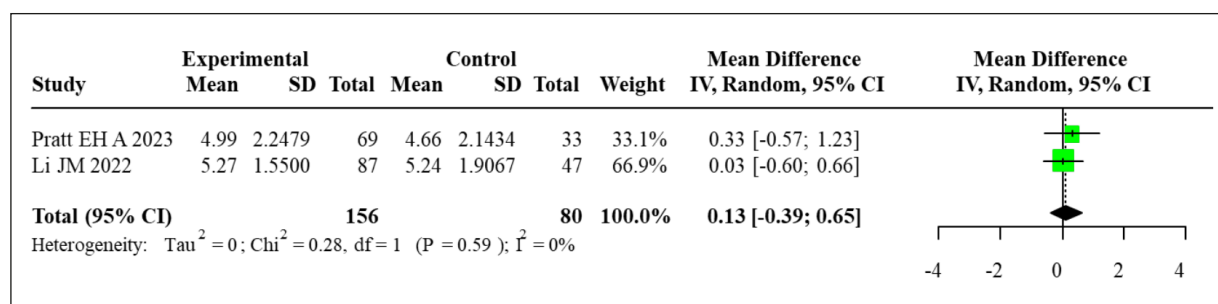


Figure 5. Forest plot of post-treatment PSS-4.

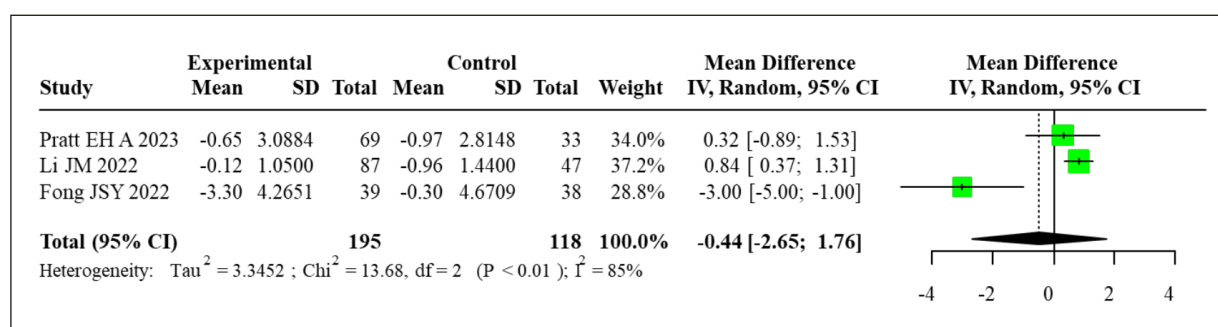


Figure 6. Forest plot of difference in PSS-4 before and after treatment.

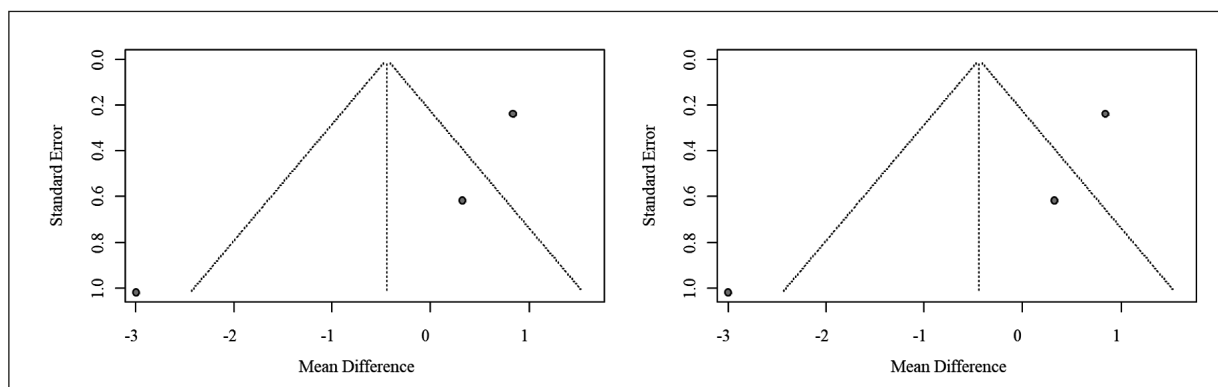


Figure 7. Funnel plot for publication bias of PSS-4.

Analysis of Treatment Effects on Fatigue

A total of 3 studies^{17,18,22} reported post-intervention MBI data, including MBI Emotional, MBI Personal Accomplishment, and MBI Depersonalization. The heterogeneity analysis indicated significant heterogeneity among the studies for all of the above indicators ($P \geq 90\%$, $p < 0.01$), and therefore a random-effects model was applied for the analysis.

The meta-analysis results showed that the pooled MD was -6.13 (95% CI: -16.68, 4.43) for MBI Emotional, 5.04 (95% CI: -3.25, 13.33) for the MBI Personal Accomplishment, and -1.68 (95% CI: -6.50, 3.13) for MBI Depersonalization. The forest plots for the above results are shown in Figures 8 to 10. Publication bias assessment for the above indicators was conducted using a funnel plot, and the results are presented in Figure 11.

