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Mindfulness and health

Edited by
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Brian James Hall and Ulrich Kirk

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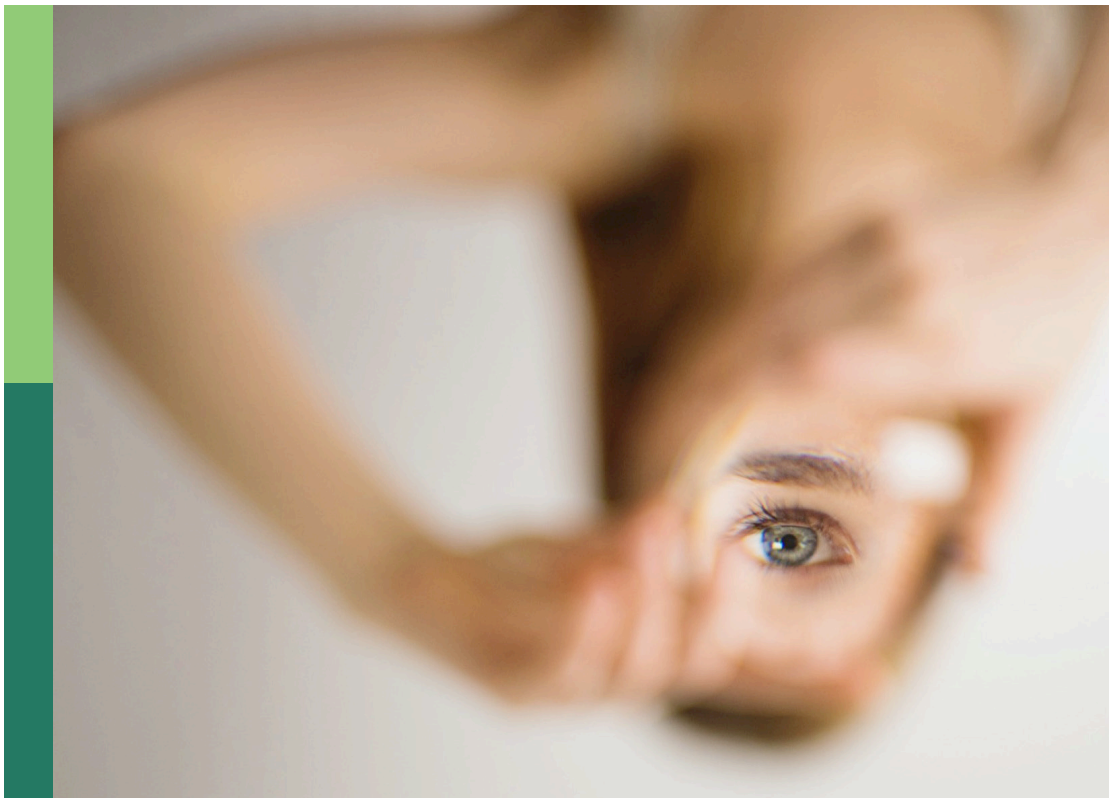

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Mindfulness and health

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Editorial: Mindfulness and health

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Editorial on the Research Topic
Mindfulness and health

Mindfulness has positive effects on physical and mental health. However, less is known about the antecedents to mindfulness, the mechanisms of mindfulness on health, and the cost and effectiveness of mindfulness-based interventions on health outcomes. This Research Topic brings research and empirical attention to antecedents to and mechanisms of mindfulness on health by including 10 contributions from authors in diverse settings and populations globally.

For instance, in the study by Xie et al. of Chinese social workers' burnout, mindfulness increased with perceived social support and in turn reduced job burnout, while mindfulness played a modest mediating effect. In another study of Chinese food and package delivery drivers' burnout (Zhang et al.), mindfulness reduced the positive relationship between job demands and drivers' burnout while it exacerbated the negative relationship between job resources and burnout. In other words, participants' levels of mindfulness acted as a protective factor from high job demands as well as a promotive factor for utilizing job resources.

Also worth noting is the increasing emphasis on the impact of mindfulness on biological processes. In Ng et al. study of a mindfulness-based stress reduction (MBSR) program in Taiwan, body scan was associated with declines in electroencephalogram (EEG) spectral powers in comparison with mindful breathing exercises; the MBSR group's improvement in emotion regulation was also associated with the EEG spectral changes in the theta, alpha, and low-beta bands. In another example, Grupe et al. study among police officers in the U.S. showed lower cortisol awakening responses among participants following an 8-week mindfulness intervention (but no effects for inflammatory biomarkers), along with improvements in distress, mental health, and sleep using self-reported surveys.

However, the complexity of using biomarkers inevitably adds another layer of difficulty in data collection and analysis. For example, Ng et al. study that used simultaneous EEG-functional magnetic resonance imaging (fMRI) signal data had a small sample size ($n = 17$ in the treatment group and 14 in waitlist control group) due to limited MRI scanning sessions. Given the nuance in operationalizing biological measurements (e.g., frequency range of EEG), the results also warrant cautious interpretation when comparing the biomarkers across studies. In the study of Grupe et al., in-person assessments could only be conducted in participants' non-work days, which led to lengthy post-intervention and follow-up assessments over several weeks. Future research that aims to collect biological data should take these limitations into consideration.

Several articles in this Research Topic focus on under-studied and under-served populations, such as delivery workers, police officers, and teachers in special education schools. As Grupe et al. mentioned, the strength of their study was their sustained engagement with marginalized communities, which allowed them to tailor their intervention for community members and prioritize the needs of participants. Although existing mindfulness literature focuses less

on marginalized populations, future research should involve these communities throughout the research process, from study planning to outcome evaluation, to maximize intervention effectiveness for individuals and families faced with greater challenges.

Some studies focus on previously under-examined outcomes or measurement issues. Cheung et al. examined the effect of mindfulness on grit, as measured by perseverance of effort and consistency of interests, factoring in participants' adverse childhood experiences among Chinese college students. Their results indicated a protective effect: Mindfulness was positively related to students' grit, and the negative effects of adverse childhood experience on grit became non-significant when controlling for level of mindfulness. Malakoutikhah et al. cross-sectional study compared the association between two different measures of mindfulness (the Relaxation/Meditation/Mindfulness Tracker t-Persian version [RMMt-P] vs. the Freiburg Mindfulness Inventory-Short-Form-Persian version [FMI-P]) and participants' anxiety, anger, and general health among an Iranian non-clinical adult sample. Their study suggests a "broadband" mindfulness measure (RMMt-P, which includes various mindfulness states such as thankfulness, relaxed, pleasant, and spaciousness) was a better predictor of general health and anger than a "narrowband" measure (FMI-P, a unidimensional measure of mindful presence and acceptance). Further, they suggest only some, but not all, mindfulness states had better predictive strength (e.g., mindful love, thankfulness, transcendence). Considering the complexity of conceptualizing and operationalizing "mindfulness," future research should consider how the measurement itself may make a difference in the results. This "measurement effect" may also vary by age, education level, and recruitment setting (e.g., clinical vs. non-clinical sample).

However, both above-mentioned studies used cross-sectional, self-reported surveys that cannot lead to a causal conclusion. This limitation may be addressed by more longitudinal studies and experimental designs. One example is the 3-wave longitudinal study by Su et al., who found that mindfulness mediates the relationship between positive parenting and Chinese middle school students' maladaptive psychological outcomes. As acknowledged by Su et al., although their multi-wave surveys allowed more rigorous mediation analysis than cross-sectional studies, further experimental designs are needed to rule out other potential factors (e.g., adolescents' resilience) and monitor the mediating effects over longer period of time.

In addition to outcome measures, baseline measures are also relevant to intervention effectiveness. In Vergara et al. comparison of three prior randomized controlled trials, participants' baseline level of mindfulness showed significant impact on individual trajectories in the intervention. Individuals who started with low-level mindfulness may benefit differently from those started with a higher level. Their findings necessitate the measurement of participants' initial status (such as the relatively stable mindfulness trait) in intervention planning. Whether a standard mindfulness intervention program works equally for everyone in the group is also worth further investigation. Echoing their conclusions, Hu et al. meta-analysis of mindfulness on empathy among healthy adults suggested that although overall mindfulness-based interventions showed a positive effect on empathy (d ranged 0.164–0.579), the effects varied by intervention dosage, format (online vs. offline), and program type.

In conclusion, this Research Topic exemplifies several potential future directions of mindfulness research in health-related fields: increasing interdisciplinary collaborations; integration of biological, emotional, and behavioral processes; interpretation of mindfulness practices in different cultural contexts; and a shift of focus from efficacy testing to moderating and mediating mechanisms of mindfulness-based interventions. With several decades of emerging empirical research, we expect there will be increase in rigorous research rooted in marginalized communities, adapted to unique cultural contexts, and that crosses disciplinary boundaries.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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The Impact of Mindfulness Training on Police Officer Stress, Mental Health, and Salivary Cortisol Levels

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Unaddressed occupational stress and trauma contribute to elevated rates of mental illness and suicide in policing, and to violent and aggressive behavior that disproportionately impacts communities of color. Emerging evidence suggests mindfulness training with police may reduce stress and aggression and improve mental health, but there is limited evidence for changes in biological outcomes or the lasting benefits of mindfulness training. We conducted a randomized controlled trial (RCT) of 114 police officers from three Midwestern U.S. law enforcement agencies. We assessed stress-related physical and mental health symptoms, blood-based inflammatory markers, and hair and salivary cortisol. Participants were then randomized to an 8-week mindfulness intervention or waitlist control (WLC), and the same assessments were repeated post-intervention and at 3-month follow-up. Relative to waitlist control, the mindfulness group had greater improvements in psychological distress, mental health symptoms, and sleep quality post-training, gains that were maintained at 3-month follow-up. Intervention participants also had a significantly lower cortisol awakening response (CAR) at 3-month follow-up relative to waitlist control. Contrary to hypotheses, there were no intervention effects on hair cortisol, diurnal cortisol slope, or inflammatory markers. In summary, an 8-week mindfulness intervention for police officers led to self-reported improvements in distress, mental health, and sleep, and a lower CAR. These benefits persisted (or emerged) at 3-month follow-up, suggesting that this training may buffer against the long-term consequences of chronic stress. Future research should assess the persistence of these benefits over a longer period while expanding the scope of outcomes to consider the broader community of mindfulness training for police.

Clinical Trial Registration: ClinicalTrials.gov #NCT03488875.

Keywords: law enforcement, stress, mental health, cortisol, mindfulness, posttraumatic stress disorder, inflammation, sleep

INTRODUCTION

There is a pressing need for evidence-based interventions to address twin crises of police officer mental health and the violent and discriminatory treatment of communities of color and marginalized groups by police. Daily exposure to direct and vicarious trauma, chronic organizational stressors, and heightened police-community tension contribute to elevated rates of posttraumatic stress, depression, alcoholism, and suicide in police officers relative to the general public (Ballenger et al., 2011; Carleton et al., 2017; Violanti et al., 2017a; Chopko et al., 2018; Syed et al., 2020). The fatigue, burnout, and hypervigilance that emerge in the absence of effective emotion regulatory strategies contribute to aggressive and discriminatory policing practices (Kop et al., 1999; Rajaratnam et al., 2011; Ma et al., 2013; Goff and Rau, 2020), exacerbating distrust and anger toward the police, particularly among communities of color that historically have been disproportionately impacted.

Recent research suggests mindfulness-based interventions (MBIs) may help address each of these crises. Commonly conceptualized as providing "stress reduction" techniques, the embodied practices and didactic knowledge contained within MBIs enhance self-awareness and self-regulation (Vago and Silbersweig, 2012), deepen one's sense of interconnection and compassion (Hutcherson et al., 2008; Kang et al., 2014), and encourage exploration and acceptance of challenging emotions (Thompson and Waltz, 2010; Lindsay and Creswell, 2017) as an alternative to culturally engrained patterns of avoidance and emotional control (Pogrebin and Poole, 1995; Karaffa and Tochkov, 2013). Two pilot studies demonstrated the acceptability, feasibility, and preliminary efficacy of MBIs adapted for police personnel (Christopher et al., 2016; Grupe et al., 2021a), and three randomized controlled trials (RCTs) have demonstrated benefits of mindfulness training relative to waitlist control (WLC) for self-reported stress, burnout, mindfulness, alcohol use, negative affect, and global health (Christopher et al., 2018; Krick and Felfe, 2019; Trombka et al., 2021). Results for anxiety and depression symptoms have been mixed, which could partially be attributable to differences in sample characteristics: a study of primarily male police officers in the U.S. Northwest found no differences (Christopher et al., 2018), whereas a study of primarily female officers in Brazil found sizable and durable reductions in anxiety and depression symptoms (Trombka et al., 2021).

Several gaps remain in our knowledge of the benefits of mindfulness training for police officer health and well-being. First, data on stress-related biological outcomes, particularly biomarkers related to cortisol and inflammation, are limited. Prolonged activation of the hypothalamic-pituitary-adrenal (HPA) axis and excessive cortisol release contribute to widespread dysregulation of central and peripheral biological systems influenced by this hormone (McEwen, 1998). Among other deleterious consequences, prolonged HPA axis activation lessens cortisol's ability to suppress inflammatory responses (Rohleder, 2012). Elevated inflammation is consequently associated with posttraumatic stress disorder (PTSD), depression, cardiovascular disease, and metabolic syndrome (Raison et al., 2006; Eraly et al., 2014; Lindqvist et al., 2014; Liu et al., 2017). Notably, MBIs have demonstrated benefits for immune system function, including relatively consistent decreases in C-reactive protein (CRP; Black and Slavich, 2016). No studies to our knowledge have investigated the impact of mindfulness training on inflammation in police officers, although one study provided tentative evidence for a lower cortisol awakening response (CAR) following mindfulness training (Christopher et al., 2018).

Second, data on the long-term impact of MBIs for police are also limited and inconsistent. One RCT in 61 United States police officers failed to find group differences 3 month post-training (Christopher et al., 2018) whereas another RCT in 170 Brazilian police officers reported robust benefits for mindfulness training vs. waitlist at 6-month follow-up for quality of life, anxiety, and depression (Trombka et al., 2021). The latter study is consistent with a single-arm pilot study that identified reductions in burnout, anxiety, and PTSD symptoms at 5-month follow-up (Grupe et al., 2021a). Demonstrating evidence for long-term benefits of these interventions is critical both for police officer well-being and that of the communities they serve.

We conducted a RCT of an 8-week adapted mindfulness training vs. waitlist control in 114 police officers from a medium-sized Midwestern United States city, recruiting from a city police department, university police department, and a county sheriff's agency. In addition to self-reported stress and mental/physical health, we collected data on biomarkers of cortisol release and inflammation immediately post-training and at 3-month follow-up. The focus of this report is on self-reported stress, stress-related physical and mental health, and biomarkers of relevance for stress-related illness. In the interest of coherence and brevity, additional outcomes are described briefly below but results will be reported elsewhere.

MATERIALS AND METHODS

Participants and Recruitment

Participants were sworn law enforcement officers employed by the Dane County Sheriff's Office, Madison Police Department, and University of Wisconsin-Madison Police Department. Participants were enrolled in two discrete cohorts, with 60 participants enrolled in Cohort 1 (March–April 2018) and 55 in Cohort 2 (February–March 2019). Participants self-selected into the study and participation, while encouraged by participating agencies, was fully voluntary. There were no inclusion criteria that participants needed to meet, for example with regard to pre-existing symptomology or health concerns. Exclusionary criteria included significant previous meditation practice or participation in a previous mindfulness class. For the first cohort of participants, personnel in command positions (lieutenant or above) were excluded, as were sheriff's deputies working primarily in the county jail; these individuals were eligible for the second cohort.

Prior to recruitment, we informally advertised the study to an officer advisory council, union leadership, and wellness committee members. Prior to Cohort 2, we spoke with key department stakeholders to develop strategies for engaging

officers of color in this research, which resulted in a more racially and ethnically representative cohort of participants. Formal recruitment activities included emails sent by agency liaisons, flyers posted at district stations, and announcements at daily briefings. Interested individuals contacted our study team and completed a phone screening to confirm eligibility (see **Figure 1** for CONSORT diagram).

Data Collection

In-Person Data Collection

Informed consent and in-person baseline assessments took place on average 15.4 days before randomization (range = 3–29). The same assessments occurred post-training (average 12.1 days, range = 3–26) and at 3-month follow-up (average 94.2 days after post-training assessment, range = 71–116). The two groups did not differ in the average amount of time between the intervention and post-test [mindfulness training = 12.3 days, waitlist control = 11.9 days; $t(107) = 0.38$, $p = 0.71$]. The follow-up assessment took place on average 3 days later for the mindfulness group (107.5 days) relative to waitlist control [104.6 days; $t(102) = 2.04$, $p = 0.04$].

At each visit, we collected accuracy and reaction time data on two computerized behavioral tasks, the mnemonic similarity task (Stark et al., 2013), and the affective go/no-go task (Hare et al., 2005; results not presented here). We obtained capillary blood on filter paper following lancet prick to assess inflammatory markers from dried blood spots (DBSs), and collected hair samples from 1" below the vertex of participants' scalps for hair cortisol concentration measurement. Participants completed a battery of self-report measures (**Table 2**; **Supplementary Table S2**) and a work and demographics questionnaire.

Field Data Collection

Following the in-person visit, participants collected field data over the course of their next scheduled work week. Participants collected four saliva samples using Salivette® cortisol tubes (Sarstedt, Nümbrecht) on each of 3 consecutive days – immediately after awakening, 30 and 45 min after awakening, and immediately before bed – and indicated the time of collection on paper logs. Participants were instructed to avoid eating, drinking, brushing teeth, smoking, or exercising prior to saliva collection. Participants were

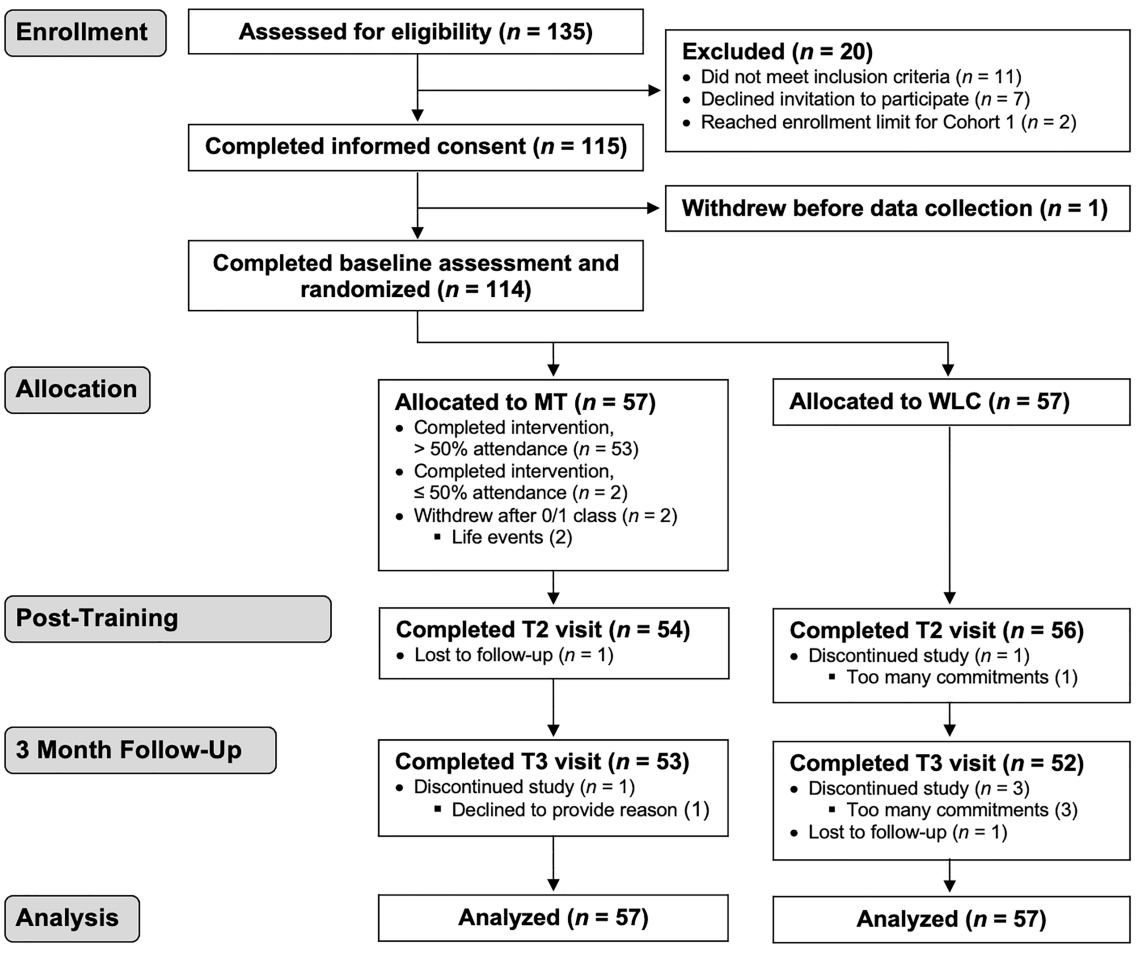

FIGURE 1 | CONSORT diagram. Primary intent-to-treat analysis includes all participants with baseline data collection ($n = 114$). MT, mindfulness training and WLC, waitlist control.

TABLE 1 | Demographic and work information.

Characteristic	MT	WLC
	N (%)	*N* (%)
Gender		
Female	23 (40)	24 (42)
Male	34 (60)	33 (58)
Race		
Caucasian	46 (81)	49 (86)
Black/African American	2 (4)	2 (4)
Asian	3 (5)	0
American Indian/Alaskan Native	0	2 (4)
More than one race	4 (7)	4 (7)
Unknown	2 (4)	0
Ethnicity		
Hispanic or Latinx	1 (2)	2 (4)
Not Hispanic or Latinx	55 (96)	55 (96)
Unknown	1 (2)	0
Marital Status[a]		
Married	16 (59)	17 (63)
Unmarried relationship	6 (22)	6 (22)
Divorced	2 (7)	2 (7)
Unknown	3 (11)	2 (7)
Education		
Some college education	4 (7)	9 (16)
Four-year college degree	38 (67)	34 (60)
Some post-graduate education	4 (7)	7 (12)
Post-graduate/professional degree	11 (19)	7 (12)
Agency		
Madison Police Department	33 (58)	31 (54)
Dane County Sheriff's Office	19 (33)	21 (37)
UW-Madison Police Department	5 (9)	5 (9)
Daily work schedule		
1st detail (~0600–1400)	28 (49)	27 (47)
2nd detail (~1200–2000)	4 (7)	4 (7)
3rd detail (~1400–2200)	18 (32)	17 (30)
4th detail (~2000–0400)	4 (7)	2 (4)
5th detail (~2200–0600)	3 (5)	7 (12)
Rank/job responsibilities		
Captain	1 (2)	0
Lieutenant	1 (2)	2 (4)
Sergeant	4 (7)	7 (12)
Detective	12 (21)	9 (16)
Investigator	1 (2)	2 (4)
Police Officer	25 (44)	20 (35)
Sheriff's Deputy	13 (23)	17 (30)
	Mean (SD)	**Mean (SD)**
Age	40.2 (7.4)	39.8 (9.3)
Years police experience	13.8 (7.9)	14.3 (8.3)

Due to rounding, percentages may not total 100%. MT, mindfulness training; WLC, waitlist control.

[a]*Information on marital status was collected for participants in Cohort 2 only (n = 27 for each group).*

provided with Fitbit Charge 2 activity trackers to assess heart rate and sleep throughout the week (analysis is ongoing; see https://osf.io/mqnga). At the end of each workday, participants completed an in-house "work events log" asking about exposure and perceived stress for work stressors (Chen and Grupe, under review). At the conclusion of the week, participants returned data collection materials in a postage-paid box.

Randomization

Block randomization to mindfulness training or waitlist control (stratified by police agency) occurred 1 week before classes began. Seven participant pairs and one group of four participants were randomized within "mini-strata," due to overlapping job responsibilities or to avoid assigning supervisor/supervisee pairs to the same class.

Intervention

The intervention was an 8-week, 18-h mindfulness-based training lightly modified from a previous feasibility pilot study (Grupe et al., 2021a,b). This police-specific training, inspired by Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Resilience Training (Christopher et al., 2016), is intended to promote resilient responses to the chronic and acute stressors of policing and to support officers' humanity and well-being. Weekly 2-h classes (and a 4-h class in week 7) consisted of didactic instruction around principles of mindfulness, stress, emotions, and scientific research on mindfulness; embodied practices, including mindfulness of the breath and body, a body scan, walking meditation, mindful movement (including adapted yoga or tai chi), mindfulness of thoughts and emotions, mindful speaking and listening, mindful eating, and compassion practice; and inquiry in dyads, triads, or the full group about participants' experiences in practice. Adaptations from traditional MBSR trainings included slightly shorter classes to better accommodate work schedules, shorter homework assignments to encourage more frequent if lighter engagement, language and practices tailored to police work and culture (and informed by time spent by our instructors with police officers in and out of work leading up to the classes), and the inclusion of informal mindfulness practices integrated into specific aspects of police work. For a curriculum overview, see **Appendix 1** [and for greater discussion of police-specific adaptations, see Grupe et al. (2021b)].

Participants were provided with guided practices recorded by instructors and police officers and were encouraged to practice 6 days/week, beginning with 9 min/day and eventually increasing to 20 min/day. The instructors offered participants suggestions for informal mindfulness practices (e.g., "drop-ins" to present-moment experiences, brief breath manipulations, and cultivating "mindful pauses") that they could integrate into daily activities. Participants were provided with paper and electronic logs (**Appendix 2**) to record formal and informal practice. Similar logs were used to track practice time between the end of the class and the follow-up assessment; because not all participants received and utilized these logs, estimates of practice time over this interval were based on retrospective practice reporting at follow-up (see "Data Analysis").

TABLE 2 | Differences between mindfulness training and waitlist control groups for all outcomes.

	Omnibus group*time				Group differences at time 2					Group differences at time 3				
Measure	χ^2	*p*	p_{fdr}	η^2	*t*	df	*p*	p_{fdr}	*d*	*t*	df	*p*	p_{fdr}	*d*
Component 1: distress	10.21	0.006	-	0.09	−2.96	172.9	0.003	-	−0.45	−2.69	176.9	0.008	-	−0.41
Perceived stress scale	5.68	0.06	0.09	0.05	−1.62	183.5	0.11	0.18	−0.24	−2.30	187.5	0.02	0.04	−0.34
PTSD checklist	6.20	0.04	0.09	0.05	−2.52	163.2	0.01	0.04	−0.40	−1.44	168.1	0.15	0.20	−0.22
PROMIS anxiety	7.08	0.03	0.09	0.06	−2.27	176.7	0.02	0.05	−0.34	−2.37	180.1	0.02	0.04	−0.35
PROMIS depression	5.42	0.07	0.09	0.05	−1.47	168.6	0.14	0.19	−0.23	−2.34	173.6	0.02	0.04	−0.36
PROMIS fatigue	5.98	0.05	0.09	0.05	−2.01	185.0	0.05	0.10	−0.30	−2.14	188.2	0.03	0.05	−0.31
PROMIS social participation	0.40	0.82	0.82	0.00	−0.22	178.5	0.82	0.82	−0.03	0.43	182.3	0.67	0.73	0.06
Work limitations questionnaire	0.91	0.63	0.72	0.01	-0.81	207.4	0.42	0.48	−0.11	0.35	208.4	0.73	0.73	0.05
OLBI exhaustion	8.28	0.02	0.09	0.07	−2.66	177.8	0.008	0.04	−0.40	−2.31	181.5	0.02	0.04	−0.35
Component 2: pain	0.03	0.99	-	0.00	0.07	193.1	0.95	-	0.01	−0.12	195.7	0.90	-	−0.02
PROMIS pain intensity	0.00	1.00	1.00	0.00	−0.01	188.2	0.99	0.99	0.00	0.03	191.7	0.98	0.98	−0.00
PROMIS pain interference	0.06	0.97	1.00	0.00	0.21	197.1	0.83	0.99	0.03	−0.04	199.3	0.97	0.98	−0.01
Component 3: physical health	2.82	0.24	-	0.01	0.32	214.9	0.75	-	0.05	1.67	215.0	0.10	-	0.23
Health behavior checklist	1.25	0.53	0.53	0.01	0.89	190.2	0.38	0.39	0.13	−0.34	194.0	0.74	0.74	−0.05
PROMIS physical function	2.37	0.31	0.53	0.02	0.86	207.2	0.39	0.39	0.12	1.42	208.2	0.16	0.32	0.20
Component 4: police stress	0.45	0.80	-	0.00	−0.66	171.5	0.51	-	−0.10	−0.27	175.3	0.79	-	−0.04
Operational PSQ	0.40	0.82	0.90	0.00	−0.60	168.0	0.55	0.64	−0.09	−0.13	172.0	0.90	0.90	−0.02
Organizational PSQ	0.21	0.90	0.90	0.00	−0.46	178.0	0.64	0.64	−0.07	−0.21	181.4	0.83	0.90	−0.03
Component 5: disrupted sleep	9.01	0.01	-	0.08	−1.66	186.1	0.10	-	−0.25	−2.99	189.3	0.003	-	−0.44
Pittsburgh sleep quality index	4.13	0.13	0.13	0.04	−0.42	177.1	0.67	0.67	−0.06	−1.98	179.1	0.05	0.05	−0.30
PROMIS sleep disturbances	9.52	0.009	0.02	0.09	−2.01	197.9	0.05	0.10	−0.29	−2.87	200.1	0.005	0.01	−0.41
Cortisol awakening response (CAR)	5.55	0.06	-	0.04	−1.31	187.6	0.19	-	−0.20	−2.31	195.3	0.02	-	−0.33
Diurnal cortisol slope	1.25	0.54	-	0.01	−0.75	116.3	0.45	-	−0.14	−0.95	125.2	0.34	-	−0.17
Hair cortisol concentration	1.03	0.60	-	0.01	0.26	119.7	0.80	-	0.05	1.01	124.7	0.31	-	0.18
High-sensitivity CRP	2.05	0.36	-	0.02	0.87	161.6	0.38	-	0.14	−0.61	167.0	0.54	-	−0.09
Cytokine 3-plex	0.39	0.82	-	0.01	0.49	141.5	0.63	-	0.08	0.49	138.3	0.62	-	0.08
IL-6	1.48	0.48	0.84	0.02	0.77	147.4	0.44	0.77	0.13	1.00	146.3	0.32	0.68	0.17
IL-10	0.46	0.79	0.84	0.01	0.65	126.1	0.52	0.77	0.12	0.42	120.1	0.68	0.68	0.08
TNF-α	0.34	0.84	0.84	0.00	−0.29	138.7	0.77	0.77	−0.05	−0.55	135.1	0.58	0.68	−0.10

Statistics are the results of linear mixed effects models adjusted for baseline scores with covariates of gender, years of police experience, and cohort (year 1/year 2), and additional covariates for biological markers as indicated in Materials and Methods, and a random intercept for each participant. p_{fdr} =false discovery rate-corrected p values within each component measure. PTSD, posttraumatic stress disorder; PROMIS, Patient-Reported Outcomes Measurement Information System; OLBI, oldenburg burnout inventory; PSQ, Police Stress Questionnaire; CRP, C-reactive protein; IL, interleukin; and TNF, tumor necrosis factor.

Data Processing

Self-Report

We collected 18 self-report (sub)scales related to stress and physical/mental health: the Organizational and Operational Police Stress Questionnaire (McCreary and Thompson, 2006); Perceived Stress Scale (Cohen and Williamson, 1988); PTSD Checklist for DSM-5 (Weathers et al., 2013); eight subscales from the Patient-Reported Outcomes Measurement Information System (PROMIS anxiety, depression, fatigue, sleep disturbances, ability to participate in social roles and activities, physical function, pain interference, and pain intensity); Pittsburgh Sleep Quality Inventory (Buysse et al., 1989); Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993); Oldenburg Burnout Inventory (Halbesleben and Demerouti, 2005); Health Behaviors Checklist (HBC; Hampson et al., 2017); and Work Limitations Questionnaire (Lerner et al., 2002). We obtained a broad array of self-report outcomes because of the eclectic nature of MBIs and the relative lack of RCTs on these interventions in law enforcement populations. In order to limit the number of comparisons and test the impact of mindfulness training on broad domains of stress and health, data-driven reduction of these (sub)scales into five discrete components was accomplished using principal component analysis (PCA) in R (see Results).

Biological Outcomes

Salivary Cortisol

Salivettes were centrifuged and samples stored at −80° until shipment to the lab of Dr. Nicolas Rohleder at Brandeis University. Salivary cortisol was measured using a commercially available luminescence immunoassay (CLIA; IBL-Hamburg, Hamburg, Germany). Intra- and inter-assay coefficients of variation were 5.61 and 8.64% (2018 cohort) and 5.32 and 8.42% (2019 cohort), respectively. Raw values were log-transformed, and observations greater than three SDs from the mean of each sampling time were excluded. The CAR (CAR) was operationalized as the difference between the greater of the 30/45-min values and the waking value. Diurnal slope was operationalized as the difference between the waking and bedtime values, divided by the number of minutes between these samples. For days with a negative CAR – suggesting non-compliance for the waking sample – both the CAR and slope were excluded (21% of observations across timepoints). We additionally excluded the 16 nightshift workers (14% of the sample) from salivary cortisol analyses as we expected these individuals would demonstrate categorically distinct diurnal responses.

Hair Cortisol Concentration

Hair cortisol concentration from the 3-cm segment proximal to the scalp was measured using immunoassay methods in the lab of Dr. Clemens Kirschbaum at Technische Universität Dresden. Samples with no discernable cortisol were assigned values of 0.15 pg/mg (the lower detection limit). Samples with "supra-physiological" levels of cortisol (operationalized as 3 SD above the mean) were assumed to be contaminated (Wang et al., 2019) and were excluded (1% of samples). Log-transformed values were used for analysis.

Inflammatory Markers

Dried blood spot samples were stored at −80° until shipment to the lab of Dr. Thom McDade at Northwestern University. CRP was quantified using an updated version of a protocol previously validated for use with DBS samples (Schmid et al., 2004). CRP values >10 mg/ml were assumed to reflect acute infection and were removed (1% of samples). The inflammatory cytokines interleukin (IL)-6, IL-10, and tumor necrosis factor (TNF)-α were quantified as described in a recent validation study (McDade et al., 2020). All inflammatory markers were log-transformed, and a summary measure of the three cytokines was derived by taking the mean of Z-transformed scores at each timepoint (normalized to mean baseline values).

Data Analysis

Statistical analyses were conducted in RStudio (Version 1.2.5042; RStudio Team, 2020) in the R programming environment (Version 3.6.3; R Core Team, 2020).

Using the "lmerTest" library, we conducted intent-to-treat, linear mixed effects analyses, including all observations at all timepoints. Models included baseline scores for each outcome as a fixed covariate (for salivary cortisol analyses, the within-subject average across baseline sampling days), a random intercept, and fixed covariates of gender, years of police experience, and cohort. Cortisol and DBS analyses additionally controlled for BMI; cortisol analyses controlled for smoking status; hair cortisol analyses controlled for hair dye or similar treatments; and salivary cortisol analyses controlled for workday. We were unable to model the non-independence of participants within mindfulness classes, as the small number of classes led to convergence errors.

The significance of Group*Time interactions (across post-intervention and follow-up timepoints) was assessed using the anova.lmerModLmerTest() function to compare models with and without the interaction term. We also calculated group differences at post-intervention and follow-up timepoints individually. We tested for "dose-response" effects by correlating change scores for each outcome with self-reported practice minutes during the class. For the follow-up period, we used retrospective self-report to classify participants as "high engagement" ($\geq$2 days of formal practice/week; $N = 22$) or "low engagement" ($\leq$1 day of formal practice/week; $N = 32$) and compared these groups on change scores over the same period.

Pre-registration

Salivary and hair cortisol processing and analysis followed our Open Science Framework pre-registration[1] with two exceptions. First, we adjusted for baseline DV values to address regression to the mean. Second, we removed the random slope and nesting for mixed models to remedy convergence errors (Matuschek et al., 2017). We only report

[1]https://osf.io/49px2

here results for intervention effects (Hypotheses 1b, 2b, and 3b). We did not pre-register hypotheses for other outcomes.

RESULTS

Participants Flow and Intervention Engagement

One participant withdraw following consent and prior to data collection, leaving 114 participants for intent-to-treat analyses (**Figure 1**). Information on demographics and job characteristics is in **Table 1**.

Intervention engagement was excellent, with 55/57 participants completing the mindfulness training. Overall class attendance was 80.3%, with 53/57 participants attending more than 50% of the classes. Participants reported a median of 42 days of formal meditation practice over 8 weeks (range = 0–55), and a median of 130 weekly practice minutes (8-week range = 0–2,669; **Supplementary Figure S1**).

Principal Component Analysis of Self-Report Data

We used PCA to reduce 18 self-report (sub)scales of stress, mental health, and physical health into five components with an eigenvalue cut-off of 1.0. After reviewing item loadings, we sequentially removed Oldenburg-disengagement and AUDIT scores, which each loaded <0.40 on all components. The remaining items each loaded >0.60 on a single component, and we retained this 16-item, 5-component structure for subsequent analyses (**Supplementary Table S1**). These five components reflected psychological distress/mental health (Component 1, eight items, and 28% total variance explained), pain (Component 2, two items, and 11% variance), physical health (Component 3, two items, and 10% variance), occupational stress (Component 4, two items, and 12% variance), and sleep disturbances (Component 5, two items, and 13% variance).

Effects of Mindfulness Training on Self-Reported Stress and Health Outcomes

A significant Group*Time interaction for Component 1 reflected reduced distress and mental health symptoms following mindfulness training relative to waitlist control, controlling for baseline symptoms, cohort, gender, and years of policing [$\chi^2(2, N=10)=10.21$, $p=0.006$, $\eta^2=0.09$; **Figure 2**; **Table 2**]. Improved mental health and reduced distress were observed immediately after the 8-week training [$t(172.9)=-2.96$, $p=0.003$, $d=-0.45$] and at 3-month follow-up [$t(176.9)=-2.69$, $p=0.008$, $d=-0.41$]. Examination of individual subscales showed significant Group*Time interactions (uncorrected for multiple comparisons) for the PTSD Checklist, PROMIS-anxiety, PROMIS-fatigue, and Oldenburg-exhaustion, with marginal interactions (and significant group differences at 3-month follow-up only) for the Perceived Stress Scale and PROMIS-depression (see **Table 2** for test statistics, including corrected/uncorrected p values).

A significant Group*Time interaction was also observed for Component 5, reflecting improved sleep quality following mindfulness training relative to waitlist control [$\chi^2(2, N=10)=9.01$, $p=0.01$, $\eta^2=0.08$; **Figure 2**; **Table 2**]. This difference was not significant immediately post-training [$t(186.1)=-1.66$, $p=0.10$, $d=-0.25$] but was significant at 3-month follow-up [$t(189.3)=-2.99$, $p=0.003$, $d=-0.44$]. Examination of individual subscales showed a significant Group*Time interaction for PROMIS-sleep disturbances but not the Pittsburgh Sleep Quality Inventory, which showed group differences at 3-month follow-up only (**Table 2**).

There were no significant Group*Time interactions for pain [Component 2; $\chi^2(2, N=10)=0.03$, $p=0.99$, $\eta^2=0.00$], physical health [Component 3; $\chi^2(2, N=10)=2.82$, $p=0.24$, $\eta^2=0.01$], or occupational stress [Component 4; $\chi^2(2, N=10)=0.45$, $p=0.80$, $\eta^2=0.00$], and no group differences at post-training ($|ts|<0.7$, $ps>0.5$) or 3-month follow-up ($|ts|<1.3$, $ps>0.2$; **Figure 2**; **Table 2**).

We tested for "dose-response" effects by relating formal practice during the 8-week class with change scores over the same interval, which revealed no significant relationships with any self-report components ($|rs|<0.24$, $ps>0.09$). High-vs.-low practice engagement over the 3-month follow-up period was associated with improved physical health over this interval [$t(52)=-2.35$, $p=0.02$, $d=-0.31$]. Greater practice was also associated with a significant *increase* in occupational stress over this period [$t(52)=2.16$, $p=0.04$, $d=0.29$]. Practice engagement was not associated with changes in distress/mental health, pain, or sleep disturbances ($|ts|<1.4$, $ps>0.1$).

Effects of Mindfulness Training on Cortisol

The CAR measured over 3 workdays showed a marginally significant Group*Time interaction, controlling for baseline CAR, cohort, gender, years of policing, smoking status, and BMI [$\chi^2(2, N=13)=5.55$, $p=0.06$, $\eta^2=0.04$; **Figure 3**; **Table 2**]. There was no significant group difference post-training [$t(187.6)=-1.31$, $p=0.19$, $d=-0.20$], but the mindfulness group had a significantly lower CAR relative to waitlist control at follow-up [$t(195.3)=-2.31$, $p=0.02$, $d=-0.33$].

Greater practice time during the class was associated with a greater reduction in the CAR between baseline and post-training assessments [$r(43)=-0.34$, $p=0.02$; **Figure 3**]. CAR changes between post-training and 3-month follow-up did not differ as a function of practice engagement over this period [$t(39)=0.49$, $p=0.63$].

Group*Time interactions were not significant for diurnal cortisol slope [$\chi^2(2, N=13)=1.25$, $p=0.54$, $\eta^2=0.01$] or hair cortisol concentration [$\chi^2(2, N=13)=1.03$, $p=0.60$, $\eta^2=0.01$; **Table 2**; **Supplementary Figure S2**]. There were no significant relationships between formal practice time and changes in diurnal slope or hair cortisol concentration, either during the class ($|rs|<0.22$, $ps>0.2$) or over the 3-month follow-up interval ($|ts|<1.4$, $ps>0.1$).

Effects of Mindfulness Training on Inflammatory Markers

Group*Time interactions were not significant for CRP [$\chi^2(2, N=11)=2.05$, $p=0.36$, $\eta^2=0.02$], the cytokine 3-plex

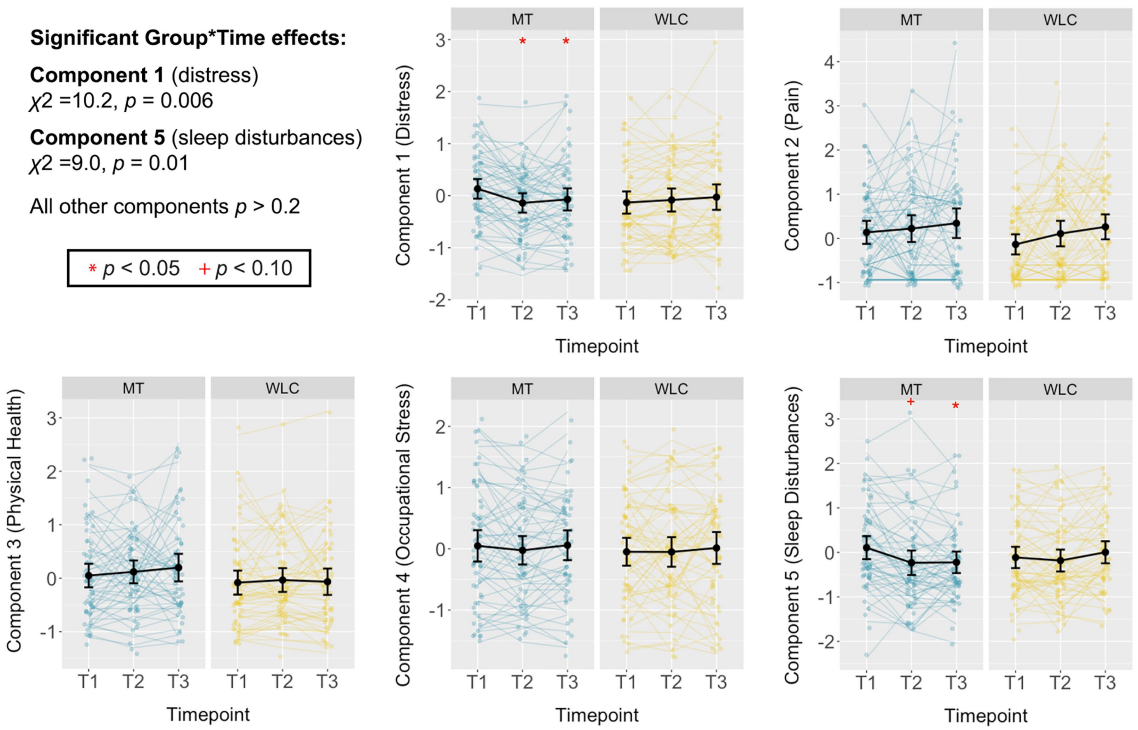

FIGURE 2 | Effects of mindfulness training on self-reported, stress-relevant health outcomes. Standardized scores for each self-report domain identified through principal component analysis (PCA), plotted separately for mindfulness training (MT), and waitlist control (WLC) groups at baseline (T1), post-training (T2), and 3-month follow-up (T3). Relative to WLC, participants in the MT group had a significant reduction in self-report outcomes related to psychological distress and mental health symptoms (Component 1; $\chi^2 = 10.2$, $p = 0.006$), with group differences evident at T2 and T3 when controlling for scores at T1. A significant Group*Time interaction was also seen for sleep disruptions (Component 5; $\chi^2 = 9.0$, $p = 0.01$), although this difference was significant at T3 only. No other intervention effects were seen ($ps > 0.2$). Summary statistics are within-group means with 95% CIs.

[$\chi^2(2, N = 11) = 0.39$, $p = 0.82$, $\eta^2 = 0.02$], or any individual cytokines (all $\chi^2 < 1.5$, all $ps > 0.4$; **Table 2**; **Supplementary Figure S3**). There were no significant relationships between formal practice time and changes in inflammatory markers, either during the class ($|rs| < 0.28$, $ps > 0.1$) or over the 3-month follow-up interval ($|ts| < 2.0$, $ps > 0.06$).

DISCUSSION

Adding to a growing literature on the benefits of mindfulness training for police officers, we found a police-specific, 8-week MBI led to improvements in psychological distress, mental health, and subjective sleep quality, with no impact on pain, physical health, or occupational stress. These results replicate and extend previous RCTs of mindfulness training for police officers (Christopher et al., 2018; Trombka et al., 2021), while demonstrating evidence for persistent (or emergent) self-reported benefits at 3-month follow-up. A thorough investigation of the impact of mindfulness training on cortisol and inflammation revealed a reduced CAR for the mindfulness group at 3-month follow-up, with no effects for other stress-related biomarkers.

Our data-driven reduction of 18 self-report indices allowed us to test the impact of mindfulness training on five domains of stress and health. Mindfulness training led to significant reductions in psychological distress and mental health symptoms, consistent with previous RCTs demonstrating reduced anxiety and depression symptoms (Trombka et al., 2021), burnout and perceived stress (Christopher et al., 2018), and negative affect (Krick and Felfe, 2019). We provide the first evidence of reduced PTSD symptoms in an RCT of mindfulness training for police officers, consistent with findings from an earlier single-arm pilot study (Grupe et al., 2021a). This result is notable given high exposure to direct and vicarious trauma in policing, and the serious and potentially deadly consequences of unmitigated trauma exposure for police officers (Syed et al., 2020) and members of the public (Chemtob et al., 1997; Weiss et al., 2012).

We also observed a modest improvement in sleep quality with mindfulness training that was significant at 3-month follow-up (see also Christopher et al., 2018). Improved sleep may benefit both police officer health *and* community well-being. For example, North American police officers who screened positive for sleep disorders (40% of the sample) not only had increased rates of diabetes, heart disease, and depression, but were more likely to express anger at work, fall asleep while driving, and incur citizen complaints (Rajaratnam et al., 2011). Future longitudinal studies, including both laboratory and field outcomes, are needed to demonstrate whether improved mental health

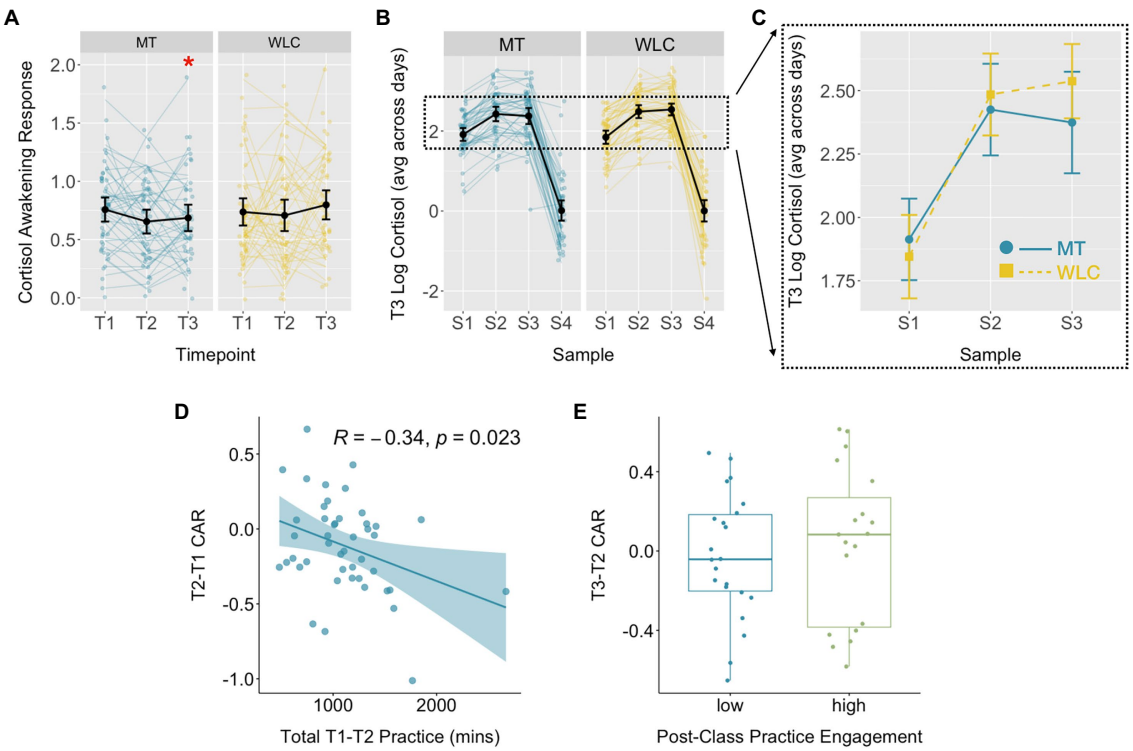

FIGURE 3 | Effects of mindfulness training on the CAR. **(A)** Log-transformed CAR for the MT and WLC groups at baseline (T1), post-mindfulness training (T2), and 3-month follow-up (T3). Controlling for T1 CAR, the MT group had a significantly lower CAR at T3 relative to WLC [$t(195.3) = 2.31$, $p = 0.02$]. **(B,C)** Log cortisol values at each of four sampling times for T3 show a steeper rise in cortisol between S1 (awakening) and S2 (30 min) for the WLC vs. MT group. Group means diverge further at S3 (45 min), with the WLC group showing a slight increase and the MT group a slight decrease. **(D)** Within the MT group, greater formal mindfulness practice during the 8-week class was associated with a greater reduction in the CAR between T1 and T2. **(E)** There was no difference between groups with relatively high vs. low practice engagement between post-training and follow-up assessments and changes in the CAR over the same interval. Summary statistics are within-group means with 95% CI.

and sleep quality lead to persistent and cascading benefits for police and community well-being.

Mindfulness training was associated with a reduction in the CAR at 3-month follow-up, consistent with results from a previous RCT in police officers (Christopher et al., 2018). Although the CAR is generally thought of as an adaptive anticipatory response to prepare for the upcoming day (Powell and Schlotz, 2012), exaggerated responses are associated with excessive worry, burnout, and depression (Schlotz et al., 2004; Fries et al., 2009). On the other hand, an abnormally low CAR – as observed in individuals with elevated PTSD symptoms (Wessa et al., 2006; de Kloet et al., 2007), including police officers (Neylan et al., 2005) – also appears maladaptive, perhaps reflecting increased negative feedback sensitivity resulting from chronic stressor exposure (Miller et al., 2007; Violanti et al., 2017b). The modest effect of mindfulness training here suggests the possibility of a particular "endophenotype" that may be amenable to change with mindfulness training (i.e., police officers with an elevated CAR at baseline), whereas those who show baseline blunting are less likely to show training effects.

We saw no training effects for diurnal cortisol slope or hair cortisol concentration. The mixed cortisol results underscore the complex interactions between chronic stress and repeated trauma exposure, psychopathology, and time-varying changes in cortisol dynamics. A seminal meta-analysis demonstrated that acute stressor exposure leads to elevated cortisol levels, giving way to blunted responses with the passage of time (Miller et al., 2007). The same meta-analysis revealed differential effects for uncontrollable, physical, and traumatic stressors vs. those that are social in nature and potentially controllable. Our participants have been exposed to a broad array of stressors – psychosocial and physical, acute and chronic, and traumatic and mundane. Our limited knowledge regarding stressor timing, chronicity, and subjective impact is an impediment to understanding what kinds of changes following mindfulness training are possible or would be considered "beneficial."

We also observed no effects for inflammatory markers. As with hair cortisol concentration and diurnal cortisol slope, inflammation has not been investigated in previous studies of mindfulness training for police officers. Given the relatively large sample size, these null findings are informative for investigators considering future studies in this area. A systematic review of MBI RCTs found some evidence for reductions in pro-inflammatory markers, particularly CRP, but many null results

(Black and Slavich, 2016). Intervention effects may be more pronounced for individuals at elevated risk for systemic inflammation, such as older adults or those with high BMI (Villalba et al., 2019), a challenging hypothesis to test in our relatively young and physically healthy sample. It may be informative to challenge police officers with a psychosocial stressor and measure evoked inflammatory responses – and/or changes in stress hormones and physiology – to test whether mindfulness training alters dynamic biological stress responses, rather than baseline levels (Rosenkranz et al., 2013; Johnson et al., 2014), consistent with a stress buffering hypothesis (Creswell and Lindsay, 2014).

Improved distress and mental health persisted at 3-month follow-up, consistent with a previous 8-week MBI in Brazilian police officers (Trombka et al., 2021) but in contrast to a study in United States police officers (Christopher et al., 2018). In addition, sleep improvements and CAR reductions were not significant until the follow-up assessment. One consideration for sustained improvements is the degree of continued mindfulness practice post-intervention. Christopher et al. (2018) reported that only two of 24 participants endorsed *any* practice between post-training and follow-up assessments [Trombka et al. (2021) did not provide data on practice engagement]. In our study, 43/54 participants assessed at follow-up reported some amount of practice after the class, with 41% reporting 2 or more weekly days of practice. Unfortunately, our measure of ongoing practice engagement was retrospective and rather coarse. A critical direction for future work is integrating detailed, real-time, and objective practice measures to illuminate how ongoing meditation practice may undergird long-term health benefits.

Limitations and Future Directions

One limitation of this study is that the mindfulness group was descriptively "less healthy" than the control group on several self-report outcomes at baseline. Although analyses controlled for baseline scores, which provides better protection against regression to the mean than difference scores (Vickers and Altman, 2001), apparent intervention effects may partially reflect random pre-intervention differences (while a common practice, testing for significant baseline differences in an RCT is non-meaningful as any differences by definition occurred by chance; de Boer et al., 2015). In support of our causal attribution of differences to the intervention, not all measures showing baseline differences resulted in post-training improvements. For example, both groups showed steady increases in pain through follow-up, and for physical health baseline differences became *more* pronounced over time. This could reflect greater body awareness following mindfulness training, although this relative worsening was not statistically significant.

Because we wanted to conduct in-person assessments during participants' non-work days – and due to staffing limitations, cancellations, and other pragmatic considerations – the time window for the "immediate" post-test was up to 4 weeks post-intervention, and the "3-month" follow-up was nearly 4 months post-intervention for some participants. Although this range of testing times may have injected noise into intervention effects that are time-sensitive, it was unlikely to systematically bias our results. The two groups did not differ in the average amount of time between the intervention and post-test, and the follow-up assessment took place on average 3 days later for the mindfulness group relative to waitlist control – a difference that should in theory favor the waitlist group, assuming intervention effects decay over time.

A more substantial limitation is the focus on data collected directly from officers, and consequent lack of evidence for the broader impact of this training. This research is predicated on the assumption that decreased police officer stress and increased well-being will have ripple effects for communities of color and marginalized individuals, whose health and safety are threatened daily by the police institution. While correlational evidence and laboratory studies provide theoretical support for this assumption (Kop et al., 1999; Rajaratnam et al., 2011; Ma et al., 2013; Andersen and Gustafsberg, 2016; Burke, 2020), without direct empirical evidence we cannot claim any community benefits for this training. Previous studies with police have shown reductions in self-reported anger and aggression following mindfulness training (Christopher et al., 2016, 2018); more compelling evidence for community benefits may involve data collected using objective metrics (e.g., administrative or body camera data on citizen interactions or use of force; Voigt et al., 2017; Wood et al., 2020), community members' reports on interactions with police officers, or the direct measurement of stress and health outcomes from community members (Geller et al., 2014; Smith et al., 2019; Browning et al., 2021; Muentner et al., 2021).

As we expand this work to consider community impacts, it is critical that specific outcomes (and broader research agendas) intended to benefit marginalized communities are designed collaboratively with these communities (Strand et al., 2003). To the extent that this research has improved police officer health and wellness, it is precisely because we have engaged police agencies in a sustained manner, asked how this work can benefit them, and designed our training and research accordingly (Grupe et al., 2021a). To move toward the goal of greater justice for those whose treatment by policing has historically been unjust and inequitable, we must similarly engage marginalized communities throughout the research process to ensure this work is aligned with their priorities and values. Through this process, we may learn more about the limitations of orienting this training around outcomes of "officer resilience" or "stress reduction." In collaboration with community members, police agencies, and contemplative teachers and practitioners, we can work to introduce a more explicit ethical and prosocial framework, attend to systems of injustice that do more to perpetuate violence and discrimination than the actions of individual "bad apples," and consider the role of contemplative practices in bringing about transformative change for individuals and larger systems.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Wisconsin-Madison Minimal Risk IRB. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DG, MR, and RD contributed to study conception and design. DG supervised all aspects of the project and wrote the first draft of the manuscript. CA, CM, and CS developed the intervention and wrote sections of the manuscript. DG and JS obtained the data. DG, JS, JM, and MR performed data analysis. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.720753/full#supplementary-material

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Mindfulness Training Associated With Resting-State Electroencephalograms Dynamics in Novice Practitioners *via* Mindful Breathing and Body-Scan

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Objectives: Mindfulness-based stress reduction has been proven to improve mental health and quality of life. This study examined how mindfulness training and various types of mindfulness practices altered brain activity.