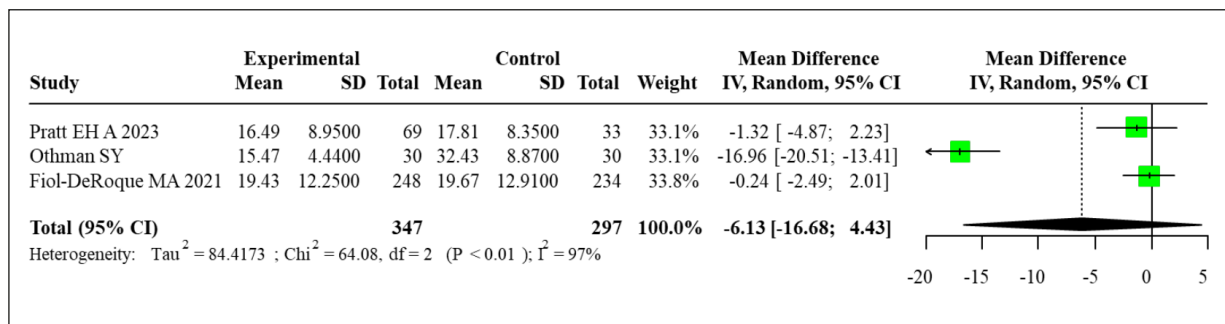


Figure 8. Forest plot of MBI emotional.

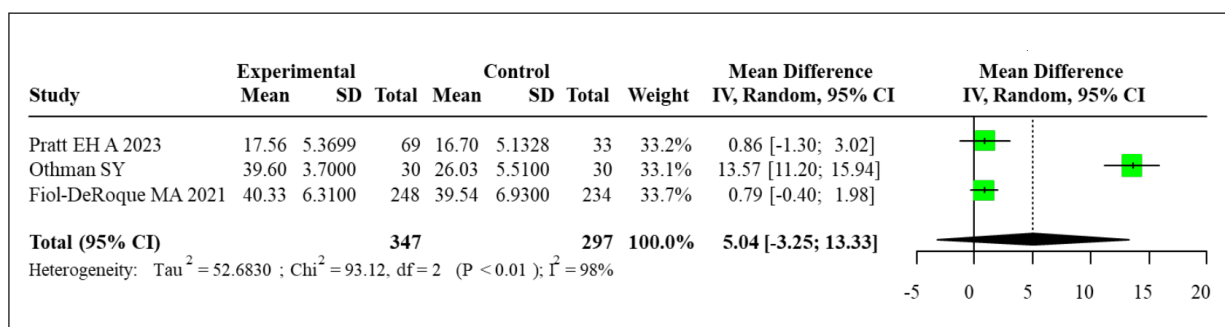


Figure 9. Forest plot of MBI personal accomplishment.

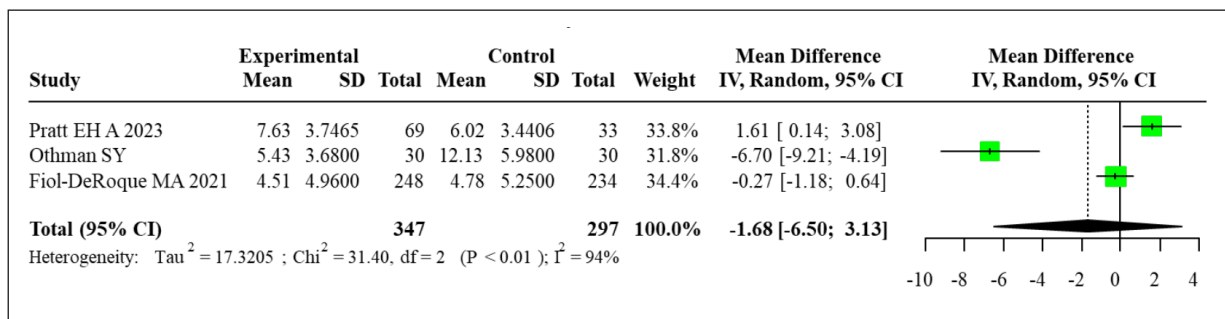


Figure 10. Forest plot of MBI depersonalization.

Discussion

The COVID-19 pandemic has presented a severe challenge, with frontline healthcare workers experiencing significant psychological pressure. They are more prone to common mental disorders such as anxiety, stress, and burnout, a phenomenon more pronounced among nurses than other healthcare professionals²⁶. It is crucial to safeguard the mental and physical well-being of health workers who are on the frontline against COVID-19. Therefore, exploration for appropri-

ate intervention strategies to alleviate symptoms of common mental disorders among healthcare workers is imperative.

This study aimed to evaluate the therapeutic effects of various intervention methods on anxiety, stress, and fatigue among frontline healthcare workers during the COVID-19 pandemic. After comprehensive searches, we included 9 randomized controlled studies that met the inclusion criteria. Mindfulness-based interventions were found to be the primary intervention method, with 4 included studies^{17,18,21,25} utilizing this approach.