Methods: Specifically, the spectral powers of scalp electroencephalography of the mindfulness-based stress reduction (MBSR) group ($n = 17$) who underwent an 8-week MBSR training—including mindful breathing and body-scan—were evaluated and compared with those of the waitlist controls ($n = 14$).

Results: Empirical results indicated that the post-intervention effect of MBSR significantly elevated the resting-state beta powers and reduced resting-state delta powers in both practices; such changes were not observed in the waitlist control. Compared with mindful breathing, body-scanning resulted in an overall decline in electroencephalograms (EEG) spectral powers at both delta and low-gamma bands among trained participants.

Conclusion: Together with our preliminary data of expert mediators, the aforementioned spectral changes were salient after intervention, but mitigated along with expertise. Additionally, after receiving training, the MBSR group's mindfulness and emotion regulation levels improved significantly, which were correlated with the EEG spectral changes in the theta, alpha, and low-beta bands. The results supported that MBSR might function as a

unique internal processing tool that involves increased vigilant capability and induces alterations similar to other cognitive training.

Keywords: mindfulness, mindfulness-based stress reduction, electroencephalograms, spectral power, five facet mindfulness questionnaire, difficulties in emotion regulation scale

INTRODUCTION

For Mindfulness refers to the mental state of being fully open and having attentional and nonjudgmental awareness of one's internal and external experiences in the present moment (Kabat-Zinn, 1994). At present, mindfulness meditation has attracted global attention because of its benefits to practitioners' mental health (Brown and Ryan, 2003). Mindfulness practices have been discovered to induce brain structure alterations (Fox et al., 2014), associated with improved working memory and attention (Van den Hurk et al., 2010; Mrazek et al., 2013). Mindfulness meditation can improve a practitioner's self-regulation capability by increasing positive affect, life satisfaction, and wellbeing (Brown and Ryan, 2003; Garland et al., 2015) and reducing depression, anxiety (Brown and Ryan, 2003; Davidson et al., 2003), stress (Irving et al., 2009), and even insomnia (Goldstein et al., 2019). Among various types of mindfulness interventions, mindfulness-based stress reduction (MBSR) is a standardized and secularized training program designed to improve mindfulness and coping abilities (Kabat-Zinn, 1994). MBSR programs typically span 8 weeks of weekly training, include one full-day workshop (Kabat-Zinn, 1994), and involve continuous mindfulness practices, such as mindful breathing, body-scan, and sitting meditation. Studies have demonstrated that after an 8-week training period, MBSR is generally effective in reducing depression and anxiety and promoting mental health (Fjorback et al., 2011). Although abundant evidence supports the role of MBSR in improving subjective perceptions, the brain mechanisms underlying MBSR remain to be investigated.

Neuroscience Evidence of Mindfulness

Mindfulness-based neuroscience studies have generally adopted a longitudinal approach instead of targeting situational practice effects. Objective measures of brain functions, such as electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), have generally been adopted to test the efficacy of mindfulness interventions. For example, in a study of the EEG power of the experienced Rinpoche, with meditation experience of >10,000 h, gamma power enhancement was evident even during a resting state (Lutz et al., 2004), and this effect was sustained even during non-rapid-eye-movement (NREM) sleep (Ferrarelli et al., 2013). For meditation novices, EEG measures following an 8-week MBSR program have been widely associated with convergent and consistent outcomes. Researchers have found MBSR practitioners tend to exhibit stronger beta power in the frontal lobe during mindfulness practice than during the resting state (Gao et al., 2016). Similarly, MBSR practitioners exhibited elevated alpha power in the occipital and right temporal lobes (Ahani et al., 2014). Theta band power was reported to increase in the central, parietal, occipital, and left and right temporal lobes after the MBSR intervention by Ahani et al. (2014). Furthermore, MBSR practitioners exhibited lower delta power in the central–parietal area after MBSR intervention (Gao et al., 2016), and patients with chronic insomnia were also found to have lower delta power in the central lobe during NREM sleep after MBSR intervention (Goldstein et al., 2019). Overall, MBSR intervention is generally believed to enhance high-frequency EEG power (i.e., beta and gamma); however, its effect on low-frequency EEG power (i.e., theta and delta) remains uncertain.

Such neurophysiological evidence concerning MBSR is consistent with the evidence on stress reduction and cognitive improvement (Davidson et al., 2003). For example, the beta power in the frontal and temporal lobes of participants without stress stimuli were higher than that of the participants with stress stimuli (Hayashi et al., 2009), suggesting a negative relationship between beta power and stress level. As for the low-frequency bands, healthy adult participants with a high perceived stress level had higher delta and theta activity in the frontal, central, and parietal lobes, compared with those who had a low perceived stress level (Luijcks et al., 2015). Another study on stress revealed that participants exhibited lower theta power under acute stressful conditions (Gärtner et al., 2014). Furthermore, another study highlighted how cognitive tasks elevated gamma power in comparison with the control conditions (Fitzgibbon et al., 2004), and a study on vigilance suggested that highly vigilant states corresponded to delta power suppression (Smallwood and Schooler, 2015). Overall, EEG evidence generally reveals that stress reduction is positively correlated to low-frequency-band power and negatively correlated to high-frequency-band power, whereas cognitive performance and vigilance state are positively correlated to high-frequency-band power and negatively correlated to low-frequency-band power. EEG spectral powers can serve as objective functional markers of cognitive enhancement and stress reduction.

The Difference Between Mindfulness Breathing and Body-Scan

In addition to the post-intervention effect of an 8-week MBSR program, the situational practice effect of such programs has recently attracted the attention of mindfulness researchers seeking to identify the variations between distinct mindfulness practices. The MBSR program involves a series of mindfulness practices (Kabat-Zinn, 1994; Davidson et al., 2003), such as mindful breathing, body-scan, compassion meditation, and open-monitoring. Davidson described the distinct practices associated with various cognitive effects in his book (Goleman and Davidson, 2017). Among the practices, mindful breathing and body-scan were most frequently used in previous studies (Ahani et al., 2014; Wahbeh et al., 2014; Isbel et al., 2019), and both of them are associated with interceptive

perceptions. However, the distinction between mindful breathing and body-scan can lead to different interoceptive effects on behavior and brain mechanisms. The fixed attention and relaxation in mindful breathing may differ from the attentional shifts to and from various body parts during body-scan. Recent studies have assessed the diverse effects of mindfulness practices using questionnaires and behavioral measures. One study demonstrated that people who practiced breath-focused meditation had a more nonjudgmental attitude toward themselves, showed more self-compassion, and experienced less emotional regulation difficulty. In contrast, those who practiced body-scan showed increased capabilities to describe their feelings and reduced rumination tendencies (Sauer-Zavala et al., 2013), suggesting that mindful breathing and body-scan affect different brain functions. Some studies have indicated that body-scan yields more positive outcomes for practitioners than does breathing. For example, body-scan practice leads to a major increase in body awareness and a decrease in thought contents, whereas breathing practice engenders a comparatively less intense change (Kok and Singer, 2017). Another study on veterans with post-traumatic stress disorder disclosed that participants who practiced body-scan exhibited greater mindfulness improvement than their breathing group counterparts (Colgan et al., 2016). Studies with self-rating scales have established that body-scan seems to provide more promising benefits than mindful breathing. On the other hand, neuroimaging studies on mindfulness generally examined mindfulness as a self-focused attention process, usually achieved through mindful breathing (Ferrarelli et al., 2013; Matiz et al., 2019). Shifted attention process, or body-scan practice, was rarely addressed before. The brain mechanisms targeted by the two mindfulness practices remain elusive at the current stage of research. Therefore, we adopted EEG measurement to examine the functional distinctions between mindful breathing and body-scan practices.

Working Hypothesis

Collectively, the EEG spectral alterations associated with various mindfulness practices remain elusive, and whether the mindful breathing and body-scan practices take effect are yet to be tested. We first proposed that the functional distinction between these two mindfulness practices lies in the spatio-spectral disparity of the EEG, meaning that frontal power elevation follows body-scan, and parietal power reduction follows mindful breathing after the 8-week MBSR intervention. Second, we proposed that the functional distinction between practices is amplified by the post-intervention effect (not observed in novices). Accordingly, we designed an EEG experiment to assess the neurophysiological changes in terms of both situational mindfulness practice and post-intervention effects. In addition, we conducted the same protocol with a waitlist control group without MBSR training to enable cross-group comparison.

MATERIALS AND METHODS

Participants

Forty-three volunteers were invited to participate in the MBSR training and register for an 8-week MBSR course in the fall of 2019. Before the course started, all volunteers were required to undergo one of the three orientation sessions to understand the details of the procedure, compensation, potential risks, and the contributions of this study. Potential participants were screened by applying the following exclusion criteria: being outside the age range of 20 to 80 years old; having prior experience of mindfulness meditation; having a metabolic illness, any history of mental illness, neural illness, or epilepsy; being a smoker or drug addict; and having any bodily metallic implant, claustrophobia, or pregnancy. Ten people who did not meet the criteria were excluded, and eventually 33 (4 men and 29 women) people aged between 29 and 68 years participated in the study (mean = 47.46, SD = 8.79; 18 participants in the MBSR group and 15 participants in the waitlist control group). The participants were new to mindfulness training before the study, and they received a free 8-week MBSR course for electing to participate. All of the participants provided written informed consent prior to participation. This study was reviewed and approved by the Taipei Medical University Joint Institute Review Board (TMU-JIRB, project number N201905049).

Intervention: MBSR and Waitlist Control

Each participant completed the EEG–fMRI experiments twice. For the MBSR group, two experiments were scheduled before and after the 8-week MBSR training (pre-test and post-test). For the waitlist control group, two scans were performed 8 weeks apart (same pre-test and post-test); however, they were prohibited from accessing and receiving information regarding mindfulness practice during this period. The MBSR group participated in an 8-week standardized MBSR course, as proposed by Santorelli et al. (2017). The MBSR course was instructed by a licensed MBSR instructor. MBSR classes were conducted weekly for 2.5 h for 8 weeks in addition to a one-day mindfulness workshop. These weekly meetings involved the development of various mindfulness skills, dialogue and reflection on mindfulness home practice, and practice segments. The participants performed types of mindfulness practice, such as a sitting meditation entailing breathing, mindful listening, body-scan, and mindful yoga. Participants were also assigned daily homework comprising both formal and informal meditation activities. Formal activities, including body-scan practice, sitting meditation, mindful yoga, mountain/lake meditation, or loving kindness meditation, required 45 min to complete each day. The participants were asked to complete a practice and information sheet. The participants in the waitlist control group were instructed to maintain their usual life activities but not engage with any mindfulness-related information during the 8 weeks. After the post-test experiment, the waitlist control group participants underwent an MBSR program for compensation.

Experimental Procedure

The study procedure is presented in **Figure 1**. In the orientation sessions, the study was explained to the participants; in particular, the use of the fMRI machine was detailed, as this study employed the EEG–fMRI simultaneous scanning technique (however, only EEG and behavioral information are included

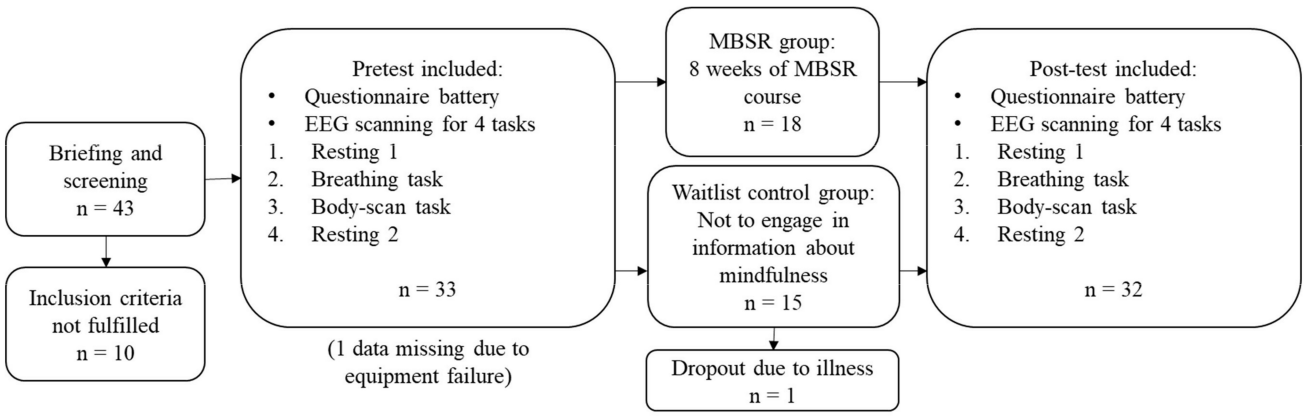

FIGURE 1 | Study design and recruitment procedure.

in this report). Thereafter, the participants finished the informed consent form and a questionnaire battery. The questionnaires were the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2008)—Taiwanese version, the Difficulties in Emotion Regulation Scale (DERS; Gratz and Roemer, 2004), and demographic questionnaires. The questionnaire battery took approximately 30 min to complete.

After the orientation sessions and within 2 months before the MBSR course, the researchers made an appointment for the participants to come into the laboratory for the pre-test experiment. The participants were introduced to the tasks that they would perform during the scanning while an EEG cap was being set up. In the scanning section, participants laid down in the MRI machine to perform four tasks. A mirror setting was installed with projectors for visual presentations. The first task was the resting state (*resting 1*): Participants were instructed not to think of anything specific with their eyes closed, not to move their heads, and not to fall asleep. The second task was the mindful breathing (*breathing*): Participants were instructed to pay attention to their natural breath and focus on the sensation near their noses during respiration. Whenever they realized that they were getting distracted, they were instructed to press a button on the right hand. The third task was the body-scan (*body-scan*): Participants were instructed to perceive the most salient body sensations and shift focus between various body parts during the session. Similar to the breathing task, they were instructed to press a button when they were distracted. Finally, an additional resting state (*resting 2*), identical to *resting 1*, was conducted to evaluate whether the brain status was returned to baseline after the mindful practices. Every task lasted 5 min, and if participants opened their eyes during a task, they would see a white fixation cross. The fixation image was black with a white cross in the center (see **Supplementary Material**). We used E-Prime 2.0.10 (Psychology Software Tools, Pittsburgh, PA, United States) for instruction presentation and response recording. After the pre-test experiment, the MBSR group participated in an 8-week MBSR course while the waitlist control group went about their usual life. Within 3 months after the completion of the MBSR course, all participants from both groups participated in the post-test experiments that were identical to the pre-test sessions. From pre-test sections to post-test sections, the mean time duration of all participants was 92.56 days (SD = 20.77 days).

It is noted that our task sequence had no counter-balance design. The consideration behind will be discussed in the limitation section.

Questionnaires

The Five Facet Mindfulness Questionnaire

Is a self-reported assessment for measuring mindfulness level (Baer et al., 2008). The FFMQ concerns five aspects of mindfulness, namely, observing, describing, being self-aware, having a nonjudgmental attitude toward inner experience, and being nonreactive to inner experience. Sample questions of the FFMQ are "I notice the smells and aromas of things" (observing), "I am good at finding words to describe my feelings" (describing), "I find myself doing things without paying attention (reversed)" (self-awareness), "I think some of my emotions are bad or inappropriate and I should not feel them (reversed)" (nonjudgmental), and "I perceive my feelings and emotions without having to react to them" (nonreactive). The FFMQ has 39 items, of which 19 are reversed. Items are rated on a 5-point Likert scale, ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*), and a total score from 39 to 195 can be obtained after answering the whole questionnaire. The FFMQ has good reliability ($\alpha = 0.72$ to .92; Baer et al., 2008). In this study, we employed a Taiwanese version of the FFMQ that was in Chinese (Huang et al., 2015), and its reliability was also satisfactory (α =0.91 and α =0.96 in the pre-test and post-test, respectively).

The Difficulties in Emotion Regulation Scale

Is a self-reported measurement tool for examining the level of difficulty experienced by people in addressing their negative emotions and producing desirable outcomes (Gratz and Roemer, 2004). The DERS concerns six aspects of emotion regulation difficulties, namely, nonacceptance of emotional responses,

difficulties engaging in goal-directed behaviors, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. Sample items are "When I'm upset, I feel guilty for feeling that way" (nonacceptance), "When I'm upset, I have difficulty getting work done" (goals), "When I'm upset, I lose control over my behaviors" (impulse), "I pay attention to how I feel (reversed)" (awareness), "When I'm upset, I believe that I will remain that way for a long time" (strategies), and "I am confused about how I feel" (clarity). The DERS has 36 items, of which 11 are reversed. Items are rated on a 5-point Likert scale, ranging from 1 (*almost never*) to 5 (*almost always*), and the total score obtained ranges from 36 to 180. The DERS has good reliability ($\alpha = 0.80$ to .89). This study employed a Taiwanese version of the DERS that was translated into Chinese through the back-translation procedure, and the reliability analysis yielded $\alpha = 0.96$ and $\alpha = 0.95$ for the pre-test and post-test, respectively.

EEG Measurement and Analysis

In each experiment, simultaneous EEG–fMRI signals were recorded for each functional scan using a 3 T PRISMA MRI scanner (Siemens, Erlangen, Germany). The 32-channel EEG data were recorded using an MR-compatible system (Brain Products GmbH, Gilching, Germany) that was positioned according to the international 10/20 system. The built-in impedance in each electrode was 5 kΩ, and abrasive electrode paste (Abralyt HiCl) was used to reduce the electrode–skin impedance. The EEG signal was recorded synchronously with the MR trigger using Brain Vision Recorder (Brain Products) with a 5 k-Hz sampling rate and a 0.5 μv voltage resolution (reference at FCz). A band-pass filter was set with cutoff frequencies of 250 Hz and 0.0159 Hz, and an additional 60-Hz notch filter was employed. Here, we have reported only the EEG outcomes, as the MRI results were designed to be reported separately.

Recorded EEG data were re-sampled to 50,000 Hz and then corrected for gradient-induced artifacts as Becker et al. (2005) suggested. Ballistocardiographic artifacts were corrected using the adaptive average subtraction method, and the R-peak intervals were estimated from the electrocardiogram electrode through Analyzer 2.1 (Brain Products) after the data were down-sampled to 250 Hz. The EEG data were then filtered with a 0.2–40 Hz band-pass FIR filter. Thereafter, an independent component analysis (ICA, with Infomax method) to eliminate artifacts caused by electrooculogram (EOG), electromyogram (EMG), and electrocardiogram (ECG) artifacts and the remaining MRI-induced artifacts. The artifact-free data were referenced to an average electrode across whole scalps, as recommended by Allen et al. (2004) and Davidson (1998). The processed data were converted into frequency domain representations using short-time Fourier transformation and Welch's periodogram method. Specifically, each 5-min EEG signal (75,000 points) was divided into 256-point segments using the Hanning window with 128 points overlapped. Each segment was zero-padded to 512 points, followed by a 512-point fast Fourier transformation. All the resultant spectra were subsequently log-transformed (10log10, results in dB; Allen et al., 2004) and averaged over segments. Finally, average EEG band powers were calculated in the frequency ranges of 1–4 Hz, 4–8 Hz, 8–13 Hz, 13–20 Hz, 20–30 Hz, and 30–40 Hz, representing delta, theta, alpha, low-beta, high-beta, and low-gamma band powers, respectively (Deuschl and Eisen, 1999; Rangaswamy et al., 2002; Teplan, 2002; Hauswald et al., 2015; Abhang et al., 2016; Grent-'t-Jong et al., 2018). These signal processes were conducted using the EEGLAB toolbox 13.6.5b (Swartz Center for Computational Neuroscience, University of California San Diego; Delorme and Makeig, 2004) with Matlab R2019a. The calculation of power spectrum density (PSD; in "dB") also followed the suggestion of Delorme and Makeig (2004). This study filtered out frequencies above 40 Hz since MR gradient-induced artifacts would severely contaminate the spectra over 40 Hz (Solana et al., 2014). Therefore, the EEG band of highest frequency in this study was low-gamma band (30–40 Hz).

Statistical Analysis

To ensure that all parameters (EEG band power and FFMQ and DERS scores) were fitted for parametric analyses, Kolmogorov–Smirnov tests were performed to examine normality. The chi-square test and *t*-test were conducted to examine whether demographic features, FFMQ, and DERS levels were different between the MBSR group and the waitlist control group before the MBSR intervention. Given that our working hypothesis is particularly to examine the effects of MBSR intervention, multiple paired *t*-tests were performed to examine whether a significant difference existed in terms of FFMQ and DERS in both groups before and after the MBSR intervention.

To examine whether EEG power spectra changed before and after the MBSR intervention, a paired-sample *t*-test was performed for every 0.5-Hz frequency bin in all four tasks (*resting 1*, *breathing* and *body-scan*, *resting 2*) in both groups and for both channels, Fz and Pz. In order to examine individual variations between EEG activities and behavioral measures, correlation analysis was then performed to reveal whether a correlation existed between the change of EEG band power before and after the MBSR intervention and the change of FFMQ and DERS scores in both groups. The change of EEG power was calculated by subtracting the pre-test EEG band power from the post-test EEG band power (post-test–pre-test), and the change in FFMQ and DERS scores was calculated similarly.

RESULTS

Normality Test

Table 1 presents the mean FFMQ and DERS scores rated by both the MBSR and control groups during the pre-test and post-test sessions. The MBSR group ($N = 18$) scored 114.94 ± 16.99 on the $FFMQ_{pre}$, 142.56 ± 23.24 on the $FFMQ_{post}$, 97.78 ± 20.72 on the $DERS_{pre}$, and 84.72 ± 23.21 on the $DERS_{post}$. The control group (N = 15) scored 116.80 ± 16.45 on the $FFMQ_{pre}$,

TABLE 1 | Demographic data and questionnaire statistics.

	Waitlist control group	MBSR group	Statistics	*p*
N	15	18		
Gender (female)	13	17	χ^2 (1) =1.60	0.206
Age	46.67 ± 8.03	48.50 ± 9.52	*t* (31) = 0.59	0.559
Year of Education	17.60 ± 2.53	16.89 ± 2.03	*t* (31) = −0.90	0.377
$FFMQ_{pre}$	116.80 ± 16.45	114.94 ± 16.99	*t* (31) = −0.32	0.753
$FFMQ_{post}$	115.87 ± 14.65	142.56 ± 23.24	*t* (17) = 5.32	<0.001
$FFMQ_{post-pre}$	−0.93 ± 13.62 *t* (14) = −0.27 *p* = 0.796	27.61 ± 22.02 *t* (17) = 5.26 *p* < 0.001		
$DERS_{pre}$	94.87 ± 22.53	97.78 ± 20.72	*t* (31) = 0.39	0.702
$DERS_{post}$	98.80 ± 16.12	84.72 ± 23.21	*t* (31) = −2.08	0.046
$DERS_{post-pre}$	3.93 ± 19.97 *t* (14) = 0.76 *p* = 0.458	−13.06 ± 25.87 *t* (17) = −2.14 *p* = 0.047		

115.87 ± 14.65 on the $FFMQ_{post}$, 84.87 ± 22.53 on the $DERS_{pre}$, and 98.80 ± 16.12 on the $DERS_{post}$. All these scores validated the assumption of normality (Kolmogorov–Smirnov test: $ps > 0.05$). In terms of resting-state EEG activity, the logarithmic powers of the delta, theta, alpha, low-beta, high-beta, and low-gamma bands over channels Fz and Pz recorded in the two sessions for both groups also validated the assumption of normality (Kolmogorov–Smirnov test: $ps > 0.05$). The only exception was the post-test low-gamma score for channel Pz in the waitlist control group ($p = 0.032$). Because our analysis focused on the main effects of the MBSR intervention group, parametric tests were employed in the subsequent analyses.

Demographic and Behavioral Analysis

Thirty-three participants (29 women and 4 men, aged 47.67 ± 8.79 years) were recruited in this study, of whom 15 (12 women and 3 men, aged 46.67 ± 8.03 years) served as the control group and 18 (17 women and 1 man, aged 48.50 ± 9.52 years) served as the MBSR group. As evident in the demographic data and questionnaire results presented in **Table 1**, no significant difference was apparent in terms of gender (χ^2 [1] = 1.60, $p = 0.206$), age (t [31] = 0.59, $p = 0.559$), and educational level (t [31] = −0.90, $p = 0.377$) between the waitlist control and MBSR groups.

A between-group analysis showed that the differences between the two groups in both questionnaire responses were significant in the post-test session (FFMQ: t [31] = 5.32, $p < 0.001$; DERS: t [31] = −2.08, $p = 0.046$) but not in the pre-test session (FFMQ: t [31] = −0.32, $p = 0.753$; DERS: t [31] = 0.39, $p = 0.702$). A within-group analysis showed that after the MBSR intervention, the MBSR group exhibited a significant increase in the FFMQ score (t [17] = 5.32, $p < 0.001$) and a decrease in the DERS score (t [17] = −2.14, $p = 0.047$) from the scores before the intervention, whereas the FFMQ (t [14] = −0.27, $p = 0.796$) and DERS (t [14] = 0.76, $p = 0.458$) scores of the waitlist control group remained unchanged.

EEG Comparison Between Pre-test and Post-test Sessions

After an 8-week mindfulness training, the effect of mindfulness practices on resting-state EEG activity was examined. **Figures 2, 3** illustrate the comparisons of PSD between the pre-test and post-test for Fz and Pz electrodes, respectively; the black asterisks indicate the significant differences in EEG powers identified at certain frequency bins. Student's *t*-test was applied for every 0.5-Hz frequency bin ranging from 0 Hz to 40 Hz (0–0.2 Hz was filtered out during preprocessing), followed by false discovery rate correction for conducting multiple comparisons across frequency bins and channels (Keselman et al., 2002).

For the MBSR group, compared with the pre-test session, the EEG activity of Fz and Pz sites measured in the post-test session revealed the following: (1) in *resting 1*, high-beta and low-gamma powers significantly increased (Fz: 24.5–40 Hz except 26 Hz, $ts \geq 2.56$, $ps < 0.05$; Pz: 20–20.5 Hz and 24.5–40 Hz, except 25.5, 26, and 35.5 Hz, $ts \geq 2.41$, $ps < 0.05$); (2) in *breathing*, high-beta and low-gamma powers significantly increased (Fz: 24.5–40 Hz except 25.5–26 Hz, $ts \geq 2.31$, $ps < 0.05$; Pz: 27–40 Hz, $ts \geq 2.70$, $ps < 0.05$) and delta powers significantly decreased (Fz: 0.2–2 Hz, $ts \geq -2.72$, $ps < 0.05$; Pz: 0.2–3 Hz, $ts \geq -2.61$, $ps < 0.05$); (3) in *body-scan*, high-beta and low-gamma powers significantly increased (Fz: 27–31.5 Hz, $ts \geq 2.83$, $ps < 0.05$; 34.5–40 Hz, $ts \geq 2.74$, $ps < 0.05$; Pz: 27–31.5 Hz, $ts \geq 3.05$, $ps < 0.05$; 34.5–40 Hz, $ts \geq 2.94$, $ps < 0.05$) and delta power significantly decreased only at Fz (0.2–1.5 Hz, $ts \geq -2.76$, $ps < 0.05$); and (4) in *resting 2*, high-beta and low-gamma powers significantly increased (Fz: 27–31.5 Hz, $ts \geq 2.80$, $ps < 0.05$; 34.5–40 Hz, $ts \geq 2.85$, $ps < 0.05$; Pz: 25–31.5 Hz except 25.5 and 26 Hz, $ts \geq 2.99$, $ps < 0.05$; 35–40 Hz, $ts \geq 3.56$, $ps < 0.05$) and delta powers significantly decreased only at Pz (0.2–0.5 Hz, $ts \geq -2.80$, $ps < 0.05$). For the waitlist control group, no significant difference was observed in EEG power between the post-test and pre-test sessions in all four tasks (lower panel of **Figures 2, 3**, $ps > 0.05$).

Figure 4 presents the spatial distribution of the EEG spectral power differences between the post-test and pre-test of the MBSR group in the four tasks. Paired-sample *t*-tests were applied to all channels to compare the difference between the post-test and pre-test conditions. The channel locations that do not exhibit significant differences ($ps > 0.05$) were marked as zero difference and depicted in green in the topoplots. The results showed that the high-beta and low-gamma bands had significant spectral differences across the whole scalp in *resting 1* and *resting 2*. There were also some small-scale differences in the delta and low-beta bands in the lateral frontal, left

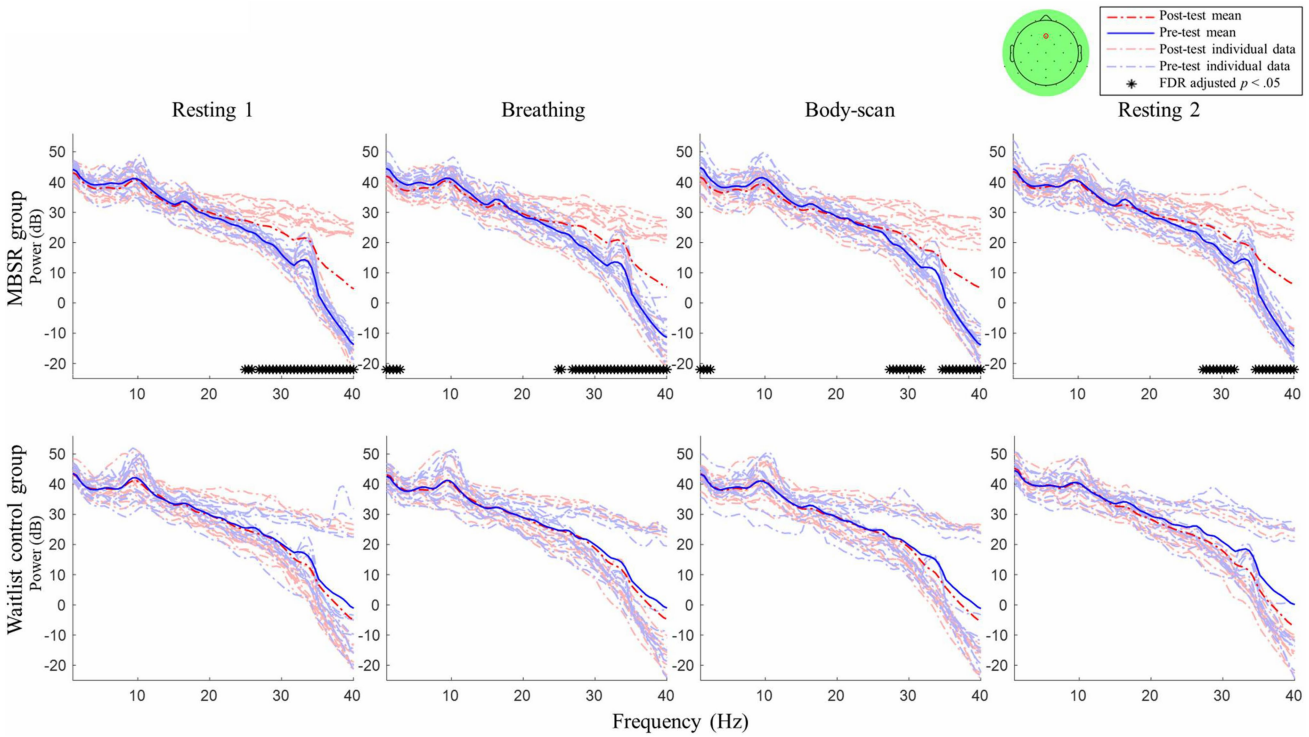

FIGURE 2 | Post–pre-test PSD *t*-test for channel Fz between the mindfulness-based stress reduction (MBSR) group and waitlist control. MBSR group $n = 17$, waitlist control group $n = 14$.

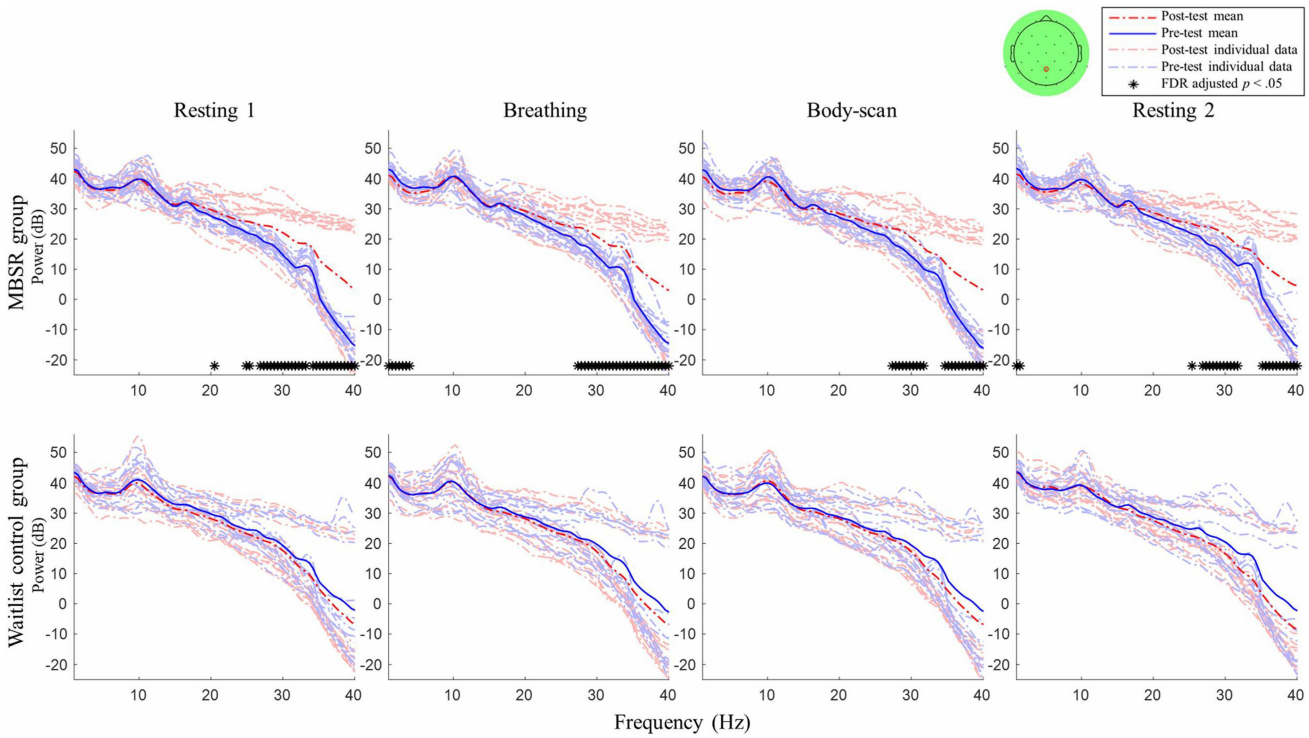

FIGURE 3 | Post–pre-test PSD *t*-test for channel Pz between the MBSR group and waitlist control. MBSR group $n = 17$, waitlist control group $n = 14$.

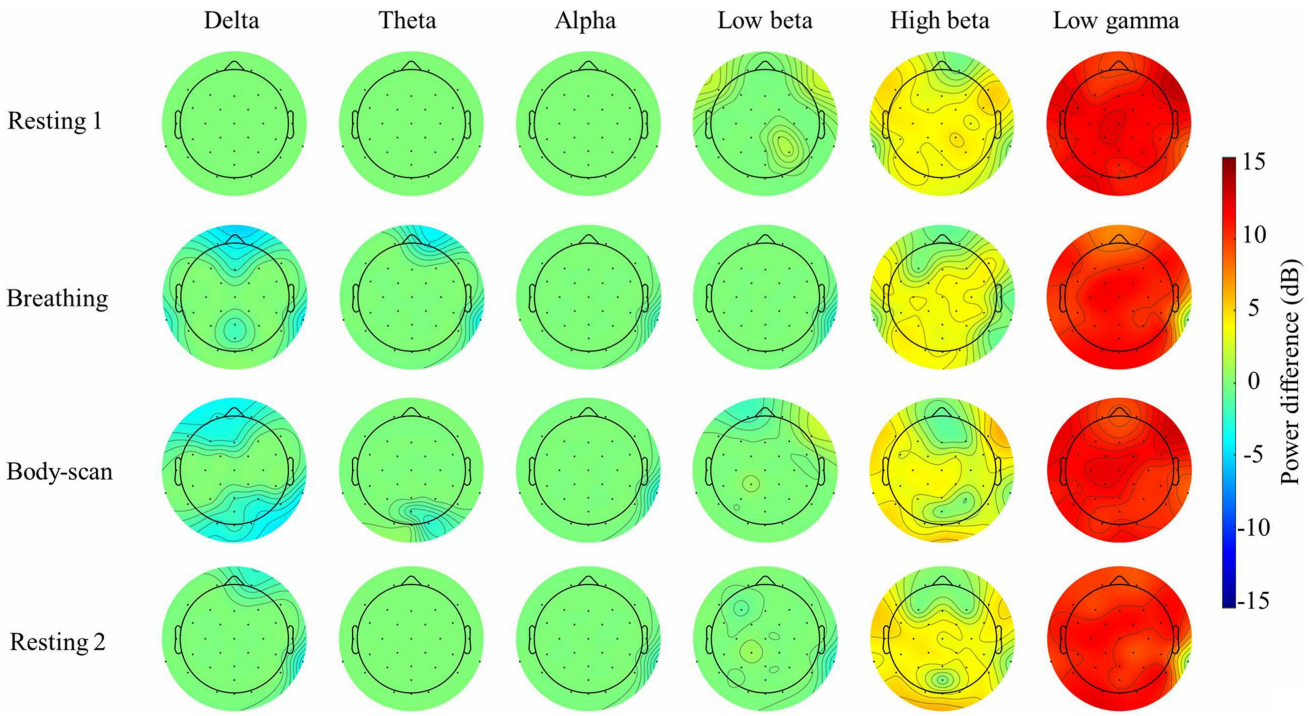

FIGURE 4 | Topoplot analysis of the Electroencephalograms (EEG) spectral power of the MSBR group in the breathing and body-scan tasks, and the paired *t*-test comparison between post-test and pre-test. Power difference = Post-test–pre-test power. Channel locations with zero power differences represent no significant difference (paired-sample *t*-test, FDR adjusted $ps > 0.05$, depicted in green)

parietal, and right temporal areas in *resting 1* and *resting 2*. The delta band had significant EEG power differences in the frontal and parietal areas, and the high-beta and low-gamma bands had significant power differences across the whole scalp in the *breathing* and *body-scan* tasks. There were also significant differences in the theta band in the frontal and occipital areas in the *breathing* and *body-scan* tasks. For the *breathing* task, there are small-scale differences in the alpha and low-beta bands in the right temporal area. For the *body-scan* task, there is a small-scale difference in the alpha in the right temporal area, and a frontal power asymmetry (right > left) in the low-beta band.

EEG Correlates of Mindfulness Practice

This study further investigated the momentary state effect of acquired mindfulness skills by examining the EEG activity. To this end, the EEG powers during *breathing* and *body-scan* were referenced to that during *resting 1*. **Figure 5** shows the spectral comparisons of *breathing*, *body-scan*, and *resting 2* in the post-test session. Compared with *resting 1*, the powers of delta, low-beta, high-beta, and low-gamma bands significantly decreased during *body-scan* at both Fz (0.2–2.5 Hz, $ts \geq -2.55$, $ps < 0.05$; 15–17.5 Hz, $ts \geq -2.92$, $ps < 0.05$; 19.5–20.5 Hz, $ts \geq -2.59$, $ps < 0.05$; 23.5–24.5 Hz, $ts \geq -2.54$, $ps < 0.05$; 28.5–37 Hz, $ts \geq -2.59$, $ps < 0.05$) and Pz (0.2–4 Hz, $ts \geq -3.08$, $ps < 0.05$; 13–16.5 Hz, $ts \geq -3.00$, $ps < 0.05$; 29.5–37.5 Hz, $ts \geq -2.44$, $ps < 0.05$). However, no significant power change was found in *breathing* and *resting 2* ($ps > 0.05$). The EEG power during *body-scan* was also referenced to the power during *breathing*, and no significant difference was found ($ps > 0.05$). For the waitlist control group that did not engage in any mindfulness practice, no significant differences were found in the EEG power between every task pair ($ps > 0.05$).

EEG Correlates of Mindfulness and Behavioral Measures

Correlation analysis was performed to examine the potential correlations between EEG activities and behavioral outcomes. **Table 2** presents the correlation coefficients between the post-test–pre-test differences of EEG power in the four tasks and those in the behavioral measures. For the MBSR group, Δlow-beta power in *resting 1* for the Pz site was found to have a negative correlation with ΔDERS ($b = -0.50$, $p = 0.040$), Δtheta in *breathing* for the Pz site had a marginally significant negative correlation with ΔFFMQ ($b = -0.48$, $p = 0.053$), Δlow-beta in *body-scan* for the Fz site had a marginally significant negative correlation with ΔFFMQ ($b = -0.48$, $p = 0.054$), Δalpha in *resting 2* for both Fz ($b = -0.64$, $p = 0.006$) and Pz sites ($b = -0.51$, $p = 0.036$) showed a negative correlation with ΔFFMQ, and Δtheta in *resting 2* for the Pz site had a marginally significant negative correlation with ΔFFMQ ($b = -0.47$, $p = 0.058$).

The correlation coefficients between the changes in the EEG band power and behavioral subscales in the MBSR group are shown in **Supplementary Material** (**Supplementary Tables 2, 3**). With regard to FFMQ subscales,

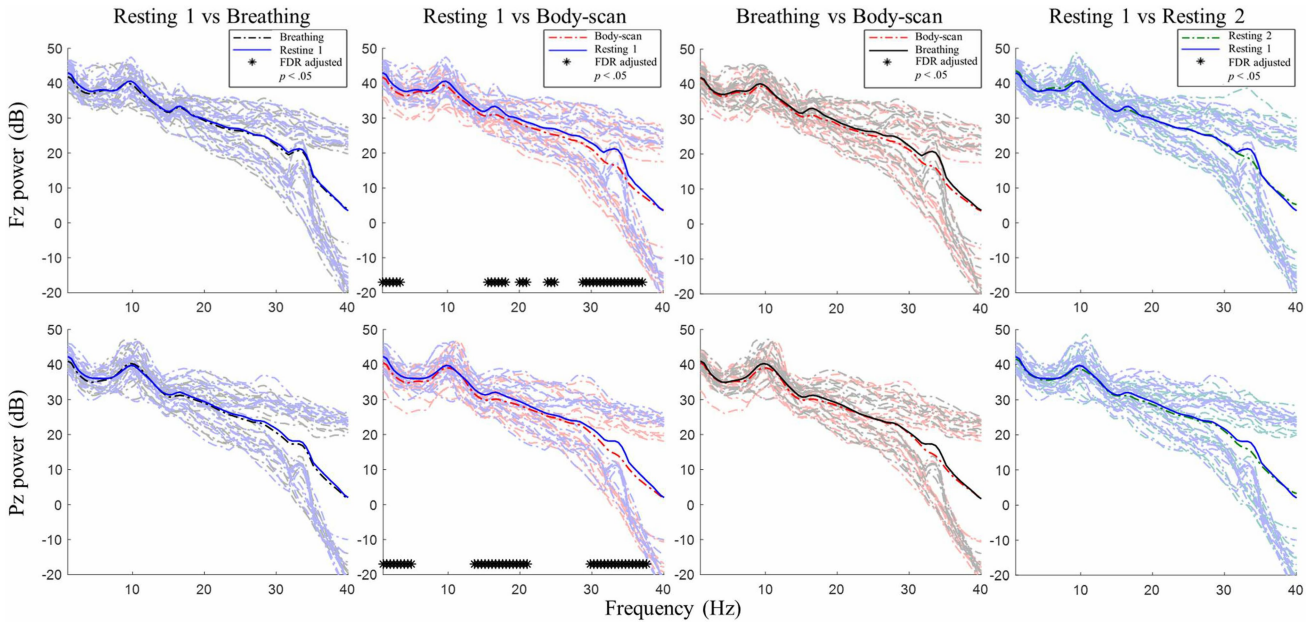

FIGURE 5 | Post-test PSD *t*-test among the four tasks in the MBSR group. $n = 18$. No significant difference was found in the post-test for the waitlist control group. No significant difference was found in the pre-test for either group.

TABLE 2 | Correlation coefficients among the changes of EEG wave bands and behavioral measures in MBSR group.

	Fz	Δdelta	Δtheta	Δalpha	Δlow-beta	Δhigh-beta	Δlow-gamma
Resting 1	ΔFFMQ	−0.06	0.02	−0.20	0.16	0.16	0.15
	ΔDERS	0.14	0.07	0.31	−0.08	−0.24	−0.19
Breathing	ΔFFMQ	−0.31	−0.15	−0.12	−0.09	0.02	0.11
	ΔDERS	0.25	0.12	0.05	0.10	−0.19	−0.18
Body-scan	ΔFFMQ	−0.01	−0.28	−0.36	−0.48[a]	0.14	0.16
	ΔDERS	−0.08	0.24	0.16	0.40	−0.23	−0.23
Resting 2	ΔFFMQ	−0.25	−0.28	−0.64**	−0.07	0.21	0.17
	ΔDERS	0.42	0.34	0.37	−0.15	−0.33	−0.20
	Pz	**Δdelta**	**Δtheta**	**Δalpha**	**Δlow-beta**	**Δhigh-beta**	**Δlow-gamma**
Resting 1	ΔFFMQ	−0.06	0.03	−0.10	0.38	0.25	0.34
	ΔDERS	−0.04	−0.07	−0.03	−0.50*	−0.42	−0.42
Breathing	ΔFFMQ	−0.29	−0.48[b]	−0.25	−0.12	0.20	0.31
	ΔDERS	0.07	0.23	−0.04	−0.05	−0.39	−0.38
Body-scan	ΔFFMQ	−0.09	−0.35	−0.41	−0.03	0.36	0.30
	ΔDERS	0.06	0.25	0.30	−0.05	−0.44	−0.42
Resting 2	ΔFFMQ	−0.20	−0.47[c]	−0.51*	−0.06	0.22	0.15
	ΔDERS	0.21	0.22	0.17	−0.25	−0.38	−0.18

*Δ = post-test score-pre-test score. p = 0.054/0.053/0.058, respectively. For the waitlist control group, none of the post-pre-test difference of EEG power was significantly correlated with that of any behavioral measure, neither for Fz nor Pz site. *p < 0.05; **p < 0.01.*

[a]*= marginally significant.*

[b]*= marginally significant.*

[c]*= marginally significant.*

alpha and theta spectral changes were significantly correlated with observing, describing during *resting 1*, and nonreactivity subscales during *resting 2* in both Fz and Pz ($ps < 0.05$). In the DERS subscales, delta spectral changes in Fz were significantly associated with goals ($p = 0.037$) during *resting 2*, whereas low-beta and high-beta spectral changes in Pz were significantly associated with awareness and clarity during *resting 1* ($ps < 0.05$), respectively.

DISCUSSION

Summary of Results

Table 1 presents the MBSR intervention effects on the FFMQ and DERS scores, indicating that participants demonstrated augmented levels of trait mindfulness and emotional regulation. The EEG spectral results (**Figures 2, 3**) showed that the 8-week intervention led to an increase in high-frequency EEG activities

across all conditions and a decrease in low-frequency EEG activities during the *breathing* and *body-scan* practices. As observed in the MBSR group at the follow-up visit in week 8 (**Figure 5**), *body-scan* suppressed EEG power across all frequencies. Additionally, the mindfulness-induced changes in theta, alpha, and low-beta band powers significantly correlated with the changes in FFMQ or DERS scores.

Intervention Effect of MBSR

The differences between the post-test and pre-test results in *resting 1* indicated the post-intervention effect of the MBSR practice on EEG activity. Previous studies have reported that relaxation exercises induced decreased beta and gamma band power (Stinson and Arthur, 2013) and increased theta band power (Field et al., 2010). The current study's EEG results and previous research on MBSR (Lutz et al., 2004; Cahn et al., 2010) have demonstrated that, unlike relaxation exercises, mindfulness practices yield increased high-frequency EEG activity. This post-intervention neuro-electrical change was sustained in our study irrespective of which mindfulness task the participants engaged in. In the MBSR group, the post–pre-test EEG power comparisons of *resting 1, breathing, body-scan,* and *resting 2* revealed the same pattern, namely, elevated high-frequency (high-beta and low-gamma) EEG power in the post-test EEG scan. The results further supported our argument that the increase in high-frequency EEG power is a post-intervention effect of mindfulness practice. Although mindfulness practice is known to provide the same relaxation effect as other relaxation exercises (Davidson et al., 2003), this study suggested that mindfulness practice differs from relaxation exercises.

The results of mindfulness practice were rather similar to the EEG findings on beta and gamma neurofeedback training (a training aimed at improving beta or gamma power) that showed that 10 days of beta and gamma neurofeedback training led to improved episodic memory among healthy adults (Keizer et al., 2010). A similar association between long-term cognitive training and gamma power elevation was also found among the elderly population (Staufenbiel et al., 2014) and patients with Alzheimer's disease (Van Deursen et al., 2008), schizophrenia (Molina et al., 2020), and attention-deficit/hyperactivity disorder (Yordanova et al., 2001). Furthermore, the results were consistent with the neuroimaging findings that highly focused participants with 6 weeks of mindfulness training showed better cognitive performance in the Stroop test, in addition to exhibiting higher dorsolateral prefrontal cortex (dlPFC) activation (Allen et al., 2012). With results showing elevated high-frequency EEG power, mindfulness practice is likely similar in effect to cognitive training.

After the MBSR intervention, the low-frequency (delta) activity at Fz decreased during *breathing* and *body-scan* (**Figure 2**) and that at Pz decreased during *breathing* (**Figure 3**). Previous studies on different mindfulness styles (i.e., Vipassana and Qigong) have suggested that compared with non-meditators, practitioners' delta activity increased in the prefrontal area during the resting state (Tei et al., 2009; Cahn et al., 2010). However, another study on MBSR reported that practitioners' frontal delta power decreased (Gao et al., 2016), indicating that different mindfulness practices may lead to different EEG results. Our data supported the results of Gao et al. (2016) that MBSR practitioners' low-frequency EEG power decreases and high-frequency EEG power increases. The current study further suggested that such EEG power changes could be introduced with 8 weeks of training.

Some have argued that the delta oscillation of EEG is related to mental task performance because delta oscillation represents people's attention to their internal process (Harmony et al., 1996; Harmony, 2013). Knyazev (2007) further suggested that delta and alpha oscillations in the prefrontal area may contribute to a reciprocal inhibitory mechanism that can manipulate people's motivation and attention and moderate people's mental task performance. Harmony (2013) suggested that the increased delta oscillation in mindfulness practitioners represents the inhibition of the prefrontal cortex in addition to the reduction of emotional and cognitive engagement. MBSR practitioners, however, are instructed to not inhibit their emotions or cognition but to accept and merely observe their inner thoughts just as they are (Davidson et al., 2003). This practice of acceptance may explain the current result that delta power decreased during mindfulness practice after 8 weeks of training. This argument is further legitimized by the result that only the MBSR-trained participants, and not the waitlist control group, demonstrated the delta power drop. This is because attentional yet nonjudgmental acceptance of oneself requires continuous and effort-intensive practices to master.

Additionally, this delta power suppression suggested that the practices might involve a stage of high vigilance (Smallwood and Schooler, 2015). A previous study on mind-wandering (Braboszcz and Delorme, 2011) showed that when people were distracted from a task and started mind-wandering, their delta and theta power increased, whereas their alpha and beta power dropped. The EEG results of mind-wandering were exactly the opposite of our mindfulness results of decreased delta power. The contradictory EEG results support the argument that mindfulness is a process of disciplining the mind and stopping mind-wandering (mindlessness; Davidson et al., 2003; Mrazek et al., 2012). Furthermore, another study suggested that mindfulness programs can reduce mind-wandering episodes (Schooler et al., 2014). This claim is supported by the results that participating in 8 weeks of mindfulness training promotes working memory capacity, which is the key to maintaining focus in a cognitively demanding and vigilance-requiring situation (Jha et al., 2010). Even 8 min of mindful breathing was found to reduce people's attentional error in a vigilance task (Mrazek et al., 2012). Therefore, EEG spectral whitening (low-frequency power drop and high-frequency power elevation) represents a mental state with less mind-wandering and higher mindfulness.

Previous neuroimaging studies on mindfulness have suggested frontal and parietal areas are mostly related to mindfulness-induced neuro changes. For example, an fMRI study on long-term mindfulness practitioners reported the increased functional connectivity among the (PCC; Brewer et al., 2011). A similar finding was also reported in the post-MBSR intervention participants (Kral et al., 2019). Meanwhile, the fMRI data

collected in this study showed that the activation difference between *breathing* and *body-scan* in the pre-test was notable in frontal and parietal spatial distribution (Guu et al., 2020). The current EEG data agreed with the previous fMRI results that the changes in mindfulness-induced neuro-activation were evident in the frontal and parietal areas (**Figure 4**). The results in **Figure 4** further suggested that some other brain areas, including the occipital and temporal areas, also exhibit comparable spectral changes. Also, there was a frontal power asymmetry in the low-beta band in *body-scan*. We expect that further studies on the frontal EEG power asymmetry will be legitimate in the exploration of mindfulness (also see Isbel et al., 2019).

It is noted that four participants in the MBSR group did not show EEG power difference between the post-test and pre-test, even though the general group power elevation was significant (see **Figures 2, 3**). The four participants reported higher FFMQ (mean difference = 24.25, SD = 12.37; group mean difference = 27.61, SD = 22.02) and half reported lower DERS (mean difference = −5.25, SD = 26.54; group mean difference = −13.06, SD = 25.87). Although both the FFMQ and DERS levels of the four participants changed in the manner intended by the MBSR intervention, the magnitude of these changes was lower than that of the MBSR group average. A potential explanation for this phenomenon was that the MBSR intervention was not effective in some of the participants, and therefore, no neurophysiological change was introduced. The same phenomenon was also found in a previous mindfulness study on the bereaved individuals (Huang et al., 2021) that some of them had their mindfulness levels decreased after the 8-week mindfulness intervention. The phenomenon suggested that mindfulness training did not guarantee success for everyone. Further studies are required to figure out the reason underneath to improve the efficacy of the mindfulness training courses.

Situational Practice Effect After the 8-Week Training

Another focus of this study was to examine whether different mindfulness practices contribute to participants' neuro-electrical responses differently. Compared with *resting 1*, the MBSR-trained participants showed significantly decreased EEG activities across delta, low-beta, and parts of high-beta and low-gamma bands at both Fz and Pz when practicing *body-scan*. During the body-scan practice, practitioners were instructed to be aware of their introspective body sensations. As suggested in a previous study (Mirams et al., 2013), body-scan exercise can improve people's somatic signal detection clarity. The EEG changes associated with the *body-scan* task found in this study reflected how the body-scan exercise is specific and concrete for practitioners. By contrast, no significant power difference was found when practicing mindful *breathing* (**Figure 5**), suggesting that *body-scan* leads to more significant EEG change among the participants than *breathing*.

Notably, the preliminary data collected from five mindfulness practitioners with more than 2 years of MBSR experience (i.e., the expert group; **Figure 6**) further revealed that experts' EEG power was consistently lower than that of the MBSR practitioners with 8 weeks of experience, irrespective of whether they were resting, practicing mindful

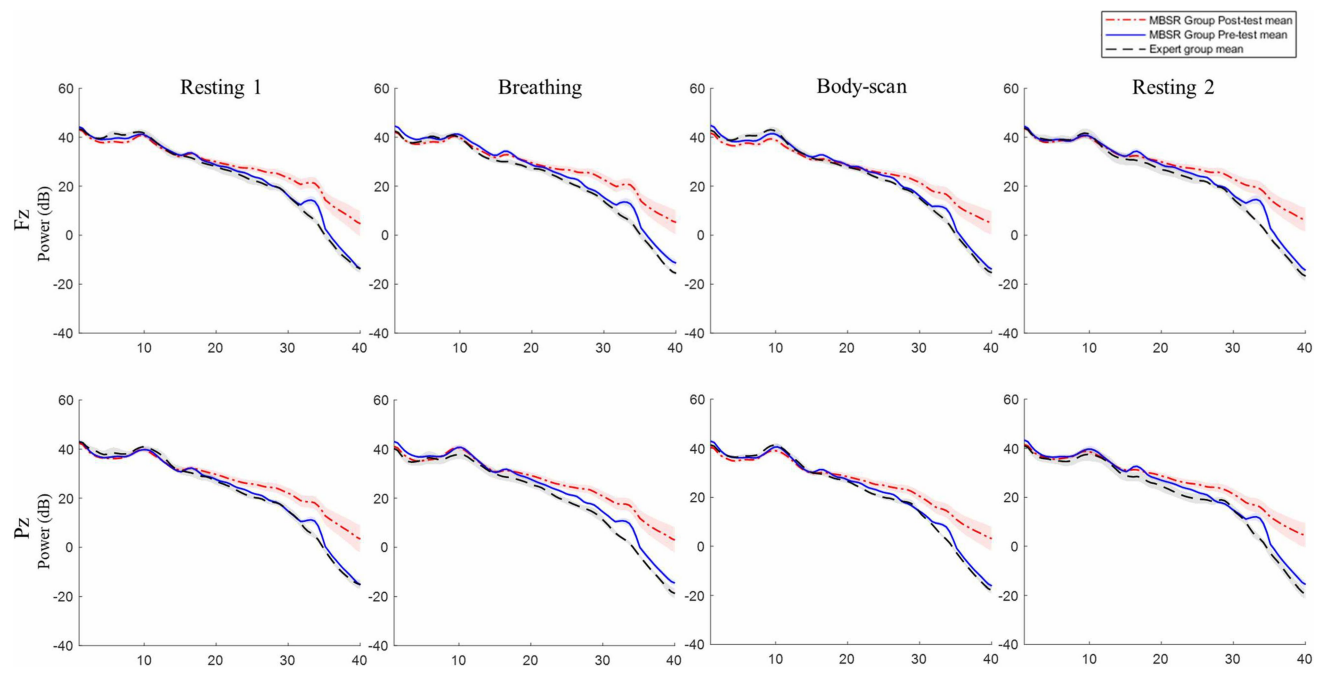

FIGURE 6 | MBSR group and expert EEG power comparison. MBSR group $n = 17$, expert group $n = 5$. Shading represents standard error of mean. No significant difference was found between expert group and the MBSR group.

breathing, or body-scan practice. In general, the high-frequency power of the MBSR practitioners elevated and the low-frequency power decreased after the 8-week MBSR training, but all EEG power decreased along with the expertise of mindfulness. Although the expert group had few participants, a general drop in EEG power across low-, middle-, and high-frequency bands could be a neuro-electrical feature of long-term MBSR practice.