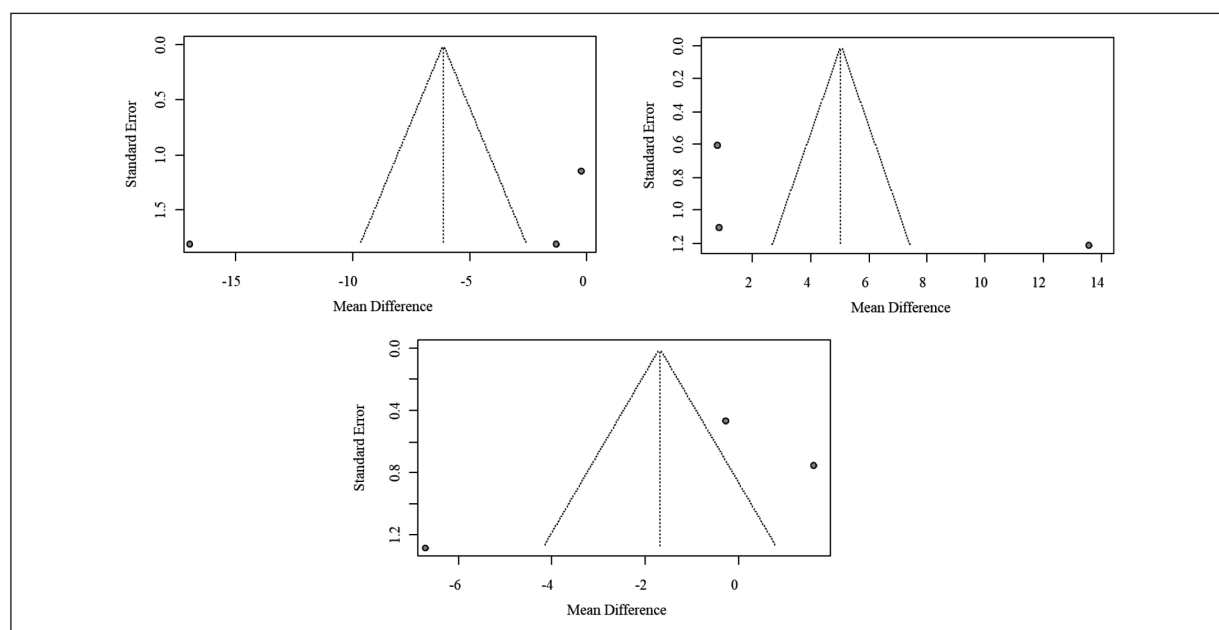


Figure 11. Funnel plot for publication bias of MBI.

Mindfulness-based therapy is a psychological intervention that addresses stress, pain, and illness through mindfulness meditation. In mindfulness practices, participants focus their attention primarily on breathing, emotions, thoughts, and bodily sensations. The practice typically begins with concentrating on the breath, which is the foundation of mindfulness practice, as it promotes self-regulation, heightened self-awareness, and reduction in the impact of stressors^{28,29}. Given the social distancing measures during the COVID-19 pandemic and the overloaded schedules, in-person counseling for healthcare workers is impractical. This has led to the emergence of web-based mindfulness interventions^{29,30}. Compared to face-to-face interventions, web-based mindfulness interventions can reduce the risk of healthcare workers contracting COVID-19, save their time, and allow for better patient care^{31,32}.

However, this study indicates that various intervention methods may lead to a trend in alleviating symptoms of anxiety, depression, and stress among frontline healthcare workers, but the overall effect did not reach statistical significance. Additionally, there was high heterogeneity among the studies on anxiety, stress, and fatigue. The reasons for this can be attributed to several factors. Firstly, significant variations were observed in the temporal and spatial dy-

namics of the pandemic, resulting in substantial differences in the epidemic situation faced by healthcare workers. This led to poor comparability of results across different studies. Secondly, evaluation scales varied across different studies, and the number of studies that collected data using the designated scales in this study was relatively small, resulting in potentially one-sided results. Furthermore, there was a wide disparity in the intervention durations across different studies, ranging from several days to several months, and evidence regarding the long-term effects of various intervention methods on mental disorders is also limited.

Limitations

The limitation of this study is that the results of the meta-analysis depend on all the included studies. The publication bias of experimenters and the unintentional negligence of meta-analysts can both lead to data omission. The objectives of the experiment may change as the experiment progresses. The main endpoint in the study design is defined, but the extension of the follow-up period may not be pre-defined, and even if it is pre-defined, other factors may also affect the publication of future studies. Therefore, the results of meta-analysis are constantly updated, and the conclusions may change over time.

Conclusions

Maintaining the mental health of frontline health workers is crucial during the COVID-19 pandemic, and mindfulness-based therapy is the most extensively employed psychological intervention method. However, its effectiveness requires further research confirmation.

Conflict of Interest

The authors declare that they have no competing interests.

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Authors' Contribution

Xiaoqing Zhou conceived the structure of the manuscript. Yinfeng Han did the experiments and made the figures. Meixiang Xu reviewed and edited the manuscript. All authors read and approved the final manuscript.

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Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval

Not applicable.

Informed Consent

Not applicable.

ORCID ID

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