Correlations Between the Change of EEG and Behavioral Indexes

The differences in the theta, alpha, and low-beta band powers between the post-test and pre-test were correlated with the change in the FFMQ or DERS scores (as shown in **Table 2**). In our major findings concerning behavior and EEG biomarkers, we found significant correlations between behavioral indexes and theta, alpha, and low-beta power. These results were consistent with Ahani et al.' (2014) finding that improvement in mindfulness levels was characterized by increases in the theta, alpha, and beta activities. Another study on emotional regulation also highlighted that frontal bilateral alpha activity and the parietal delta/beta ratio predicted people's spontaneous emotion regulation level (Tortella-Feliu et al., 2014). This leads to the following question: Why was a major EEG power difference observed in high- and low-frequency bands in our data despite the clear correlation between EEG power and behavioral indexes observed in the theta, alpha, and beta bands? A possible reason could be that the major differences in neurophysiological changes after 8-weeks of mindfulness practice can be observed through delta, high-beta, and low-gamma spectral power and that the biomarker of mindfulness is found in alpha. A previous study on experienced Zen meditators showed that the hours of meditation practice and weekly frequency were negatively correlated with alpha power but not gamma power (Pasquini et al., 2015). Our results further suggest that mindfulness and its positive outcomes involve a complex mechanism. The EEG signals represent the mixtures of these contributing factors. Future EEG biomarker studies on mindfulness may also include the factor of cognitive ability to clarify such a complex mechanism.

Limitation

It is noted that the task sequence was suggested by licensed and experienced MBSR instructors. Even though we are well aware that counter-balance is valuable in terms of causal interpretation, we treasure the ecological validity of mindfulness practice. In MBSR training, practitioners start learning mindfulness from breathing, then advance to body-scan afterward. It is unlikely that practitioners can practice body-scan without settling their mind with breathing first. In order to ensure that the experimental conditions were faithful to natural MBSR practice as much as possible, the participants were always asked to practice *breathing* and then *body-scan* in both scanning sessions.

There may also be some concern about the relatively small sample size of this study. We admitted that this can be a shortcoming of this study, and the major difficulty of data collection came from the limited MRI scanning sessions we can enrolled. We argued that our results are convincing because the results are still significant with small sample size, and the trends are consistent with our predictions based on the previous works on mindfulness.

Another limitation of this study is the frequency range of EEG data. Due to the contamination of MR gradient-induced artifacts, the current study examined the EEG data only up to 40 Hz, leading not to make a fully compatible interpretation between the current results and the other studies involving high-gamma activity. The following studies on this topic may examine mindfulness practitioners' EEG signals outside of an MRI scanner to address this limitation.

We were aware that there is a psychometric discussion on the diverse nature of mindfulness assessment (Grossman, 2011). Although FFMQ is not the one and only one mindfulness assessment developed, FFMQ is one of the most used and sophisticated mindfulness assessments (Carpenter et al., 2019). Especially, the validity of FFMQ on the assessment of MBSR intervention outcomes has wildly been supported (Lamothe et al., 2016; Vibe et al., 2017). Still, further studies may examine the validity of other mindfulness questionnaires on MSBR outcomes and the correlation differences between the questionnaires and EEG band powers.

The current result is only a glimpse of the neuro-evidence of mindfulness practitioners. Other perspectives and evidence, including EEG connectivity analysis and MRI joint analysis, can be used and may reveal the bigger picture of mindfulness neuro-mechanism in the following studies.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, and further inquiries can be directed to the corresponding authors.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Taipei Medical University Joint Institute Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

H-YN: conceptualization, data curation, formal analysis, investigation, visualization, and writing—original draft. CW: funding acquisition, conceptualization, project administration, supervision, and writing—review and editing. F-YH: supervision, methodology, and resources—MBSR instruction. Y-TC and S-FG: data curation. C-MH, Y-PC, and C-FH: supervision and

methodology. T-PJ: supervision, conceptualization, methodology, and writing—review and editing. C-HC: supervision, conceptualization, methodology, formal analysis, and writing—review and editing. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.748584/full#supplementary-material

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Subjective Well-being of Special Education Teachers in China: The Relation of Social Support and Self-Efficacy

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In order to explore the relationship of social support, self-efficacy, and subjective well-being of special education teachers in China, 496 teachers from 67 special education schools were surveyed by questionnaire. We found that (1) the subjective well-being of special education teachers in China was in the medial level. (2) There were significant differences in subjective well-being level among teachers of different genders, teacher position, education background, and teaching age. Male teachers were of higher subjective well-being; subjective well-being of head teachers was lower than those were not head teachers; teachers with the educational background of postgraduate were of higher relaxation and tension than those with junior college educational background; the control scores of emotion and behavior of teachers with teaching age of 3 years and below were significantly lower than those of teachers with teaching age of more than 10 years. (3) Self-efficacy played a partially mediating role in the relationship between social support and subjective well-being of special education teachers. Suggestions to improve the subjective well-being of special education teachers were discussed in the article.

Keywords: special education teachers, social support, self-efficacy, subjective well-being, China

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INTRODUCTION

Since the end of the 20th century, after Seligman proposed positive psychology, psychologists have begun to look at the potential, motivation, and abilities of people with a more open and appreciative attitude (Seligman and Csikszentmihalyi, 2000; Sheldon and King, 2001). As one of the important contents of positive psychology, subjective well-being (SWB) has attracted the attention of scholars all over the world. SWB benefits individuals in many aspects such as health and longevity, work, income, and friendship (Diener and Ryan, 2009; Diener and Chan, 2011). SWB was the overall feelings and judgments of an individual about their quality of life, which was based on their subjective standards. It has the characteristics of subjectivity, stability, integrity, etc. Its components include satisfaction with personal life and important fields in life, positive emotional experience and low-level negative emotional experience (Diener et al., 1999).

Impact of Subjective Well-Being of Teachers for Teachers and Students

For teachers, the level of SWB reflects their mental health and reflects their satisfaction with their current life and work conditions. SWB would not only affect their work enthusiasm and

initiative (Du, 2017; Buriæ et al., 2019), but also affect the mental health of students (Liu, 2014; Perera et al., 2019). Teachers with lower levels of mental health usually behave negatively and passively when facing challenges in teaching (Bi, 2013). A survey showed that special education teachers have more severe mental health problems. Among them, teachers with mild or above psychological problems account for 25% of the total (Zhao and Wang, 2013). Compared with general teachers, special education teachers, due to the particularity of their education targets, lack a sense of accomplishment by working much with low effectiveness, which leads to a low happiness index (Wan and Zhao, 2013). They are more likely to experience a state of low happiness earlier (Shen et al., 2012). With the successive promulgation of policy documents such as the "Opinions on Comprehensively Deepening the Reform of Teacher Team Building in the New Era," "Opinions on Strengthening the Building of Special Education Teacher Team," "Special Education Teacher Professional Standards (Trial)," and other policy documents by the State Council and the Ministry of Education, more specific requirements for the professional development of education teachers have been made. It has been further pointed out that teachers should be the instructors of the healthy growth of students. The opinions also mentioned that the benefits and rights protection should be strengthened to further expand the happiness of teachers (The Central Committee of the Communist Party of China and the State Council, 2018). For the special education teacher group in China, improving their (happiness) development and exploring their key influencing factors and their mechanism of actions are urgent (Peng et al., 2018).

Relationship Between Social Support and Subjective Well-Being of Teachers

Scholars have found that the social support is one of the important predictors of SWB (Meehan et al., 1993; Song and Fan, 2013). From the perspective of the main components of it, the social support can be divided into the informal and formal social support. The former mainly refers to the support and assistance provided by informal social relations resources such as family, neighbors, friends, and colleagues; the latter refers to the guarantee and support provided to people through formal organizations such as government, enterprises, community organizations, and formal institutional arrangements (Zhang, 2001). The social support can also be divided into objective support and subjective support as well. That is, the actual support that can be seen and the emotional support that is experienced (Langford et al., 1997; Langher et al., 2017). Good social support has a clear positive correlation with life satisfaction, a significant positive correlation with positive emotions, and a clear negative correlation with negative emotions, including the loneliness, depression, and anxiety (Lam, 2019; Gkda, 2021). The higher the degree of social support, the stronger the SWB (Lu and Ying, 2014; Lam, 2019). González and Restrepo-Chavarriaga (2010) found that there was a close connection between social support and well-being: the higher the level of social support, the higher the quality of life of people. People who have good social support, good interpersonal communication and relationships, and the more positive emotions they experience, the higher the degree of happiness they would feel (Ding, 2007). Numerous studies find the positive association between social support and well-being of teachers in global context, including United States (Carroll, 2020), Macao (Huang, 2011), Romanian (Stanculescu, 2014), and so on.

Role of Self-Efficacy Between Social Support and Subjective Well-Being of Teachers

How does social support of teachers affect their SWB? The self-efficacy may be an important mediating factor, which refers to the subjective judgment of people on whether they can successfully perform a certain behavior for achievements (Bandura, 1977). The social support may affect the inner psychology of the individual or it may affect the psychological quality of the individual by affecting some of the inner psychological factors of the individual (Uchino et al., 1996). The effect of external social factors on the inner psychology of an individual needs to go through the mediating effect of self-concept (Judge et al., 1997) and self-efficacy is one of the important components of self-concept (Liu, 2001). Bandura (2008) believed that the self-efficacy, optimism, hope, and resilience played an important role in managing and coping with stress and improving happiness. Studies have pointed out that there is a significant correlation between self-efficacy and SWB (Caprara and Steca, 2005; Yu et al., 2005). For teachers, the higher the self-efficacy they feel, the higher the level of SWB there is (Cui, 2016). When teachers possess high self-efficacy to perform required tasks (Klassen and Chiu, 2011), they would experience favorable outcomes, including satisfaction (Zee and Koomen, 2016) and well-being (Huang et al., 2019; Perera et al., 2019; Moè and Katz, 2020). Studies have shown that social support can help individuals to improve their coping ability and improve their sense of efficacy in their own coping capabilities, thereby reducing negative reactions to stressful events and promoting individual growth (Cohen and Syme, 1985; Stanculescu, 2014). When teachers have high level of perceived social support and a good sense of their abilities to affect the outcomes of students (teacher self-efficacy), they experience SWB.

Current Study

Overall, previous studies focus on SWB of teachers (Chan, 2013; Renshaw et al., 2015; Farhah et al., 2021), while SWB of special education teachers was neglected. Besides, few previous studies explored and proved mediating effect of self-efficacy between the social support and their SWB of special education teachers in China. A deeper reciprocal relation between the relation in social support, efficacy and SWB of special education teachers should be investigated in China. To fill in the gaps, we investigated SWB of special education teachers in China and mediating reaction was explored on the mediating effect of self-efficacy between social support and their SWB of special education teachers. Drawing on prior empirical findings and self-efficacy theory, we tested the following hypotheses: (1) social support of

special education teachers was positively associated with their SWB in China; (2) self-efficacy of special education teachers was positively associated with their SWB in China; and (3) self-efficacy of special education teachers played the mediating role between social support and SWB of teachers.

MATERIALS AND METHODS

Participants and Procedure

We contacted the principals of special education schools to help send the questionnaire link to special education teachers. There were 508 special education teachers in 67 special education schools participating in this study. After deleting the questionnaires missing one-third questions and with all the same choices in the items, eventually 496 valid questionnaires were collected, with 97.6% recovery rate. The basic information of the research sample was: there were 108 male teachers (21.8%) and 388 female teachers (78.2%); 441 Han teachers (88.9%) and 55 ethnic minority teachers (11.1%); most teachers have educational backgrounds in the undergraduate and junior college (408 undergraduate teachers and 72 junior college teachers, a total of 96.8%), including 197 teachers with special education majors (39.7%) and 276 teachers with non-special education majors (55.6%) and there were 23 teachers with non-educational majors; from the perspective of teaching experience, there were 110 teachers with 3 years or less of teaching experience (22.2%), 62 teachers with 3–5 years of teaching experience, 81 teachers with 6–10 years of teaching experience, and 243 teachers with more than 10 years of teaching experience (49%). Of all the 496 teachers, a total of 280 teachers were head teachers and the remaining 216 teachers were not head teachers.

Measures

Social Support Scale

The Social Support Scale compiled by Xiao in 1990 was adopted in this study. The scale has been proven to have good reliability and validity through a large number of studies (Liu et al., 2013). There were 10 items in total in this scale, including three dimensions: the objective support (sum of scores in items 2, 6, and 7, e.g., what were the sources of financial and tangible supports you have received when you were experiencing difficult emergencies), the subjective support (sum of scores in items 1, 3, 4, and 5, e.g., how many close friends that can you ask for help and support), and the utilization of support (sum of scores in items 8, 9, and 10, e.g., who would you turn to when you were in trouble). The total score of social support was the account of the scores in all the ten items. The internal consistency reliability coefficient of the scale in this study was 0.76.

Subjective Well-Being Scale

The SWB Scale revised by Duan in 1996 was used in this study. The original scale was a standardized test tool developed by the National Center for Health Statistics to evaluate the statements of happiness of subjects. It consisted of 33 items. The higher the score, the stronger the happiness. The first 18 items of the scale were used by Duan to measure the subjects and the correlation between each item of the scale and the total score was between 0.48 and 0.78 (Fazio, 1977). The correlation between the individual item score and the total score was between 0.49 and 0.78; the correlation between the subscale and the total scale was between 0.56 and 0.88; the internal consistency coefficient was 0.91 for males, 0.95 for females, and the test-retest reliability was 0.85. Thus, the validity index was considered valid. The scale was constituted by 6 factors: the worry about health [e.g., have you been bothered by illness, discomfort, pain, or fear of illness (in the past month)], energy [e.g., did you wake up feeling refreshed and energized (in the past month)], satisfaction and interest in life [e.g., how happy, fulfilled, or enjoyable your life has been (in the past month)], melancholy or happy mood [e.g., have you ever wondered if anything was worth doing because you were sad, discouraged, disappointed, or in a lot of trouble (in the past month)], control of emotion and behavior [e.g., have you been firmly in control of your actions, thoughts, emotions, or feelings (in the past month)], and relaxation and tension (anxiety) [e.g., are you under or have you been under any restraint, stimulation, or pressure (in the past month)] (Duan, 1996). The reliability coefficient of internal consistency in this study was 0.89.

Teachers' Self-Efficacy Scale

The Teachers' Self-efficacy Scale was compiled by Tshannen-Moran and Hoy (2001) and was revised in Chinese by Lu (2017). A total of 24 items were included in the scale. The self-efficacy of the teacher was evaluated from three different dimensions, including the student management (e.g., you feel how much you can do when you help your students to think deeply), instructional strategy (e.g., how well have you done adapting the course to the level of the students), and class management (e.g., how good are you at keeping a few problem students from ruining the class?). The Likert 9-point scale was applied in the scale for scoring. The higher the score, the higher the sense of self-efficacy (Dixon et al., 2014). In this study, the internal consistency coefficient of Chinese version of the scale revised by Lu (2017) reached 0.95. The internal consistency coefficients of the three dimensions of the student engagement, teaching strategy, and classroom management were 0.875, 0.876, and 0.881, respectively, and the test-retest reliability was 0.76, 0.80, and 0.85, respectively. Therefore, the research of this study should be reliable. The content and structure of the scale were reasonable that found by the content validity and structure validity test as well (Lu, 2017). The internal consistency reliability coefficient of the scale in this study was 0.95.

Data Analysis

Differences in SWB levels among teachers by their sociodemographic variables were tested with ANOVAs and *t*-tests in SPSS software version 20.0 (SPSS Incorporation, Chicago, IL, United States). *Post hoc* analyses were subsequently performed by least significant difference (LSD). Second, the correlation of SWB, social support, and self-efficacy were analyzed using the Pearson's correlation coefficient function in SPSS. Third, to test whether self-efficacy plays a mediating role between social support and SWB, the mediation model was applied using the PROCESS macro in SPSS.

RESULTS

Subjective Well-Being of Special Education Teachers in China

Subjective well-being status of special education teachers in China is shown in **Table 1**. Overall SWB level of special education teachers in China scored 74, among which female teachers scored 72 and male teachers scored 78. SWB score of special education teachers in China was at a medial level among teachers, since the average score of elementary education teachers was 73.2 (Xin et al., 2021).

The difference of SWB of special education teachers in China was analyzed on different background variables (see **Table 2**). In terms of education background, teachers with different education levels differed significantly on the dimension of relaxation and tension ($F = 4.237$, $p = 0.015 < 0.05$) (see **Table 3**), but not for total SWB and other dimensions. The teachers of bachelor degree were significantly lower than those graduated from junior college ($P = 0.024 < 0.05$) and postgraduate or above ($P = 0.048 < 0.05$). Two were on the dimension of relaxation and tension. There were no significant differences in SWB levels among teachers with different teaching years, while multiple tests showed that teachers with 3 and fewer years of teaching experience had significantly lower scores control of emotion and behavior than teachers with more than 10 years of teaching experience ($F = 0.52$, $p < 0.05$). There were significant differences in total SWB scores of teachers by genders. SWB of male special education teachers was much higher than female ones ($F = 3.754$, $p < 0.001$), specifically on four dimensions of energy factor ($F = 3.725$, $p < 0.001$), including satisfaction and interest in life ($F = 3.12$, $p < 0.01$), depressed or happy mood ($F = 2.695$, $p < 0.01$), and control of emotions and behaviors ($F = 3.778$, $p < 0.001$). There were significant differences in dimensions of SWB ($F = -1.98$, $p < 0.05$) and the subdimension control of emotions and behaviors ($F = -2.08$, $p < 0.05$) for special education teachers whether they were head teachers.

Correlation of Social Support, Subjective Well-Being, and Self-Efficacy

The Pearson correlation was used to analyze the correlation among the social support, SWB, and self-efficacy of special education teachers (see **Table 4**). There were significant positive correlation between social support and its three subdimensions and SWB and the three dimensions of social support, objective support, subjective support, and utilization of support were significantly and positively correlated with the energy factor of SWB, satisfaction and interest in life, depressed or happy mood, control over emotions and behavior, and relaxation or tension. Meanwhile, there were significant positive correlation between the social support and its three dimensions and self-efficacy and its dimensions, which were significantly and positively correlated with self-efficacy and its three dimensions. Besides, there were significant positive correlation between self-efficacy and its three dimensions and SWB.

TABLE 1 | The basic situation of subjective well-being of special education teachers in China.

Total score and dimensions	*M*	*SD*	*Max*	*Min*
Total subjective well-being score	73.57	13.69	109	20
Sub-concern about health	6.92	2.47	16	1
Sub-energy	17.59	4.33	27	4
Sub-satisfaction and interest in life	6.38	1.85	11	2
Sub-depression or happy mood	15.23	3.51	22	2
Sub-control of emotion and behavior	12.47	2.21	17	3
Sub-relaxation and tension (anxiety)	14.98	4.08	26	3

Mediation of Self-Efficacy Between Social Support and Subjective Well-Being

We test whether self-efficacy played a mediating role in the relationship between social support and SWB. The independent variables (social support), dependent variables (SWB of teachers), and intermediary variables (self-efficacy) are included in the model under the control of gender, teaching age, and professional background of teachers and tested by bootstrap. The results are shown in **Table 5** and **Figure 1**. As shown in **Table 5**, the three paths of the social support and self-efficacy, the self-efficacy and SWB, and the social support and SWB were all extremely significant. Social support had direct effect on SWB and also to increase SWB of teachers by positively associated with their self-efficacy suggested that self-efficacy has a partial mediating effect between the social support and SWB. The direct effect of social support to SWB was 0.606, the indirect effect of social support to SWB was 0.149, and the total effect of social support to SWB was 0.755.

DISCUSSION

Subjective Well-Being of Special Education Teachers in China

The results of the survey on SWB of the special education teachers in China show that their SWB was on the average level of Chinese elementary schools teachers (Xin et al., 2021). It is in line with finding of Kyriacou (2011) and is a little different with the findings of Huang et al. (2016) and Olagunju et al. (2020), pointing out that SWB of special education teachers is low. Kyriacou (2011) found that, despite teaching being recognized as a high-stress occupation, teachers are reportedly healthier than other the professional groups. While for special education teachers, Olagunju et al. (2020) found that about four in every ten Nigerian special education teachers had psychological distress. The education system and culture have great impact in SWB of teachers (Xin et al., 2021). The reason of difference with Huang et al. (2016) may be that the survey groups are located in different regions of China. Besides, the government has paid more and more attention to the development of special education, issued a series of policies to support the construction of special education schools, and supported the construction of special education teachers by improving the treatment of special education teachers

TABLE 2 | The differences by education, teaching experience, gender, and whether they were classroom teachers on subjective well-being.

		Total score and dimensions (M ± SD)	Sub- concern about health (M ± SD)	Sub-energy (M ± SD)	Sub- satisfaction and interest in life (M ± SD)	Sub-depression or happy mood (M ± SD)	Sub- control of emotion and behavior(M ± SD)	Sub- relaxation and tension (anxiety) (M ± SD)
Educational background	Junior College	75.97 ± 13.23	6.60 ± 1.92	18.19 ± 3.98	6.43 ± 1.72	15.99 ± 3.78	12.83 ± 2.11	15.93 ± 4.38
	Undergraduate	73.01 ± 13.73	6.97 ± 2.55	17.45 ± 4.39	6.38 ± 1.87	15.08 ± 3.48	12.38 ± 2.22	14.75 ± 3.96
	Postgraduate or above	77.40 ± 14.38	6.93 ± 2.40	18.67 ± 4.20	6.07 ± 1.91	15.40 ± 2.87	13.47 ± 2.23	16.87 ± 4.98
F		2.037	0.710	1.393	0.241	2.050	2.849	4.237**
P		0.131	0.492	0.249	0.786	0.130	0.059	0.015
Teaching experience	below 3 years	73.49 ± 13.56	7.14 ± 2.5	17.61 ± 4.18	6.42 ± 2.01	15.15 ± 3.44	12.21 ± 2.30	14.96 ± 4.19
	3-5 years	73.82 ± 15.19	7.18 ± 2.8	17.24 ± 4.66	6.37 ± 1.95	15.39 ± 3.8	12.15 ± 2.14	15.50 ± 4.60
	6-10 years	72.53 ± 12.15	6.80 ± 2.24	17.43 ± 3,91	6.22 ± 1.65	15.01 ± 2.86	12.33 ± 2.06	14.73 ± 3.43
	10 above	73.89 ± 13.91	6.80 ± 2.44	17.72 ± 4.45	6.41 ± 1.81	15.29 ± 3.67	12.72 ± 2.22	14.94 ± 4.11
F		0.207	0.765	0.247	0.229	0.187	2.142	0.444
P		0.892	0.514	0.863	0.876	0.905	0.094	0.722
Gender	Male	77.89 ± 12.19	7.22 ± 2.59	18.94 ± 4.24	6.86 ± 2	16.03 ± 3.75	13.18 ± 2.09	15.66 ± 3.89
	Female	72.37 ± 13.86	6.84 ± 2.43	17.21 ± 4.28	6.24 ± 1.78	15.01 ± 3.41	12.28 ± 2.21	14.79 ± 4.12
T		3.754***	1.436	3.725***	3.12**	2.695**	3.778***	1.95
P		0.000	0.152	0.000	0.002	0.007	0.000	0.052
Being head teachers in classroom	Yes	72.50 ± 13.15	6.82 ± 2.28	17.27 ± 4.26	6.30 ± 1.76	15.03 ± 3.34	12.29 ± 2.16	14.80 ± 3.98
	No	74.95 ± 14.28	7.06 ± 2.69	18 ± 4.39	6.47 ± 1.96	15.49 ± 3.71	12.71 ± 2.26	15.22 ± 4.21
T		−1.98*	−1.07	−1.88	−1.03	−1.47	−2.08*	−1.15
P		0.048	0.287	0.061	0.304	0.143	0.038	0.250

*$p<0.05$, **$p<0.01$, ***$p<0.001$.

TABLE 3 | Multiple comparisons (LSD).

Dependent Variable	(I) Educational background	(J) Educational background	Mean Difference (I-J)	Std. Error	Sig.
Sub- relaxation and tension (anxiety)	Junior College	Undergraduate	1.178*	0.519	0.024
		Postgraduate or above	−0.936	1.152	0.417
	Undergraduate	Junior College	−1.178*	0.519	0.024
		Postgraduate or above	−2.114*	1.067	0.048
	Postgraduate or above	Junior College	0.936	1.152	0.417
		Undergraduate	2.114*	1.067	0.048

*$p < 0.05$.

TABLE 4 | The correlation of teachers' social support, subjective well-being and self-efficacy (n = 496).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Total subjective well-being														
2 Sub-concern about health	0.320**	1												
3 Sub-energy	0.855**	0.079	1											
4 Sub-satisfaction and interest in life	0.656**	−0.02	594**	1										
5 Sub-depression or happy mood	0.883**	0.123**	0.752**	0.536**	1									
6 Sub-control of emotion and behavior	0.668**	0.082	0.478**	0.460**	0.536**	1								
7 Sub-relaxation and tension (anxiety)	0.838**	0.245**	0.585**	0.419**	0.696**	0.473**	1							
8 self-efficacy	0.334**	−0.220**	0.336**	0.281**	0.373**	0.345**	0.264**	1						
9 Sub-student engagement	0.342**	−0.207**	0.347**	0.311**	0.380**	0.315**	0.267**	0.940**	1					
10 Sub-teaching strategy	0.306**	−0.210**	0.324**	0.257**	0.335**	0.313**	0.236**	0.959**	0.845**	1				
11 Sub-classroom management	0.305**	−0.212**	0.324**	0.233**	0.347**	0.357**	0.249**	0.955**	0.831**	0.897**	1			
12 Total social support	0.385**	0.059	0.304**	0.282**	0.371**	0.306**	0.321**	0.329**	0.307**	0.311**	0.321**	1		
13 Sub-objective support	0.345**	0.066	0.255**	0.262**	0.329**	0.291**	0.288**	0.259**	0.230**	0.245**	0.266**	0.865**	1	
14 Sub-subjective support	0.279**	0.045	0.232**	0.199**	0.261**	0.228**	0.223**	0.269**	0.258**	0.254**	0.254**	0.823**	0.519**	1
15 Sub-utilization of support	0.258**	0.009	0.217**	0.179**	0.269**	0.158**	0.233**	0.238**	0.234**	0.224**	0.220**	0.550**	0.320**	0.251**

*$p<0.05$, **$p<0.01$, ***$p<0.001$.

TABLE 5 | The mediation effects of self-efficacy (2000 Bootsraps).

independent variable	dependent variable	Mediate variables	X→M		M→Y		X→Y		direct effect		indirect effect		total effect	
			coeff	SE	coeff	se	Coeff	Se	coeff	se	coeff	95%CI	coeff	se
social support	subjective well-being	self-efficacy	0.056***	0.004	2.671***	0.245	0.606***	0.081	0.606***	0.081	0.149***	0.086,0.223	0.755***	0.08

*X is social support, M is self-efficacy, Y is subjective well-being. *p<0.05, **p<0.01, ***p<0.001*

and promoting their professional development (Zhang and Wei, 2014). The special "national training plan" has been carried out in rural areas, which could promote SWB of special teachers in China to some extent.

By analyzing the demographic variables that impact SWB of special education teachers, it was found that SWB level of teachers was associated with many factors, including gender and teaching age, whether being a head teacher. There are significant differences in SWB level of special education teachers of different genders. Male special education teachers in northwest China had higher SWB and the scores of the total score of happiness, energy factor, satisfaction and interest in life, melancholy or happy mood, and control of emotion and behavior are significantly higher than those of female ones. The association between gender of SWB teachers remains controversial. Some studies based on teacher gender theory have pointed out that female teachers are generally significantly higher than male ones in terms of happiness level (Liu, 2011; Wang, 2017), while some research found that female teachers reported a higher level of psychological distress (Pevalin, 2000; Dai, 2014; Chaplain and Jackson, 2017). The reason may be as female teachers, since they not only have to face the same educational and teaching pressure as male ones, but also have to bear more responsibilities of family such as bearing, raising, educating children, and housework in China (Ding, 2006), which may result that the happiness of female special education teachers in China is significantly lower than that of male ones.

In addition, professional-related factors of teachers, including education background, teaching years, and whether they are head teachers, all have association with SWB level of special education teachers. The results showed that there was no significant difference in the total score of SWB, but in the dimension of relaxation and tension among the special education teachers with different educational backgrounds in China. The teachers

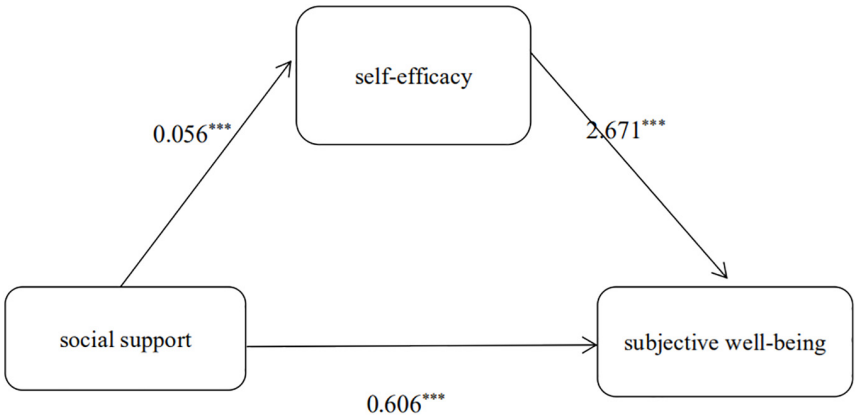

FIGURE 1 | The mediated effect model of social-efficacy between social support and subjective well-being of special education teachers in China. ***$p < 0.001$.

of bachelor degree were significantly lower than others in the dimension of relaxation and tension. On one hand, teachers of bachelor degree felt more anxious than those with higher education background. Teachers graduated from master program are more confident in the teaching work and be more trusted by the administrators in the school (Liang, 2017) and they are also less likely to suffer from anxiety (Wang et al., 2009). On the other hand, teachers of bachelor degree felt more anxious than those graduated from junior college. It is similar with study of Zhang (2020). She found that special education teachers graduated from junior college scored higher in job satisfaction than undergraduate teachers. It is since teachers graduated from junior college have low expectation on their career and are relatively less under pressure in the work (Wang, 2017).

In terms of teaching age, the teachers with more than 10 years of teaching experience scored significantly higher than ones with 3 years or less on the emotion and behavior control dimension of SWB, which indicated that the work pressure of teachers with longer teaching experience was significantly lower than that of ones with shorter teaching experience (Pang, 2003) and they have higher sense of self-efficacy (Vasher, 2012) and SWB. Teachers who have longer teaching experience will more consciously conduct self-education, self-perfection, and self-improvement in teaching management (Gavish and Friedman, 2010; Aloe et al., 2014; Ren and Wang, 2015), whereas teachers who are new and have shorter experience are more likely to suffer from stress in teaching management, time management, and work-life balance. Without proper social support, they are 60% less likely to stay in teaching for the long term (Calnan, 2017).

This study result showed that SWB level of special education teachers serving as head teachers was significantly lower than that of ones not in the northwest region of China. There are significant differences on the control of the emotional and behavioral dimensions; the teacher who do not work as a head teacher can better control of their emotions and behavior. Consistent with previous studies (Dai, 2014; Chaplain and Jackson, 2017), i.e., positions of teachers have a significant impact on their level of happiness, the teacher incharge of the class is usually affected by the school chores and heavy workload, so they are faced with greater work pressure as well as a lower sense of self-efficacy. Dramatic changes to the role of a modern head teacher have been associated with increased levels of stress (Chaplain and Jackson, 2017). For special education head teachers, they are responsible for organizing the daily running of the classroom and dealing with challenge behaviors of students (Langher et al., 2017), whose SWB is low. Because of students with disabilities have great individual differences, generally weak learning ability and most accompanied by more emotional and behavioral problems, they also need to deal with the curriculum organization and management and solve unexpected problems.

Mediation Effect of Self-Efficacy on the Relationship Between Social Support and SWB of Special Education Teachers

The results showed that the level of social support obtained by special education teachers in China can positively predict their SWB level. That is, the higher the social support level, the SWB level will be higher. It is consistent with the previous research (Lam, 2019). Social support is closely related with SWB of teachers (Lam, 2019; Carroll, 2020). The study of Chinese researchers also shows that different dimensions of social support of special education teachers have a good predictive effect on SWB of teachers and its various dimensions (Tang, 2006; Lu and Ying, 2014). Social objective support can provide material or information help, increase happiness of teachers, and improve their self-confidence and the increase of utilization of support of an individual will reduce worries and the possibility of their inner depression and pain. Therefore, teachers with high utilization of social support usually have a higher level of SWB (Zhang, 2005; Chaplain and Jackson, 2017; Langher et al., 2017) and the special education teachers who can make good use of various social support resources usually feel less psychological pressure, have more positive task motivation, and then have higher SWB (Wang et al., 2012).

Further analysis found that self-efficacy of teachers played a mediating role in the relationship between social support

and SWB of special education teachers in northwest China. That is, social support affected SWB of teachers level by improving self-efficacy of teachers. Social support not only directly affects SWB of special education teachers, but also impacts on self-efficacy and improves their SWB of teachers (Huang, 2011; Stanculescu, 2014; Carroll, 2020). On one hand, social support can have a direct effect through encouragement. On the other hand, it can also have an indirect effect through changing self-efficacy, so as to change individual behavior and produce a lasting effect on such change (Jiang et al., 2004). Meanwhile, the higher the level of social support, the more likely to promote individuals to adopt positive coping strategies to solve problems (Chan, 2002; Watts, 2014). Teacher needs personal accomplishment serve as emotional resources that favors positive personal outcomes (Katz and Shahar, 2015; Aelterman et al., 2016). As a high-order personality structure, the sense of self-efficacy is closely related with the psychological state of an individual: the higher the level of the sense of self-efficacy of an individual, the higher the level of SWB (Huang et al., 2012). High social support gives confidence of special education teachers in their own teaching ability and makes them have higher evaluation of life quality as well as SWB.

LIMITATION AND FURTHER RESEARCH

Limitations in this study were noted. First, the main limitation of this study is its cross-sectional nature that does not allow to infer causal relationships between the studied variables. Further studies can be elucidating the complexity of the reciprocal relations between these variables by examining the role of potential mediators longitudinally. Second, although the study focus on SWB of Chinese special education teachers, the comparison of special education teachers in a broader context would be help to understanding the impact of culture. An important area of future research will be conducted in different countries.

PRACTICAL IMPLICATION

First, for the development of special education in different regions, the government should set quantifiable and actionable policy goals. In this study, the research on SWB of special education teachers is inconsistent with previous studies in central and eastern regions, which main reason lies in the unbalanced development of special education in different regions making different working environment of special education teachers. "The Opinions of the General Office of the State Council on Further Adjusting and Optimizing the Structure to Improve the Efficiency of the Use of Educational Funds" points those educational resources should be tilted to remote and poor areas to promote the rational allocation of educational resources and educational equity. All the relevant policy documents, such as "the First and Second Special Education Promotion Plan and Opinions on Comprehensively Deepening the Reform of Teacher Team Construction in the New Era", indicate that the construction of special education teachers has become a key task for the development of special education at this stage. However, there are some deviations in the implementation of the policy and it is necessary to formulate operational and instructive local policies to promote the development of regional special education and to procedurally supervise the implementation of the policies.

Second, school organizations should provide targeted support to teachers of different genders and teaching ages. Any kind of behavior or psychological expression arises from the totality of various interdependent facts, which have the characteristics of a dynamic field. School organization is one of the most leading social environments for teachers, which has a direct impact on the quality of life of teachers. This study shows that female and newly recruited special education teachers in China have a low SWB, which can be effectively elevated by improving their social support and self-efficacy. Therefore, school organizations should fully respect their work and give certain social support, including psychological counseling, flexible teaching adjustment during lactation period, carrying out colorful activities, and so on, to show the charm of female teachers and enhance their self-confidence. In fact, new teachers often lack a clear plan for their future career development. They are prone to various problems in teaching and feel great pressure. They need to improve their sense of self-efficacy by elevating their professional ability. Schools can help new teachers to adapt to the teaching environment as soon as possible and improve their teaching skills through class evaluation, teaching on behalf of teachers as well as teaching and research groups. At the same time, we should make full use of national and provincial training programs to provide relevant professional training opportunities for young special education teachers to meet their professional development needs.

Third, the on-service training system for special education teachers in China should be improved. The establishment and improvement of the social support system needs the joint efforts of the school, society, and teachers. "What Every Special Educator Must Know: Ethics, Standards, and Guidelines for Special Educators," emended by the Council for Exceptional Children (2022), which stipulates that special education teachers are required to develop a career plan during their post-service development and have the right to seek adequate professional development resources from their institutions. Social resources are of great significance to the professional development of special education teachers and the improvement of their quality of life. The government and schools should provide effective training opportunities and sufficient training resources for teachers, effectively improve their sense of teaching efficacy, enable them to correctly deal with the possible new situations and situations in the working situation, and adapt to the new work objects as well as contents more quickly. In addition, scientific teaching evaluation mechanism is the quality assurance of social support system operation. Scientific teaching evaluation mechanism cannot only promote career planning and work effectiveness of special education teachers, but also enhance their social support utilization degree, so as to improve SWB of this group and promote the improvement of special education quality.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Beijing Normal University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

WF designed the study, collected the data, and wrote the manuscript. LW collected and analyzed the data. XH, HC, and JH wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Social Support, Mindfulness, and Job Burnout of Social Workers in China

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In the last 20 years, amid extensive social and economic reforms, China's social structure and community life have changed considerably. A large number of social workers are needed to provide many more social services to community residents. The central government has issued many policies to rapidly develop human service organizations and increase the number of social workers. Thus, by the end of 2019, the number of social workers has reached more than 1.5 million in China. At the same time, local governments have issued many policies to promote an increase in the number of social workers. According to statistics from the Chengdu Civil Affairs Bureau, from 2010 to 2021, the number of social workers in Chengdu City increased, remarkably, from 553 to 17,622. Although the number of social workers has increased rapidly, some problems still exist. According to a survey by the Chengdu Social Workers Association, the turnover rate of social workers has reached approximately 20% in Chengdu City in 2018. Therefore, we aim to determine what influences social workers' job burnout. Through regression analysis and mediation effect tests, we found the following: First, when controlling for gender, age, education, and workday, social support of social workers had a significant negative impact on job burnout ($\beta = -0.376$). Second, the mindfulness of social workers had a significant negative impact on job burnout ($\beta = -0.320$). Third, the mindfulness of social workers played a mediating role between social support and job burnout. The mediating effect was −0.116 ($p < 0.001$). Fourth, among the three dimensions of social support, mindfulness played a partially mediating role in family support and other support. The mediating effect between other support, which is the support from leaders and colleagues, and job burnout was the strongest, with a mediating effect of −0.109 ($p < 0.001$). In other words, the support provided by agency leaders and colleagues can maximize the level of mindfulness of social workers, thereby reducing social workers' job burnout most effectively. We can thus reduce social workers' job burnout by improving their level of mindfulness and the social support for them in China.

Keywords: social workers, social support, mindfulness, job burnout, China

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INTRODUCTION

In recent decades, a lot of studies have discussed the stress, burnout, and turnover rate of helping professions (Lloyd et al., 2002; Pang et al., 2010; Yang et al., 2017; Jiang et al., 2019; Wang et al., 2021). Empirical research has shown that social workers may experience occupational stress, job burnout, and turnover intention (Soderfeldt et al., 1995; He, 2015;

Lin and Deng, 2019; Zeng et al., 2019; Hu, 2021). However, despite the rapid development of the current social work industry, social workers in China still face a high turnover rate and job burnout (Jiang and Wang, 2016; Wang et al., 2019). Research has shown that job burnout is one of the strongest predictors of turnover intention (Mor Barak et al., 2001). Job burnout can cause anxiety and stress in social workers and gradually consume the individuals' physical and mental resources. It is not conducive to the social workers' physical and mental health (Durham, 1992; Shapiro et al., 2010). The job burnout of social workers has become an urgent problem to be solved for China. Despite this, little research examines the factors affecting job burnout of Chinese social workers (Huang et al., 2021). Therefore, this study focuses on support-related factors that contribute to and protect against job burnout in a sample of Chinese social workers from Chengdu, China. We also examine how mindfulness serves as a mediator in such relations. The results of this study not only can further enrich the research on factors affecting job burnout, but also can further alleviate job burnout among Chinese social workers and promote the sustainable and stable development of the Chinese social work industry.

LITERATURE REVIEW

The Current State of Social Work

In China, the economic reforms in the 1980s initially revealed a large number of social problems related to disadvantaged groups, which threatened the stability and cohesion of Chinese society (Ma, 2002). Therefore, amid the complexities and problems of economic transformation, social work has been restored and reconstructed in China (Liu, 2012). In 1988, the National Education Commission approved the opening of the Department of Social Work in the Department of Sociology of Peking University, focusing on the reconstruction of social work education. Since 1988, social work major in various universities has been a rapid development trend (Liu, 2001; Law and Gu, 2008). In 2015, There were a total of 1,842 MSW teachers nationwide, including 1,265 full-time teachers, and about 11–12 MSW professional teachers in various universities (Xie, 2017). As of the end of 2018, there were 348 undergraduate social work programs, 147 Master of Social Work programs, and 17 Ph.D. programs in China, with more than 40,000 graduates each year (Chan et al., 2020). At the end of 2018, there were 816,000 social organizations nationwide. Compared with 762,000 in 2017, the total number has increased by 54,000, the growth rate was 7.1%, and the growth rate has dropped by about 1.3% (Report on Social Organizations in China, 2019).

In Chengdu, Southwest Petroleum University took the lead in opening social work major. From 2002 to 2004, seven universities in the province successively opened social work major and recruited undergraduates majoring in social work. Since 2005, more than 10 universities in the province have established undergraduate and master's programs in social work (Jiang, 2013). Following the 5.12 Wenchuan Big Earthquake in 2008 in Sichuan Province, social work experts and social workers from all over the country went to Sichuan to carry out social work services, which greatly promoted the development of social organizations in Chengdu and the growth of social workers (Huang, 2020). Meanwhile, the loss of social workers is also a common phenomenon. For example, the turnover rate of social workers in Shenzhen reached 22% in 2014 (Du, 2015), and the turnover rate of social workers in cities, such as Beijing, Shanghai, Nanjing (Li, 2016), and Guangzhou, also approached approximately 20% (Fang, 2015).

Job Burnout

Maslach and Jackson (1981) defines job burnout as a symptom of encompasses exhaustion, cynicism, and sense of inefficacy in the occupational field, mainly occurs in human service professionals (Freuden-berger, 1974). Most domestic scholars use Maslach's definition when studying job burnout and believe that such as heavy workload, lack of job recognition, and high work pressure are common causes of social workers suffering from job burnout (An, 2010; Sun and Liu, 2017; Tan, 2017). Burnout significantly positively predicts turnover rate (Mor Barak et al., 2001). Job burnout can cause anxiety and stress in social workers and gradually consume the individuals' physical and mental resources, and it is not conducive to the social workers' physical and mental health (Durham, 1992; Shapiro et al., 2010). It is very necessary to investigate the factors affecting burnout of Chinese social workers.

Social Support and Job Burnout

Social support refers to the spiritual and material support given to individuals by organizations, family, relatives, friends, colleagues, partners, etc. It reflects the closeness and quality of a person's social connections (Blumenthal et al., 1987), which have an impact on a person's mental health. Social support can be divided into objective social support and perceived social support (Furmark et al., 2009). In this study, we combine Zimet et al. (1988) definition of perceived social support and defined perceived social support into the emotional experience that social workers experience through understanding and support from family, friends, and other sources. It is in a relatively stable state over a short period of time. A large number of studies have shown that social support is beneficial to individuals' mental health (Cobb and Wills, 1985), and the discussion on the factors affecting social workers' job burnout has mainly focused on the influence of different sources of social support. The theory of social support suggests that the survival of an individual depends on the support and help of others. The more social support an individual has, the better he or she can address the difficulties he or she faces. A large number of studies have also shown that there is a significant negative correlation between social support and job burnout. Related research has mainly discussed the impact of social support on job burnout according to the source and type of social support. For example, the study of Lee et al. (1990) confirmed that there was a negative correlation between social support and job burnout caused by work: among the various types, social support from leaders had the most obvious negative effect on job burnout. Schwarzer (1992) research

on teachers found that compared with the support provided by family and friends, support from colleagues was more effective in reducing teachers' job burnout. Sarros and Sarros (1992) mainly discussed the roles played by different types of social support. Their research implied that the actual support teachers received was more effective in reducing job burnout than emotional support. Feldman et al. (2002) believed that the higher the family support for employees in the transportation industry was, the less likely they were to suffer from job burnout.

Some research on the relationship between social support and job burnout has compared China to Western countries, but the research conclusions are basically consistent with the existing research conclusions in Western countries. Moreover, most Chinese scholars have found through their research that individuals' social support was helpful to alleviate their job burnout. These studies have mainly concentrated on teachers, psychological counselors, medical staff, judges, and social workers because these groups have certain shared characteristics. For example, they have long and emotional working hours, highly emotional labor requirements, and a high susceptibility to external evaluation and self-evaluation (Yang et al., 2017); thus, they are more likely to develop job burnout. Lu (2015) stated in his research conclusion that the more social support elementary and middle school teachers received, the weaker their sense of job burnout. Qiao (2019) conducted questionnaire surveys and interviews with social workers in Chengdu and found that the higher the level of social support of social workers was, the weaker their feelings of job burnout. Zhang (2016) investigated a group of psychological counselors. He found that the social support obtained by this group can help alleviate burnout at work. The research content mainly focused on the relationship between social support, job burnout, and the influence mechanism between the two. Ma (2015) suggested that judges' job burnout in China was generally more serious and that social support could produce more active coping styles, thereby reducing job burnout. Zhao et al. (2019) used a questionnaire survey method to show that social support could effectively reduce the job burnout of medical staff by enhancing the self-efficacy of medical staff in China.

Social Support, Mindfulness, and Job Burnout

Previous studies of the mindfulness of social workers have focused more on the role of mindfulness in an intervention after job burnout occurs. Mindfulness in this article refers to a state of attention that is consciously aware of a moment without any judgment (Kabat-Zin, 2003). In this state, an individual will focus his or her consciousness and attention on current internal and external stimuli, including internal feelings and thoughts, as well as external sights and sounds, and accept these stimuli without evaluation (Baer et al., 2004). Different mindfulness states can be quantified by different mindfulness levels. Each person's original mindfulness level is different, and each person's mindfulness level is not fixed in different situations (Brown and Ryan, 2003).

In a study on sleep quality of college students, researchers found that students with high levels of perceived social support also had high levels of mindfulness, and mindfulness played a mediating effect between comprehension of perceived social support and sleep quality (Chen, 2018). In addition, perceived social support also has a positive impact on mindfulness. It means that firefighters with high levels of perceived social support have a high level of mindfulness. After facing the fire disaster and trauma, firefighters can show positive growth. Social support has a positive impact on mindfulness (Chen et al., 2020). Tan and Tao (2021) through a cluster sampling survey of doctors found that the perceived social support obtained by doctors had a positive impact on the improvement of their mindfulness level, and mindfulness played a part of the mediation between the perceived social support and job burnout. Through the positive emotional experiences of being supported, understood, and respected by individuals, social support provides encouragement and courage to overcome difficulties and challenges, thereby improving individuals' self-satisfaction and confidence (Xie et al., 2019).

The mindfulness coping model entails that when an individual faces an external stimulus beyond his or her tolerance, the individual will adopt a decentralized adaptive response to his or her stress evaluation in a mindful way, focusing on the dynamic process of consciousness instead of the content of consciousness, thereby expanding his or her attention and strengthening his or her cognitive flexibility. Relying on their expanded metacognitive state, individuals actively re-evaluate stressful events, redefine or construct stressful events, and, finally, trigger positive feelings that can relieve stress, such as compassion, trust, self-confidence, or inner-peace (Garland et al., 2009). Continuous work pressure will quickly consume individuals' physical and mental resources. When this unhealthy state persists, it will trigger emotional states, such as anxiety, depression, and burnout. However, if an individual can maintain abundant personal resources, such as mindfulness, he or she can effectively relieve negative emotions (Mesmer-Magnus et al., 2017). Recent studies have proven that mindfulness, as a personal psychological resource, plays a positive role in reducing people's job burnout. Some studies showed that improving individuals' mindfulness level can effectively alleviate the job burnout symptoms of social workers, such as insomnia, anxiety, and depression, thereby improving social workers' physical and mental health (Brekke, 2012). Zeng and Qian (2017) found that the mindfulness of nurses was negatively associated with job burnout. Chen et al. (2018) used a five-factor mindfulness scale to test employees' mindfulness level and concluded that employees' mindfulness reduced job burnout. Cheng et al. (2020) found that the lower the level of mindfulness was, the more serious a teacher's job burnout, which can further strengthen a teacher's intention to resign.

In summary, mindfulness is affected by social support (Chen, 2018; Chen et al., 2020; Tan and Tao, 2021). In addition, mindfulness, as an important psychological resource, can reduce individuals' job burnout, relieve bad emotions, and improve individuals' physical and mental health (Brekke, 2012; Zeng and Qian, 2017; Chen et al., 2018, 2020). In the research on teachers, doctors, and other groups, mindfulness is generally used as a

mediator (Chen, 2018; Tan and Tao, 2021). Social work is a typical helping profession, often accompanied by emotional labor, which can be seen as a high incidence of job burnout (Ren, 2017; Li, 2019). However, empirical research on the relationship between social support, mindfulness, and job burnout of Chinese social workers is still lacking. Thus, this article follows the perspective of social support theory to construct a model of the relationship between social workers' social support, mindfulness, and job burnout (see **Figure 1**), proposing the following hypotheses:

H1: The social support of social workers has a negative correlation with job burnout.

H2: The level of mindfulness of social workers has a negative correlation with job burnout.

H3: The mindfulness of social workers plays a mediating role between social support and job burnout.

H3-a: The mindfulness of social workers plays a mediating role between family support and job burnout.

H3-b: The mindfulness of social workers plays a mediating role between friend support and job burnout.

H3-c: The mindfulness of social workers plays a mediating role between other support and job burnout.

MATERIALS AND METHODS

Data and Sample

The data for the present study were collected from social workers in Chengdu, China, *via* an anonymous online survey. Chengdu is the city of Sichuan province and has a rapid development in social work. We randomly selected two districts out of 22 districts in Chengdu. With the help of Civil's Affairs Bureaus (CAB), we successfully contacted social work professional associations and agencies to recruit participants within the two districts. Each district has around 600 social workers. On May 5, 2021, social workers of these associations and agencies were invited to participate in the survey. We sent reminders to participants 1 week and 2 weeks. On May 29, 2021, 915 social workers responded to the survey. We excluded 18 surveys from the final analysis due to incomplete and invalid data. The final sample contained from 897 social workers. The response rate of the survey was 75%. An informed consent process was implemented prior to the survey. Meanwhile, participants were informed that their participation was voluntary and that they could choose to stop the survey at any time. Every participant could compensate with 5RMB (1USD).

Measures

The dependent variable, job burnout, was measured by the Maslach Burnout Inventory (MBI; Maslach et al., 1996). There are three versions of the MBI that are applicable to different groups of people: the MBI-Human Services Survey, MBI-Teacher Survey, and MBI-Universal Survey. Among them, the MBI-Human Services Survey (MBI-HSS) is suitable for people engaged in the service industry, including police, medical staff, and mental health workers. Social workers mainly supply persons with specialized social services, so the MBI-HSS is suitable for them. The original MBI-HSS had a total of 22 items, and after revision, 17 items were established. The survey contains three dimensions: emotional exhaustion (seven items; e.g., "I feel that my feelings have been exhausted at work"), depersonalization (three items; e.g., "Since taking this job, I have become more indifferent to people"), and personal accomplishment (seven items; e.g., "I can solve problems at work very effectively"). The scale uses a 1–7 grade scoring method, and the scores range from 1 (never) to 7 (every day). In three dimensions, high scores on the emotional exhaustion dimension and depersonalization dimension are indicative of burnout, and low scores on the personal accomplishment dimension are indicative of burnout. Thus, the personal accomplishment dimension items are reverse scoring (Florent et al., 2017). After reverse scoring, the higher the score of personal achievement dimension, the more serious the job burnout. The final total score of MBI includes the forward scoring of the first two dimensions and the reverse scoring of the third dimension. That is, high scores on the MBI are indicative

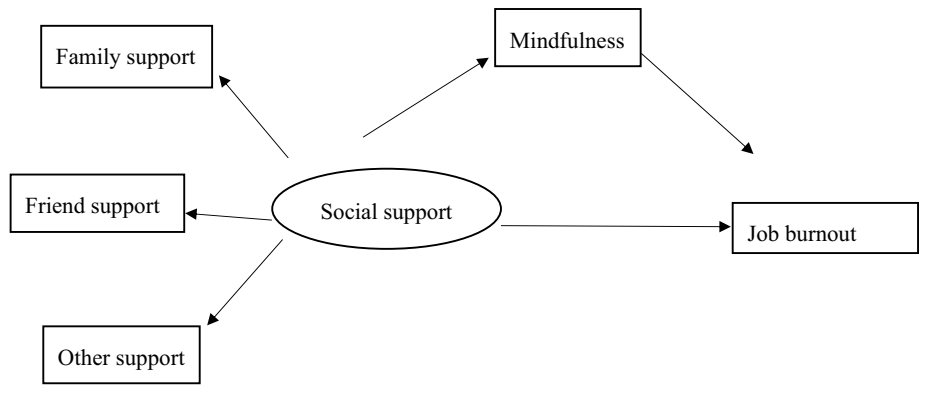

FIGURE 1 | Relational model of social support, mindfulness, and job burnout.

of burnout. The scale total score ranges from 17 to 119 points. The Cronbach's coefficient of the scale was 0.88.

The independent variable, perceived social support, was assessed by the perceived social support scale (PSSS; Jiang, 1999). It was based on the perceived social support scale compiled by Zimet et al. (1988). The scale mainly measures the social support perceived by individuals. It consists of three subscales and 12 self-assessment items. The scale consists of three subscales. Through factor analysis, each subscale has strong factorial validity, and subjects can clearly perceive and distinguish the three sources of social support (Zimet et al., 1988). The three subscales are family support (four items; e.g., "My family truly tries to help me"), friend support (four items; e.g., "My friends truly try to help me"), and other support (four items; e.g., "There is a special person who is around when I am in need"). The scale uses a 1–7 grade scoring method, and the scores range from 1 (strongly disagree) to 7 (strongly agree). The total score reflects the total degree of social support felt by the individual. The higher the total score is, the higher the individual's level of social support. The scale total score ranges from 12 to 84 points. In our research, Cronbach's alpha coefficients of the total scale and subscale were 0.95 for social support, 0.90 for family support, 0.93 for friend support, and 0.90 for other support.

We used Five Facet Mindfulness Questionnaire (FFMQ) to measure state mindfulness of samples (Baer et al., 2004). The original FFMQ has five dimensions and contains 39 items, which are evaluated from five dimensions: observation (eight items), description (eight items), conscious action (eight items), nonjudgment (eight items), and inaction (seven items). These items are based on a combination of exploratory factor analysis and confirmatory factor analysis of the MAAS, FMS, and KMS. Meng et al. (2020) based on an exploratory factor analysis and confirmatory factor analysis of the original FFMQ Scale, developed a Short-Form Five Facet Mindfulness Questionnaire (SF-FFMQ) specifically for China. The scale contains 20 items (e.g., "When I'm walking, I deliberately notice the sensations of my body moving"), which is also divided into five dimensions. Some items require reverse scoring (e.g., "I find myself doing things without intending to"). Participants are asked to score each item on the Likert scale, from 1 (not at all) to 5 (completely). The scale total score ranges from 20 to 100 points that reflects the individual's mindfulness level. The higher the score is, the higher the individual's mindfulness level. The Cronbach's coefficient of the scale was 0.92.

Analytical Strategy

We conducted analysis and Pearson's correlation analysis, in order to observe the sample characteristics and the correlations among all variables. Then, we conducted regression analysis and bootstrap analysis to examine the relations among social support, family support, friend support, other support, mindfulness, and job burnout, while controlling gender, age, education, and working time. All control variables were assumed to have impact on mindfulness and job burnout. Bootstrap analysis repeats sampling of samples. Compared with the stepwise method of Baron and Kenny (1986), bootstrap analysis can obtain a more accurate confidence interval and a higher test power (Hayes and Scharkow, 2013; Kristopher et al., 2014). Therefore, this article combined the advantages of the stepwise method and bootstrap analysis, first through the regression analysis to test the coefficients, and then used the bootstrap analysis to re-test the indirect effects and confidence intervals to improve the test power and the explanatory power of the results. STATA15.0 software was used for all analyses.

RESULTS

Since the data in this study were derived from the subjects' self-reports, there may be common method deviations. We used Harman's single factor method for the common method deviation test. We found five factors with eigenvalues greater than one, and the variance explained by the first factor was 36.53%; less than the critical value of 40%. Our study had no serious common method deviation in the data.

Table 1 presents the descriptive statistics and correlations of key variables. The average age of the sample was 31.8 years old. About 78% were female. A large number of social workers had college and above degree (54.6%). The average weekly workdays of many social workers were approximately 5.2 days. The average score of social support obtained by the sample was 59.3. Among the participants, many felt the most support came from their friends ($M = 20.1$, SD = 4.4). Notably, the samples' average mindfulness score was 61.9. The average score of job burnout of the sample was 53.9 (SD = 16.6).

The correlations of the key variable results are shown in **Table 1**. Age was positively correlated with social support ($r = 0.12$, $p < 0.001$), family support ($r = 0.17$, $p < 0.001$), and other support ($r = 0.09$, $p < 0.01$). Education was negatively correlated with family support ($r = -0.08$, $p < 0.05$). In addition, age ($r = 0.11$, $p < 0.001$), education ($r = 0.09$, $p < 0.01$), social support ($r = 0.37$, $p < 0.001$), family support ($r = 0.32$, $p < 0.001$), friend support ($r = 0.35$, $p < 0.001$), and other support ($r = 0.33$, $p < 0.001$) were all positively correlated with mindfulness. Ultimately, regarding job burnout, the older the social worker was, the lower the level of job burnout ($r = -0.16$, $p < 0.001$). The higher the educational background was, the more serious the job burnout ($r = 0.13$, $p < 0.001$), and the longer the weekly workdays was, the more serious the job burnout ($r = 0.07$, $p < 0.05$). In general, social support ($r = -0.40$, $p < 0.001$), family support ($r = -0.36$, $p < 0.001$), friend support ($r = -0.34$, $p < 0.001$), and other support ($r = -0.37$, $p < 0.001$) were all negatively correlated with job burnout. The higher the level of mindfulness of social workers was, the more likely they were to reduce their own burnout ($r = -0.41$, $p < 0.001$).

Table 2 presents the regression analysis of the 3 models. Model 1 analyzed the impact of social support on job burnout. The results showed that adj.$R^2 = 0.18$, $F = 40.84$, $p = 0.000$; social support was negatively associated with job burnout ($\beta = -0.376$, $p < 0.001$). That is, the higher the level of social support that social workers received, the lower their level of job burnout. Model 2 analyzed the impact of social support

TABLE 1 | Descriptive statistics and correlations of key variables.

Variable	Mean (S.D.)	1	2	3	4	5	6	7	8	9	10
1. Female (0–1)	0.8 (0.4)	—									
2. Age (20–50)	31.8 (7.3)	0.04	—								
3. Education-College and above (0–1)	0.6 (0.5)	0.05	−0.32***	—							
4. Weekly workdays (0–7)	5.2 (0.5)	0.09*	0.11**	0.01	—						
5. Social support	59.3 (12.4)	−0.02	0.12***	−0.06	−0.002	—					
6. Family support	19.5 (4.9)	−0.04	0.17***	−0.08*	−0.03	0.89***	—				
7. Friend support	20.1 (4.4)	−0.03	0.06	−0.02	0.002	0.92***	0.72***	—			
8. Other support	19.6 (4.4)	0.01	0.09**	−0.06	0.02	0.90***	0.68***	0.79***	—		
9. Mindfulness	61.9 (6.5)	0.03	0.11***	0.09**	0.06	0.37***	0.32***	0.35***	0.33***	—	
10. Job burnout	53.9 (16.6)	0.09*	−0.16***	0.13***	0.07*	−0.40***	−0.36***	−0.34***	−0.37***	−0.41***	—

*N = 897, *p < 0.05, **p < 0.01, and ***p < 0.001.*

TABLE 2 | Regression analysis of job burnout.

Variable	Model 1			Model 2			Model 3		
	β	SE	*P*	*β*	SE	*P*	*β*	SE	*P*
Social support	−0.376	0.030	***	−0.260	0.031	***			
Family support							−0.124	0.043	**
Friend support							0.017	0.051	
Other support							−0.183	0.048	***
Mindfulness				−0.320	0.031	***	−0.321	0.031	***
Gender	0.071	0.030	*	0.077	0.029	**	0.080	0.029	**
Age	−0.106	0.032	**	−0.070	0.031	*	−0.067	0.031	*
Education	0.069	0.032	*	0.116	0.031	***	0.113	0.031	***
Workday	0.078	0.031	*	0.093	0.029	**	0.093	0.029	**
N		897			897			897	
F		40.84***			55.40***			42.37***	
Adjusted R^2		0.18			0.27			0.27	

*N = 897, *p < 0.05, **p < 0.01, and ***p < 0.001.*

and mindfulness on job burnout, adj.$R^2 = 0.27$, $F = 55.40$, $p = 0.000$, indicating that the goodness of fit of Model 2 is higher than that of Model 1. Social support was negatively associated with job burnout ($\beta = -0.260$, $p < 0.001$), and mindfulness was also negatively associated with job burnout ($\beta = -0.320$, $p < 0.001$). Thus, the results of Model 1 and Model 2 verified Hypothesis 1 and Hypothesis 2. Furthermore, Model 3 analyzed the three dimensions of social support, including family support, friend support, and other support's effects on job burnout. The results showed that family support ($\beta = -0.124$, $p < 0.01$), other support ($\beta = -0.183$, $p < 0.001$), and mindfulness ($\beta = -0.321$, $p < 0.001$) were negatively associated with job burnout.

Furthermore, regression analysis indicated that among the control variables, gender, age, education, and workday all passed the significance test in the three models, indicating that the four variables all have a significant association with job burnout. For example, in Model 1, gender ($\beta = 0.071$, $p < 0.05$), education ($\beta = 0.069$, $p < 0.05$), and workday ($\beta = 0.078$, $p < 0.05$) were positively associated with job burnout. In contrast, age was negatively associated with job burnout ($\beta = -0.106$, $p < 0.01$). Thus, according to the regression coefficients of the three support dimensions, other support had the greatest impact on social workers' job burnout, followed by family support, but friend support had no significant correlation with job burnout.

Mediating Role of Mindfulness

Under the condition of controlling for gender, age, education, and workday, we tested whether mindfulness can mediate the relationship between social support and job burnout. **Table 3** and **Figure 2** suggested that after adding the intermediary variable mindfulness, social support had a significant negative predictive effect on job burnout ($\beta = -0.260$, $p < 0.001$), and the coefficient was less than the original −0.376. The total effect of social support on job burnout was −0.376, and the indirect effect of social support *via* mindfulness was −0.116 ($p < 0.001$). Thus, mindfulness played a partial mediating role in the impact of social support on job burnout. The mediating effect was −0.116, the 95% bootstrap confidence interval was [−0.148, −0.088], and the proportion of the effect mediated by mindfulness was 0.309 (−0.116/−0.376). This verified Hypothesis 3. We further tested the mediating role of mindfulness in the impact of different dimensions of social support on job burnout; **Table 3** illustrated that mindfulness played a partial mediating role in the impact of family support on job burnout. The mediating effect was −0.107 ($p < 0.001$), the 95%

bootstrap confidence interval was [−0.139, −0.082], and the proportion of family support's effect on job burnout that was mediated by mindfulness was 0.318 (−0.107/−0.337). In addition, mindfulness played a similarly partial mediating role in the impact of other support on job burnout. The mediating effect was −0.109, the 95% bootstrap confidence interval was [−0.142, −0.082], and the proportion of other support's effect on job burnout that was mediated by mindfulness was 0.304 (−0.109/−0.359). Accordingly, Hypotheses H3-a and H3-c were verified.

In summary, mindfulness played a mediating role between the social support of social workers and job burnout. Through further analysis, it was found that mindfulness also played a partially mediating role between the two dimensions of family support and other support of social workers and job burnout. Moreover, mindfulness had the strongest mediating effect between other support and job burnout. Therefore, the support provided by agency leaders and colleagues can maximize individuals' level of mindfulness, thereby more effectively reducing social workers' job burnout.

DISCUSSION

Empirical research from studies mainly focused on samples of teachers, doctors, etc. It has shown that social support is beneficial to individuals' mental health (Cobb and Wills, 1985) and reduce job burnout (Halbesleben, 2006; Salami, 2009; Zhu et al., 2013). Research also showed that mindfulness, as a personal psychological resource, plays a positive role in reducing individuals' job burnout (Brekke, 2012; Zeng and Qian, 2017; Chen et al., 2018). Less is known about whether the mediation effect of mindfulness in the relation between social support and job burnout is in social workers. This study examined how social support and different dimensions were related to job burnout and whether these relations were mediated by mindfulness in social workers. Therefore, the present study extends the literature by investigating the mediation effect of mindfulness in the relation between social support and job burnout in social workers.

The descriptive statistics indicated that social workers had long working hours, heavy workloads, and high work intensity on the job. The regression analysis results provided support for the hypothesized process of job burnout in social workers. The results showed that the high level of social support received by social workers was correlated with a low level of job burnout ($\beta = -0.376$), which was consistent with previous research results (Qiao, 2019). The improvement in the level of social support promotes individuals to overcome difficulties from their external environment and enhances their motivation to cope with stressful events (Shi and Shi, 2013). Moreover, we also found that among the three dimensions of social support, family support ($\beta = -0.124$), and other support ($\beta = -0.183$) were significantly negatively associated with job burnout. Of them, the support provided by leaders and colleagues was the most helpful in reducing job burnout, which was consistent with the conclusions of existing research (Schwarzer, 1992; Qu et al., 2013; Zhang et al., 2014). In addition to serviced persons, social workers spend the most time with their colleagues and leaders in their daily work. When they face great pressures and difficulties at work, their family and friends cannot help them solve practical work problems in addition to providing them with spiritual support. However, leaders and colleagues can provide more actual support, which includes sharing a workload and providing practical solutions at work (Liu et al., 2018). Leaders and colleagues can help social workers solve some actual difficulties during workdays. When most of their problems at work can be resolved under the support provided by leaders and colleagues, social workers will experience less work pressure and feel better. In this way, the job burnout of social workers can be relieved to a large extent (Feng and Wang, 2014; Kong, 2017).

Importantly, mindfulness was found to act as a mediator of relation between social support and job burnout, pointing to mindfulness as a key point of intervention, which was consistent with the existing research results (Tan and Tao, 2021). On the one hand, the results showed that social support was positively correlated with mindfulness ($\beta = 0.364$), which was consistent with previous research results (Huang et al., 2021). In their research, support from colleagues of social workers can be seen as a job resource, which enables social workers to have a better state of mindfulness. Tan and Tao (2021) through a cluster sampling survey of doctors found that the perceived social support obtained by doctors had a positive impact on the improvement of their mindfulness level. In a study of the relationship between social support and better mental health, there is a positive correlation between social support and mindfulness (Klainin-Yobas et al., 2016; Mettler et al., 2019). Ali et al. (2019) showed that students who had better social support had more mindfulness. Besides, a study also found that social support is the main influencing factor of the level of mindfulness of pregnant women with threatened preterm labor. Good social support can provide a buffer and protect, promote physical and psychological adaptation of the individual, and promote positive behavior change, so as to conduct more effective self-behavior regulation, thereby improving mindfulness level. The higher the level of social support, the higher the level of mindfulness (He et al., 2021). On the other hand, when individuals have a high level of mindfulness, it can effectively reduce the job burnout that occurs at work (Bonifas

TABLE 3 | Bootstrap analysis of mediation effect test.

Path	Estimate	SE	Boot CI (95%)
Social support→Mindfulness→Job burnout	−0.116***	0.015	[−0.148, −0.088]
Family support→Mindfulness→Job burnout	−0.107***	0.015	[−0.139, −0.082]
Other support→Mindfulness→Job burnout	−0.109***	0.015	[−0.142, −0.082]

*N = 897, *p < 0.05, **p < 0.01, and ***p < 0.001.*

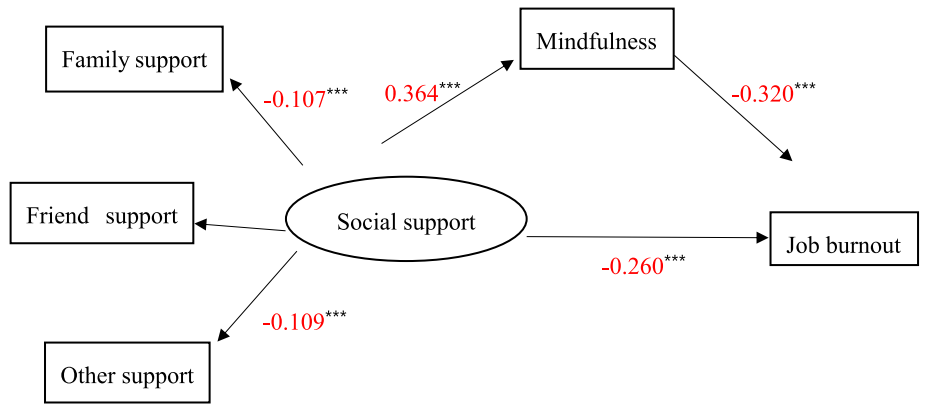

FIGURE 2 | Standardized estimates of social support, mindfulness, and job burnout. The *** means $p < 0.001$.

and Napoli, 2014; $\beta = -0.320$). In this study, mindfulness of social workers was significantly negatively correlated with job burnout, which was consistent with the findings of Brekke (2012). Mindfulness can help social workers receive enough emotional energy and create emotional space, allowing them to accept their shortcomings and limitations, and let go of their prejudices against external criticism or self-judgment (Birnbaum and Birnbaum, 2008). At the same time, the improvement of the level of mindfulness can reduce the emotional fatigue and occupational stress of social workers, thereby improving psychological flexibility (Gail et al., 2012). In addition, the mediating effect results further showed that mindfulness played a partial mediating role between social workers' family support, other support, and job burnout. Of these, mindfulness had the greatest mediating effect on the impact of other support on job burnout (indirect effect was −0.109). When social workers are faced with work challenges, their leaders and colleagues of human service organizations provide them with substantial assistance to the greatest possible extent on the work, which can help them to positively release occupational stress and generate positive emotions, and, ultimately, reduce job burnout (Tang and Ye, 2007; Zhang and Liu, 2010; Zhao, 2016).

Based on our all findings of our study, the level of mindfulness of social workers can be improved, social workers' job burnout can be alleviated efficiently. We should give attention to not only the role of social workers' social support in relieving job burnout but also to improving the level of mindfulness of social workers. We offer a few practice suggestions for social workers, human service organizations, and the government. These three should make collective efforts to reduce job burnout. First, social workers should further strengthen their personal qualities and abilities and rely on their own efforts to obtain the support of their families, leaders, and colleagues. Second, human service organizations should adopt some methods to reduce the work pressure on social workers, such as cultivating social workers' mindfulness, organizing team building activities, raising wages, and taking care of their mental health. Third, local governments should issue some policies to strengthen the publicity of social workers, which can improve the professional identity of social workers.

This article follows the perspective of social support theory to construct a model of the relationship between social workers' social support, mindfulness, and job burnout. To summarize, it does contribute to further understanding the social workers' job burnout and extends the literature by investigating the mediation effect of mindfulness in the relationship between social support and job burnout in developing countries. Moreover, our findings provide empirical evidence and useful opinions for alleviating job burnout of social workers, enhancing social support for social workers, and promoting the sustainable and stable development of the social work industry in reality.

The results of this study have some limitations. First, the data mainly come from social workers' subjective reports, which may include some subjects' memory bias. Second, the data all belongs to cross-sectional data. If we want to know the long-term effects of social support and mindfulness on job burnout, we need to track the sampled individuals and collect long-term data. Fortunately, this paper is a useful beginning that allows us to analyze the negative influence of social support and mindfulness on job burnout. If we want to reduce the job burnout of social workers, we should improve their social support, especially leaders' and colleagues' support, and adopt some methods to improve the mindfulness of social workers. Future research may consider collecting data from multiple sources, such as social workers' families, friends, leaders, and colleagues, to compare subjective and objective data. Longitudinal research could also be considered to test the stability of the relationship among social support and mindfulness and job burnout.

CONCLUSION

Based on intermediary model, this study analyzed the relations among social support and dimensions, job burnout in a sample of 897 social workers from China. Furthermore, we explored whether mindfulness mediates the relations between social support and dimensions, and job burnout.

The results demonstrate how social support affects social workers' job burnout. Our empirical findings show that social support has a significantly negative association with job burnout. On the one hand, social support has a significant negative impact on social workers' job burnout. On the other hand, social support can also indirectly predict job burnout through mindfulness. Thus, mindfulness intervention may be useful for social workers to reduce or avoid their job burnout.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

XX, YZ, JF, and GY: conceptualization and writing—review and editing. XX and YZ: methodology, software, and validation. YZ: analysis and data curation. YZ, JF, and GY: investigation. YZ and JF: writing—original draft preparation. XX: resources. All authors contributed to the article and approved the submitted version.

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Job Demands and Resources, Mindfulness, and Burnout Among Delivery Drivers in China

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The food and package delivery workforce in China has grown substantially in the past decade. However, delivery drivers face volatile and stressful work conditions, which can give rise to high turnover and burnout. Past research has indicated that job demands and resources (JD-R) significantly predict burnout. Scholars have also found evidence that mindfulness may be a protective factor against negative outcomes like burnout. Using data collected from 240 food and package delivery drivers in Beijing, China, we examined the effects of JD-R on burnout and whether these relations were moderated by mindfulness. Estimates produced by regression analyses indicated that job demands (JD) have significantly positive effects on burnout ($\beta = 0.33$), while job resources (JR) have a significant negative effect on burnout ($\beta = -0.32$). Mindfulness significantly moderated the effects of JD and JR on burnout ($\beta = -1.64$ and -1.30, respectively). Results suggest that mindfulness is a protective factor for delivery drivers. Practice and policy implications are discussed.

Keywords: job demands, resources, mindfulness, burnout, food delivery, package delivery, China

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INTRODUCTION

With its rapidly growing e-economy, China has seen considerable growth in the delivery sector over the past decade (CBNData, 2018; State Post Office, 2020; Chan, 2021; Zhao et al., 2021). Between 2019 and 2020, the online food delivery market alone increased 15%, totaling 665 billion yuan (103 billion USD; China Hotel Association, 2021). In 2019, there were more than 7 million food delivery drivers were employed across the country (Wang, 2021). Similarly, by 2018, China had 3 million individuals employed as package delivery drivers, a 50% increase from 2016 (CBNData, 2018). In 2019, alone, over 60 billion package deliveries made, drawing in a revenue of over 700 billion yuan (108.5 billion USD) and accounting 7.6% of China's 2019 GDP (State Post Office, 2020). These expanding markets and labor forces come with numerous work demands for delivery drivers (Fang et al., 2017; CBNData, 2018; China Post Express News, 2019; Zheng, 2020; Huang, 2021; Lin and Li, 2021). It comes as no surprise, then, that delivery drivers experience significant burnout (CBNData, 2018; Sun, 2019; Chan, 2021; Wang, 2021). Despite considerable evidence supporting mindfulness's protective properties against burnout (Hülsheger et al., 2013; Taylor and Millear, 2016; Grover et al., 2017; Guidetti et al., 2019), few studies have incorporated mindfulness into the application of the job demands and resources (JD-R) model to examine burnout in delivery drivers, a burgeoning labor force in China. Thus, this study endeavors to understand how JD-R affect Chinese delivery drivers

and whether mindfulness may moderate these relations. Such a study can provide guidance for interventions that might mitigate the occupational stress faced by this rapidly expanding yet vulnerable group of laborers in China.

BACKGROUND

It has been well documented that delivery drivers face a significant amount of work-related stress in China. Lin and Li (2021) found that over 95% of food delivery drivers reported experiencing occupational stress, and three-quarters had reported levels of stress that indicated high health risks. Studies have found that the use of algorithmic management tools to monitor driver performance increases the intensity of labor for delivery drivers, and, subsequently, burnout and turnover rates (Sun, 2019; Li and Jiang, 2020; Chan, 2021). For example, Zheng (2020) found that 25% of food delivery drivers had left their position at least once. Work demands not only include long shifts and efficient delivery but also emotional labor, such as the need to engage in emotional regulation and professional behaviors when engaging with customers (Sun, 2019). Yet, for all the work demands involved in this industry, workers' minimum earnings are not guaranteed (Chan, 2021). Algorithmic management of these platforms allows for flexibility in this line of work, which can seem attractive to some (Zheng, 2020). At the same time, however, when demand for food delivery in a particular location is low, the demand for delivery drivers is similarly low, leading to unpredictable and inconsistent income for the many individuals who rely on this work to support themselves and their families (Chan, 2021). These work conditions have been further exacerbated by the COVID-19 pandemic, which has brought about increasing health risks, job insecurity, and financial instability (Huang, 2021).

Like food delivery drivers, package delivery drivers also experience significant job demands and burnout. Reports indicate that over half of all package delivery drivers work more than 10 h a day, and around one-fifth worked more than 12 h a day (CBNData, 2018; China Post Express News, 2019). As a result, many struggle with work-life balance and have fewer opportunities to engage in rest and leisure (Fang et al., 2017). It follows, then, that studies have found that package delivery drivers experienced low job satisfaction and poor wellbeing, along with high occupational stress, burnout, and turnover (Lin et al., 2018; Xiao, 2019; Zhang, 2019; Li et al., 2020). Zheng (2020) found that 17% of package delivery drivers had left their position at least once. However, many returned to their job due to a lack of work opportunities. This can also be explained by the demographics of delivery drivers, many of whom are migrant workers with low educational attainment (Fang et al., 2017; Zhao and Liu, 2017; Zheng, 2020). The work demands faced by both food and package delivery drivers necessitate the study of potential protective factors that can mitigate their burnout.

The high job stress and negative work outcomes experienced by drivers in China are consistent with findings from various cross-cultural studies (Montoro et al., 2018; Useche et al., 2018; Alonso et al., 2020). For example, Useche et al. (2018) analyzed data from 3,665 Colombian professional drivers and found that about 29% of the experienced high job strain. Likewise, using data from 1,200 Spanish drivers, Alonso et al. (2020) found that about 42% of drivers reported emotional exhaustion at work. In this sample, job stress was positively associated with the number of motor vehicle accidents in the last 3 years. Driving anger appeared to mediate the relations among driving stress, risk predisposition, and traffic sanctions (Montoro et al., 2018).

The JD-R Model and Burnout

Past literature has applied the JD-R model (Demerouti et al., 2001) to explain how work conditions, classified as either job demands (JD) or job resources (JR), can affect employees' stress and job burnout (Demerouti et al., 2001; Bakker et al., 2003; Bakker and Demerouti, 2017; Useche et al., 2018; Alonso et al., 2020). JD include physical, social, or organizational job aspects that require sustained physical or mental effort (Demerouti et al., 2001). In the JD-R model, JD are hypothesized to lead to burnout through the "health impairment process" (Bakker and Demerouti, 2017). When an individual must meet the JD of their position or role, they must endure a psychological cost (i.e., exhaustion), which, over time, can deplete their energy and lead to burnout. On the other hand, the job aspects that can support individuals in achieving their work goals, or JR (Demerouti et al., 2001) can reduce burnout through the "motivational process" (Bakker and Demerouti, 2017). In this process, JR reduce the psychological costs associated with JD and reduce the risk of experiencing burnout (Demerouti et al., 2001). Inadequate JR in a work environment can contribute to burnout by leaving individuals without the necessary supports to perform efficiently, which can, in turn, lead to feelings of frustration and withdrawal, as well as disengagement from the job (i.e., burnout).

To date, the JD-R model has been useful for the study of employees' wellbeing across several lines of work and in many cultural contexts (Bakker et al., 2003; Hakanen et al., 2008; Van der Doef et al., 2012; Kim and Wang, 2018; Van der Heijden et al., 2019; Mäkikangas et al., 2020). Other outcomes of interest include those related to work, such as stress, burnout, work-related health outcomes, and work engagement (Hakanen et al., 2008; Schaufeli et al., 2009; Schaufeli and Taris, 2014; Useche et al., 2018; Alonso et al., 2020). Past findings indicate JD's major role in developing burnout *via* the health-impairment process, as well as JR's part in mitigating burnout through the motivation process. In samples using food and package delivery drivers, workload was an especially significant stressor that contributed to burnout (Xiao, 2019; Li et al., 2020). However, at present, the literature on the JD and JR in this particular labor force is limited, as it is only recently that the delivery industry in China has substantially proliferated. Thus, there remains a knowledge gap in the JD, JR, and burnout of delivery drivers and how these relations may differ according to personal characteristics. In this study, we focus on

understanding how the relations among JD-R and burnout differ by mindfulness of delivery drivers.

Mindfulness

The psychological construct of mindfulness and the behavioral health intervention of mindfulness have both been centered in scholarship across a multitude of disciplines (Kabat-Zinn, 2003; Keng et al., 2011; Bartlett et al., 2019; Althammer et al., 2021). The former, as a psychological trait, is defined as a state of conscious awareness that is brought about through purposeful and non-judgmental attention to the present moment (Hanh, 1976; Kabat-Zinn, 1990; Baer et al., 2006). Mindfulness is a multi-dimensional construct, but its two key components can be identified as "mindful attention" and "mindful metacognition." Mindful attention regulates an individual's attention by emphasizing an awareness of or alertness to immediate surroundings in the present moment. Meanwhile, mindful metacognition, or "decentering," can be described as detaching oneself from monitoring reactionary thoughts and feelings. Mindful metacognition is important for individuals to stay non-judgmental of the present moment. At the same time, mindful metacognition does not require that individuals *avoid* having thoughts and feelings in reaction to their immediate surroundings. On the contrary, mindful metacognition encourages that individuals acknowledge their thoughts and feelings as they arise, then "let go" of them (Bishop et al., 2004; Reina and Kudesia, 2020). Mindfulness has trait-like properties in that it varies among individuals and from moment to moment (Bishop et al., 2004; Hülsheger et al., 2013).

Studies on mindfulness continue to proliferate due to mounting evidence of its positive relations with many outcomes, including social and emotional competence (Schonert-Reichl and Lawlor, 2010; Klingbeil et al., 2017) and perceived health and wellbeing (Branstrom et al., 2011; Althammer et al., 2021). Others have suggested that mindfulness can be protective through the regulation of stress reactions in work environments (Roeser et al., 2013; Bartlett et al., 2019; Althammer et al., 2021). In one study, mindfulness had a negative association with emotional exhaustion and a positive association with job satisfaction (Hülsheger et al., 2013). Another study, which collected data from 381 adults with varying levels of educational attainment, found that the different facets of mindfulness could predict certain components of burnout (Taylor and Millear, 2016). "Mindful not reacting" ($p < 0.05$) and "mindful not judging" ($p < 0.01$), for example, were both significantly associated with less emotional exhaustion. These results were expanded upon by Grover et al. (2017), whose analysis of data from a sample of 415 nurses indicated that mindfulness buffered the effects of emotional demands on psychological stress. Together, the literature suggests that mindfulness can be a personal resource that protects against burnout in the JD-R model (Hülsheger et al., 2013; Taylor and Millear, 2016; Grover et al., 2017; Guidetti et al., 2019; Althammer et al., 2021). The ability to pay attention to the present moment in a non-judgmental way can allow individuals to better cope with daily work stressors, reducing their risk of burnout (Bartlett et al., 2019; Smith et al., 2019; Althammer et al., 2021). Thus, mindfulness may have a moderating effect in the relations among JD-R and burnout.

OBJECTIVES AND HYPOTHESES

The objectives of this study are to examine the effects of JD-R on burnout and to investigate the extent of mindfulness mitigate burnout among a sample of Chinese food and package delivery drivers. Based on the JD-R theory and the mindfulness framework (Bakker and Demerouti, 2017; Bartlett et al., 2019; Reina and Kudesia, 2020), we hypothesize the following: (1) JD increase burnout experienced by delivery drivers; (2) JR reduce burnout experienced by delivery drivers; and (3) mindfulness moderates the relations identified in hypotheses (1) and (2). The study's findings can advance the understanding of how JD-R theory affects delivery drivers and provides evidence of how mindfulness may mitigate burnout among vulnerable delivery drivers in China.

MATERIALS AND METHODS

Data and Sample

The data for the present study came from web-based surveys that were administered to food and package delivery drivers in Beijing, China. Respondents were recruited *via* convenience sampling. The first author engaged with approximately 300 food delivery drivers near large shopping malls with significant concentrations of dining establishments. Recruitment took place between 11 June 2021, and 30 June 2021. A total of 110 food delivery drivers participated in the web-based survey. These drivers were employed by major food delivery platforms in China (e.g., Meituan, Eleme, Dada, and Shansong). After omitting four cases with incomplete answers, the final analytic sample consisted of 106 respondents.

Package delivery drivers were recruited by contacting the main package distribution centers that service Beijing. Fifteen centers, located in the Haidian, Chaoyang, Fengtai and Daxing Districts of Beijing, were selected. These centers housed companies such as S.F. Express, STO Express, YTO Express, ZTO Express, YunDa Express, and Jingdong Logistics. On 6 July 2021, we sent the survey link to package delivery drivers that were employed by the various distribution centers. Approximately 260 drivers received the link. Reminders to participate in the survey were sent to the drivers 7 days and 14 days after the initial invitation. By August 31, 2021, 145 package delivery drivers had completed the survey. After excluding 11 incomplete surveys, the final analytic sample contained 134 package delivery drivers. In total, the final analytic sample contained 240 food and package delivery drivers (106 + 134).

Survey completion time averaged about 12 min. An informed consent process was implemented prior to the survey. Both food and package delivery drivers were informed that the survey was anonymous and that their participation was voluntary. Those who completed the survey received 5 RMB (1 USD).

The research protocol was approved by the research review committee at Huamin Research Center in Rutgers University and one of the co-authors' universities in China.

Measures

We used the Oldenburg Burnout Inventory (OBI; Demerouti and Bakker, 2008) to measure *burnout*, our main outcome variable. OBI has been verified for psychometric soundness, reliability, and validity in samples that are diverse in occupation, language, and culture (Demerouti et al., 2001, 2003; Halbesleben and Demerouti, 2005). In OBI, burnout is conceptualized as a two-dimensional construct, comprised of exhaustion and disengagement. Exhaustion results from intense and sustained physical, affective, and/or cognitive strain, while disengagement describes the behavior of distancing the oneself from work. Each subscale contains eight items (16 total items). Both subscales contain four positively worded items and four negatively worded items. Response categories ranged from 1 (strongly disagree) to 4 (strongly agree), and responses to positively worded items were reversed-coded so that higher scores would represent greater burnout. Burnout was calculated as the average score of the responses to all 16 items in the instrument. In this study, the Cronbach's alpha of OBI was 0.79.

We used Lequeurre et al.'s (2013) Questionnaire sur les Ressources et Contraintes Profesionnelles to measure the explanatory variables, *JD* and *JR*. The questionnaire has been used with a sample of Chinese workers and showed high reliability (Cronbach's alpha above 0.80; Deng et al., 2021). JD were measured by adapting items from the subconstructs of *workload* and *emotional workload*. In QCRP, items measuring *workload* measure the extent to which a respondent perceives that the time needed to meet work responsibilities exceeds the actual amount of time they are given at work. *Emotional workload* describes the effort needed to cope with job-inherent emotions. Job-inherent emotions are emotions that are considered "organizationally desired." Delivery drivers, for instance, must remain calm under efficiency pressures (e.g., delivering many food orders within a certain time frame) and when faced with challenging customers (e.g., individuals who are angry that their order was incorrect or not delivered on time). Workload and emotional workload were measured by four items each. JR were measured by four items: *relationship with colleagues, relationship with supervisor, support from company,* and *support from customers*. *Relationship with colleagues* and *relationship with supervisor* describe the extent to which an individual perceives that they can receive social support from their co-workers and from their supervisor, respectively. S*upport from company and customers* measures the degree to which respondents feel that they receive support from their company and from customers when they encounter challenges or when their deliveries are late. We selected these specific JD and JR based on a review of the literature and the nature of food and package delivery drivers' work conditions in China. Response categories followed a 7-point Likert scale, in which 1 represented "never" and 7 represented "always." Higher scores are interpreted as greater JD or JR. JD and JR scores were calculated by taking the average of all corresponding items' responses. In this study, the Cronbach's alpha for JD and JR were 0.84 and 0.70, respectively.

We used Meng et al.'s (2020) Chinese version of the short-form Five Facet Mindfulness Questionnaire to measure *mindfulness*, our moderating variable. This 20-item instrument measures mindfulness as a multi-dimensional construct with five facets: (1) non-reactivity to inner experience; (2) observing; (3) acting with awareness; (4) describing; and (5) non-judging of experience (Baer et al., 2006). *Non-reactivity to inner experiences* is an individual's ability to stay calm when noticing thoughts and/or feelings that would typically trigger emotional responses. *Observing* is the tendency to notice thoughts and feelings as they arise. *Acting with awareness* is when an individual maintains awareness of the present and simultaneously disattends from potential distractions. *Describing* is the ability to identify thoughts and to label feelings that occur in response to the moment. *Non-judging of experience* is the tendency to consider thoughts and feelings objectively, avoiding value statements or judgments about those thoughts and feelings. In past research, FFMQ has shown high internal consistency and convergent and discriminant relationships with other variables (Baer et al., 2006; De Bruin et al., 2014; Giovannini et al., 2014). More specifically, the short-form version of FFMQ has been found to have high internal consistency and validity (Meng et al., 2020). Responses to items followed a 5-point Likert scale. 1 represented "never," while 5 represented "always." We reverse-coded negatively worded items such that responses with higher scores represented greater levels of mindfulness. Mindfulness was calculated by taking the sum of all item responses. Scores could range from 20 to 100. The Cronbach's alpha for the Chinese version of the short-form FFMQ was 0.90 in this study.

To account for various demographic and socioeconomic characteristics that may affect our variables of interest, we collected data on sex (female = 0, male = 1), age, educational attainment (below high school; high school; and above high school), marital status (0 = married, 1 = never married), and type of delivery (0 = food, 1 = package). Full sample demographics are displayed in **Table 1**. A majority of the sample (about 80%) was male. The average age of the sample was 35.5. A majority had below high school education (42.9%) or had a high school degree (33.3%). About 42% of sample had never been married. A 55.8% of the sample consisted of package delivery drivers (see **Table 1**).

Analytical Approach

Analyses started with descriptive and correlation analyses to examine variable distributions in our sample and bivariate relations among our variables, respectively. Then, we conducted ordinary least squares (OLS) regression analysis to estimate the effects of JD-R on burnout and whether mindfulness moderated these relations, controlling for demographic and socioeconomic characteristics. All analyses were conducted using STATA software 16.0.

RESULTS

Table 1 presents the descriptive statistics of the variables. On average, the sample reported a burnout score of 2.5 (SD = 0.4) and an average mindfulness score of 60.5 (SD = 6.7). The average

TABLE 1 | Descriptive statistics of key variables.

S. No.		Mean (SD)
1.	Burnout [1–4]	2.5 (0.4)
2.	Mindfulness [49–85]	60.5 (6.7)
3.	Jon Demands [1–7]	4.9 (1.3)
4.	Job Resources [1–7]	4.3 (1.4)
5.	Delivery Job Type [%]	
	Food Delivery Driver	44.2
	Package Delivery Driver	55.8
6.	Male [%]	79.6
7.	Age [18–60]	35.5 (10.9)
8.	Education [%]	
	Below High School	42.9
	High School	33.3
	Above High School	23.8
9.	Marital Status [%]	
	Never Married	42.1
	Married	57.9

N = 240, Numbers in brackets show ranges of the variable.

JD score was 4.9 (SD = 1.3), and the average JR score was 4.3 (SD = 1.4). In Lequeurre et al.'s (2013) sample of military personnel ($n = 490$), the average JD and JR scores were 3.5 (SD = 1.3) and 5.0 (SD = 1.3), respectively. While these samples are not necessarily comparable due to the different expectations and requirements of delivery drivers and military personnel, the sample averages for our study sample suggest that the delivery drivers had high JD and low JR.

In **Table 2**, we present the results of Pearson's correlation analysis. The results were consistent with our first and second hypotheses. JD were positively associated with burnout ($r = 0.23$, $p < 0.001$), while JR and mindfulness were negatively associated with burnout ($r = -0.26$, $p < 0.001$ and $r = -0.17$, $p < 0.01$, respectively). JD-R and mindfulness were highly positively correlated with one another. In further regression analysis, we found that the positive correlation between JD and mindfulness was driven by JR. These results are available upon request.

Table 3 presents the standardized estimates of burnout from OLS regression. JD had a strong and positive association with burnout ($\beta = 0.33$, $p < 0.001$). On the other hand, JR were negatively associated with burnout ($\beta = -0.32$, $p < 0.001$). These findings are in line with hypotheses (1) and (2). Mindfulness was also negatively associated with burnout ($\beta = -0.16$, $p < 0.05$). It was also observed that drivers who had identified that they had never been married experienced greater burnout than those who were married ($\beta = 0.15$, $p < 0.05$). All other estimates (i.e., delivery type, sex, age, and educational attainment) were not statistically significant. The adjusted R-square of the model was 0.19.

To test hypothesis (3), which posited that mindfulness would moderate the relations among JD-R and burnout, we added interaction variables—between JD and mindfulness and between JR and mindfulness—to the regression model. To avoid the issue of multilinearity, we ran the regression model twice, each time adding only one interaction variable. The results of these two interaction regressions (i.e., JD*mindfulness and JR*mindfulness) are presented in **Figures 1, 2**, respectively. In **Figure 1**, mindfulness appears to buffer the negative effect of JD on burnout ($\beta = -1.64$, $p < 0.001$). Likewise, in **Figure 2**, mindfulness appeared to reduce burnout significantly, specifically when delivery drivers reported high JR ($\beta = -1.30$, $p < 0.05$).

DISCUSSION

This study aimed to examine the relations among JD-R and burnout and whether mindfulness moderated these relations in a sample of food and package delivery drivers in China. The results of OLS regression were in line with the hypothesized dual processes of health impairment and motivation by which JD-R affect burnout in our study sample. JD increased burnout *via* the health-impairment process, while JR reduced burnout through the motivation process. The results are in line with those of previous studies conducted in other countries (Bakker and Demerouti, 2017; Useche et al., 2018; Alonso et al., 2020). The magnitude of OLS estimates suggests that both JD and JR have moderate effects on burnout. This raises the need to effectively reduce JD and improve JR among delivery workers, especially given that this labor force tends to experience relatively higher JD and have fewer JR (Useche et al., 2018; Alonso et al., 2020; Li et al., 2020; Wang, 2021). One key facilitator of JD is the use of algorithmic management by food and package delivery platforms, which are designed for profit maximization and efficiency. These management tools fail to consider drivers' work conditions (Sun, 2019). It is also necessary to increase JR by balancing power among companies, drivers, and customers. As "intermediaries between the company and the public," delivery drivers' day-to-day tasks involve high levels of interpersonal contact, which is positively associated with experiencing work aggression (Grandey et al., 2004, p. 399). Further, the common mantra "the customer is always right" is pervasive in service industries and signals the inherent power imbalance between service workers and customers (Hochschild, 1983). Customer aggression can place significant strain on delivery drivers, as they must perform the emotional labor of regulating their emotions and maintaining their composure in the face of a high-stress interaction. Studies have found that, in response to customer aggression and driving stress, workers may adopt a range of coping strategies, including problem solving, escaping or avoiding, driving aggressively, and support-seeking (Yagil, 2008; Montoro et al., 2018; Fombelle et al., 2020). Negative strategies, such as aggressive driving, associated with driving anger, are more likely to lead to negative outcomes, including poor health and work safety (Montoro et al., 2018; Useche et al., 2018), while prevention strategies increased likelihood of positive outcomes (Fombelle et al., 2020). Thus, it is imperative that companies provide support to their drivers, setting realistic expectations for drivers and customers alike. Often, delivery drivers are indiscriminately forced to bear the burden of responsibility in disputes (Sun, 2019; Chan, 2021).

Our findings show that mindfulness can be an effective protective factor against burnout in food and package delivery drivers in China. Not only was the main effect of mindfulness significantly and negatively associated with burnout, but it

TABLE 2 | Correlation analysis of key variables.

S. No.		1	2	3	4	5	6	7	8
1.	Burnout	–							
2.	Job Demands	0.23***	–						
3.	Job Resources	−0.26***	0.30***	–					
4.	Mindfulness	−0.17**	0.15*	0.24***	–				
5.	Package Delivery Driver	0.12	0.29***	0.08	0.06	–			
6.	Male	0.05	0.22***	0.16*	0.01	0.13*	–		
7.	Age	−0.08	−0.33***	−0.15*	−0.01	−0.36***	−0.21**	–	
8.	Education – Below High School	−0.02	−0.07	−0.05	−0.05	0.04	0.00	0.07	–
9.	Never Married	0.10	−0.01	0.00	0.09	0.01	0.08	−0.29***	−0.16*

*N = 240. *p < 0.05; **p < 0.01; ***p < 0.001.*

TABLE 3 | Regression analysis of burnout.

	β	SE	*p*
Job Demands	0.33	0.02	***
Job Resources	−0.32	0.02	***
Mindfulness	−0.16	0.00	*
Package Delivery Driver	0.07	0.05	
Male	0.01	0.06	
Age	0.07	0.00	
Education – Below High School	0.03	0.06	
Education – High School	0.07	0.07	
Never Married	0.15	0.05	*
Adjusted *R*-square	0.19		

*N = 240. *p < 0.05; ***p < 0.001.*

also significan1tly moderated the effects of JD-R on burnout. For drivers with high JD, mindfulness reduced the negative effect of JD on burnout. Further, mindfulness reduced burnout even more when drivers had high JR. These findings support hypothesis (3). Mindfulness may have had this effect because of its ability to facilitate positive emotion regulation, such that in high-stress situations, individuals can detach themselves from and remain neutral about the present moment. A mindful state can, in turn, allow individuals to make informed decisions about how to cope with a given situation. For example, a delivery driver with high mindfulness may be able make the choice to engage in problem solving or to seek support following an experience with customer aggression (Yagil, 2008; Fombelle et al., 2020). By contrast, if an individual becomes too overwhelmed with reactionary thoughts and feelings, they may behave in accordance, which can place them in unsafe situations (e.g., motor vehicle accidents) and/or lead them to receive disciplinary action (e.g., getting fired or receiving traffic sanctions).

While past studies have shown that JD-R are important predictors of burnout (Purvanova and Muros, 2010; Bakker and Demerouti, 2018; Templeton et al., 2019; Hybels et al., 2020) and that mindfulness may be an important moderator in this relation (Hülsheger et al., 2013; Taylor and Millear, 2016; Grover et al., 2017; Bartlett et al., 2019; Guidetti et al., 2019; Althammer et al., 2021), our study extends this literature by using a sample of delivery drivers, who comprise an emerging and fast-growing labor force in China. This is especially significant, considering the dearth of research on this vulnerable population. Thus, this study provides guidance for both future practice and research.

In applied contexts, the findings suggest that food and package delivery companies in China must reduce drivers' JD and provide more substantial JR to lower the extent of burnout among their workers. This is also supported by past studies that have similarly reported that drivers tend to experience high occupational stress and burnout but fewer job supports (Lin et al., 2018; Useche et al., 2018; Sun, 2019; Zhang, 2019; Alonso et al., 2020). In addition, given that mindfulness showed significant moderation effects between JD-R and burnout, food and package delivery companies may consider the implementation of mindfulness-based interventions (Bartlett et al., 2019; Guidetti et al., 2019; Althammer et al., 2021). Interventions such as mindfulness-based stress reduction, mindfulness-based cognitive therapy, and mindfulness-based interventions have been found to promote mental health and wellbeing while also reducing burnout (Mellor et al., 2016; Lomas et al., 2018; Slutsky et al., 2018; Bartlett et al., 2019; Guidetti et al., 2019; Suleiman-Martos et al., 2020; Althammer et al., 2021). It is important to note, however, that these studies were conducted in Western cultural contexts, and whether they might have similar results in other cultural contexts, such as in China, is unknown. The results of this study provide support for the utility of future research investigating the extent to which mindfulness-based interventions can reduce burnout in Chinese delivery drivers. So far, a handful of studies (e.g., Hall et al., 2018; Lu et al., 2018; Huang et al., 2019) have found that mindfulness interventions have positive outcomes in Chinese samples, though these studies focused on practice with younger populations. While the mean age of our study sample was 35.5 (range 18–60), these studies focused on children (Lu et al., 2018), adolescents (Huang et al., 2019), and college students (Hall et al., 2018). While it is reasonable to suspect some overlaps in age between our sample and a college student sample, just over three-quarters of the participants (76.2%) in our sample either had high school degree (33.3%) or did not complete high school (42.9%), indicating a significant difference in educational attainment between our sample and those of studies which study college students.

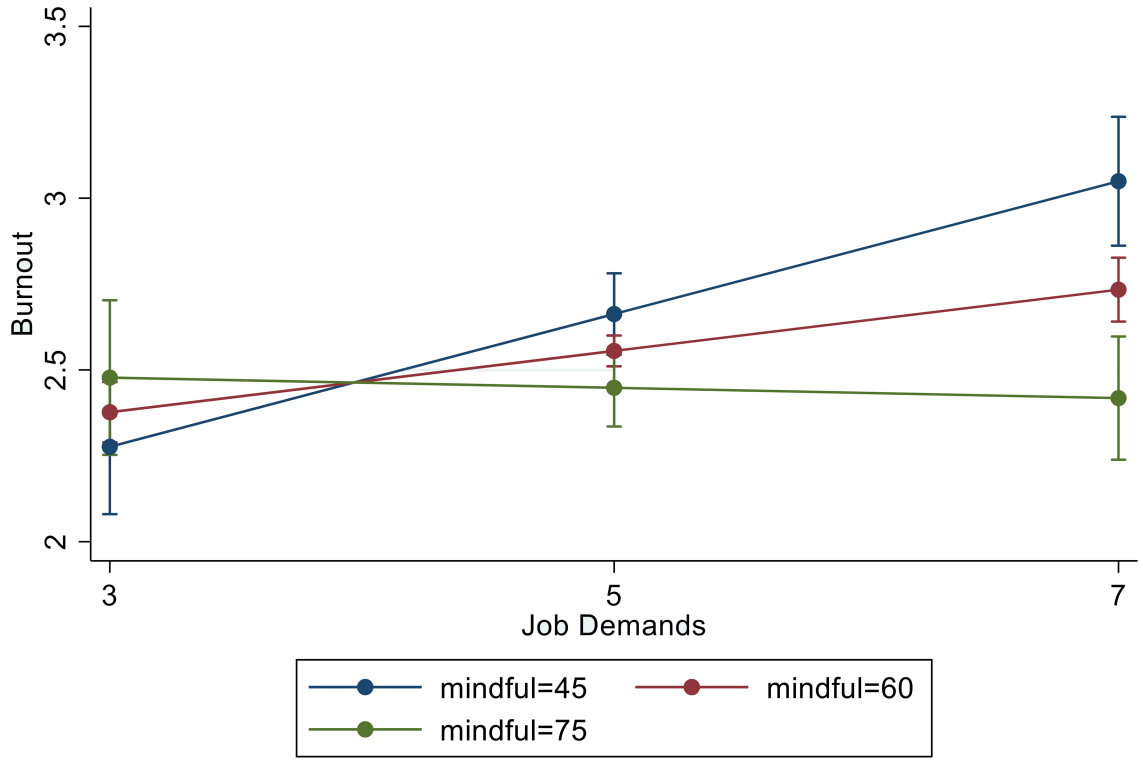

FIGURE 1 | Burnout by job demands and mindfulness.

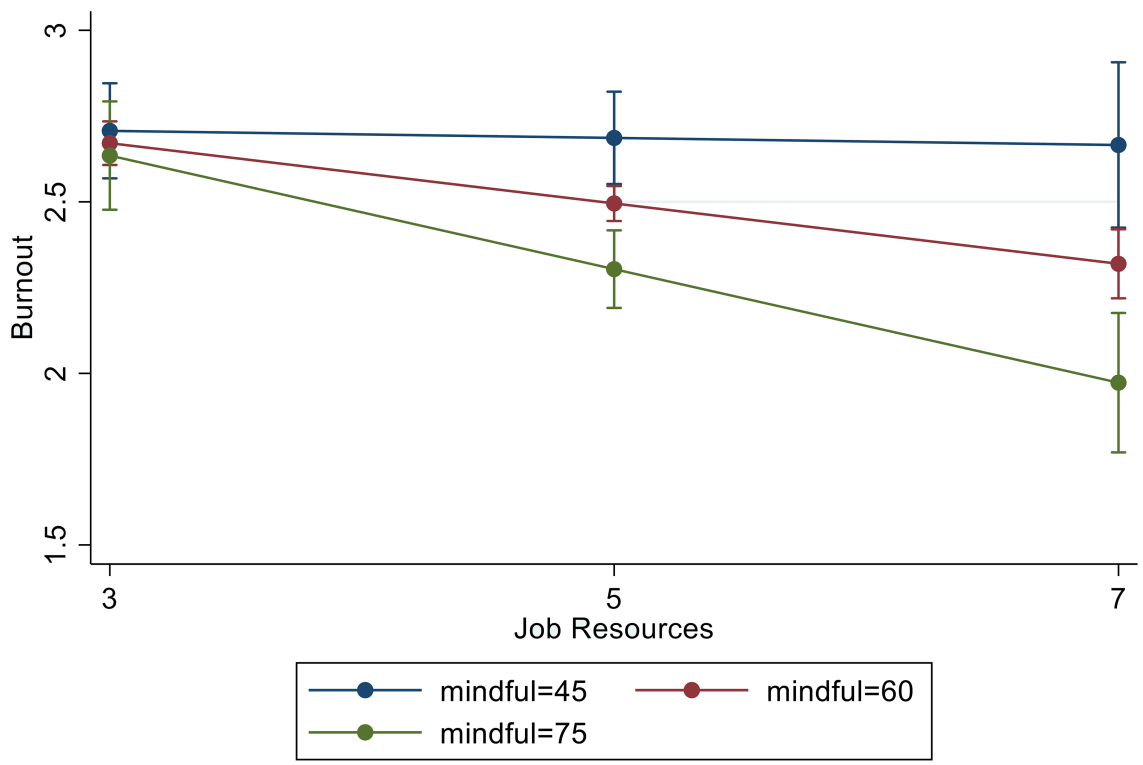

FIGURE 2 | Burnout by job resources and mindfulness.

Our study is one of few to center the work experiences of food and package delivery drivers in China, but these findings must be contextualized within a few study limitations. First, the use of a cross-sectional dataset only allows us to estimate associative relations among our main variables. As a result, causal relations cannot be inferred. The use of longitudinal design may better approximate causal relations. Further, our results may be subject to omitted variable bias, as our model may not have included different variables that could affect JD-R, burnout, and mindfulness. The results may also be subject to social desirability bias—and other reporting errors—due to the reliance on delivery drivers' self-reports for data collection. Triangulating data from multiple sources in future studies may help address this issue. Lastly, the study sample was relatively small and recruited *via* convenience sampling, which limits the generalizability of our results. A future study may build upon these results by using a larger sample that is recruited *via* random sampling.

CONCLUSION

This study analyzed data collected from 240 food and package delivery drivers in Beijing, China, to investigate the associations among JD-R, mindfulness, and burnout. The results were consistent with our hypotheses. JD and JR had moderate associations with burnout in opposite directions. Whereas JD and burnout were positively associated with one another, JR and burnout were negatively associated. Mindfulness was protective against burnout, particularly among those respondents with high JD and high JR. These findings expand upon existing research by focusing on Chinese delivery drivers, a rapidly growing labor force that faces high JD and has few JR. The findings also provide support for future work implementing mindfulness-based programs and future studies that evaluate the effectiveness of such interventions to increase mindfulness and protect against burnout in Chinese delivery drivers.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Review Committee, Huamin Research Center at Rutgers University and the Department of Youth Work Research, China Youth University of Political Studies. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

CZ, SC, and CH: conceptualization, methodology, software, validation, formal analysis, and writing—original draft preparation. CZ and CH: resources, investigation, and data curation. All authors contributed to the article and approved the submitted version.

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A Comparison Between the Relaxation/Meditation/Mindfulness Tracker t Inventory and the Freiburg Mindfulness Inventory for Predicting General Health, Anxiety, and Anger in Adult General Population

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Introduction: An individual's level of mindfulness can predict his/her level of general health, anxiety, and anger. If we have a valuable tool for measuring mindfulness, we can predict such factors more concisely. Therefore, the aim of this study was to compare a narrowband and a broadband mindfulness scale in predicting the level of general health, anxiety, and anger in a general population.

Materials and Methods: This was a cross-sectional study on an Iranian general population (all citizens living in Kerman) from September 22, 2020 to April 14, 2021. The convenience sampling method was used. Data were collated *via* electronic and paper forms of the Relaxation/Meditation/Mindfulness Tracker t-Persian version (RMMt-P), the Freiburg Mindfulness Inventory- Short-Form-Persian version (FMI-P), the General Health Questionnaire, the trait anxiety section of the State–Trait Anxiety Inventory, and the trait anger section of the State–Trait Anger Expression Inventory-2.

Results: The FMI-P predicted 0.05% of GHQ variance while the first and third levels of RMMt-P predicted 0.145%. The FMI-P predicted 0.19% of anxiety variance, while the first and third levels of RMMt-P predicted 0.195%. The FMI-P predicted 0.0% of anger variance, while the first, second, and third levels of RMMt-P predicted 0.08%. RMMt-P Level 1 was a better predictor of general health, anger, and anxiety.

Conclusion: The current study found that the RMMt-P was a better predictor of general health and anger than the FMI-P. These findings suggest that the type of questionnaire used in the study of mindfulness is important, but more research is needed to determine the extent of these relationships.

Keywords: RMM tracker, FMI scale, general health, anxiety, anger

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INTRODUCTION

Mindfulness is based on eastern meditation traditions and is used as a therapeutic method to promote mental health (Desbordes et al., 2015; Rayan and Ahmad, 2018). Mindfulness is defined differently by researchers, physicians, and clinicians; each of these individuals believes that certain aspects of this concept are more important than the others (Brown et al., 2007). According to Kabat-Zinn (2012), mindfulness is having awareness, paying attention, and being in the present moment only as an observer who observes current thoughts and feelings without judging or reacting to them. Brown et al. (2009) defined mindfulness as being aware of the inputs of one's mind and paying attention to what is happening (Brown et al., 2009). Walach et al. (2006) described it as warm, friendly, accepting, and non-judgmental attitudes toward the elements of the mind (Walach et al., 2006). Many definitions share three characteristics: being in a state of consciousness, being present in the moment, and not passing judgment (Shepherd, 2020). Mindfulness is a mental state characterized by non-judgmental thought observation that may temporarily lessen subjective information evaluation by limiting referencing to self-related values, thus possibly acts as an inhibitor of mental activities leading to anxiety, anger, or negative thoughts in general (Vuong and Napier, 2015).

Different studies have found that mindfulness-based interventions are an effective way to improve medical and psychological symptoms and conditions, as well as to improve general health, anxiety, and anger (Hirano and Yukawa, 2013; Aghaie et al., 2018; Guo et al., 2019; El Morr et al., 2020; Shepherd, 2020; Burgess et al., 2021; Takebe and Sato, 2021). The results of a systematic review and meta-analysis on the effect of mindfulness-based interventions on wellbeing, mental health, and general health showed that the mindfulness-based interventions had a large effect size on wellbeing, mental health, and general health (Aghaie et al., 2018). Karing (2021) reported that mindfulness, along with optimism, was one of the two most relevant protective factors against anxiety. In addition, Kim (2021) indicated that maladaptive emotion regulation strategies, such as rumination and expressive suppression, mediated the relationship between mindfulness and aggression and that mindfulness was associated with decreased use of these strategies. Beyond individual levels, applying mindfulness practices on larger scales requires a multifaceted integral framework. A combination of scientific research, communities' insights, and well-coordinated management can make mindfulness an effective tool against many public health problems (Vuong et al., 2022).

Given that reviewed studies establish a relationship between mindfulness and the aforementioned variables, we could try to predict individuals' general health, as well as their anxiety and anger levels, simply by measuring their mindfulness level. To do so, we need standard tools capable of accurately measuring this concept.

There are several tools available for measuring mindfulness with broadband and narrowband assessments of experiences. These tools vary in terms of how they measure mindfulness; some measure mindfulness as a one-dimensional structure versus a multifaceted structure (Baer et al., 2006), while others view it as a trait or state structure (Dane, 2011). Certain tools only assess a person's mental state, while others assess feelings and physical experiences (Grossman, 2008).

The Freiburg Mindfulness Inventory (FMI) is one of the narrowband measures. Buchheld et al. (2001) developed the FMI in 2001, which consisted of 30 items divided into four factors: mindful presence, non-judgmental acceptance, openness to experience, and insight. Later, Walach et al. (2006) developed a short form of FMI (14 items), which was more suitable for use in the general population. Kohls et al. (2009)showed that the short form measured the two factors of Presence and Acceptance.

Many measures of mindfulness are narrowband measures that assess aspects of awareness, presence, and acceptance (Smith, 2019a). However, the Relaxation, Meditation, and Mindfulness Tracker t (RMMt) is known as a broadband measure to assess the 5+1 dimensions of Smith's model of mindfulness and relaxation. This model is designed to measure the full range of potential mindfulness and relaxation states associated with mindfulness practices. It measures five levels of mindfulness (Mindful Basic Relaxation; Mindful Quiet Focus; Mindful Awakening; Mindful Deepening; and Mindful Transformation/Transcendence) and one dimension of Mindful Transcendent Positive Emotion (Smith, 2019a).

Mental health is a significant indicator of a society's general health. According to World Health Organization (WHO), People with severe mental health conditions die prematurely—up to two decades earlier—due to preventable physical conditions. Mental health problems now account for one out of every five years of disability. Mental health conditions are increasing worldwide because of demographic changes. There has been a 13% rise in mental health conditions in the 10 years (2007 to 2017; World Health Organization, n. d.). Anxiety, along with depression, is one of the most common mental health conditions, costing the global economy one trillion dollars each year (World Health Organization, n. d.). Since an individual's level of mindfulness can predict his/her level of general health, anxiety, and anger, we could predict such factors more concisely if we had a valuable tool for measuring mindfulness. Therefore, the aim of this study was to compare a narrowband mindfulness scale and a broadband mindfulness scale in predicting the level of general health, anxiety, and anger in a general population.

MATERIALS AND METHODS

Study Design and Settings

This was a cross-sectional study to compare two measures of mindfulness (i.e., the RMMt-P and FMI-P) in predicting the general health, anxiety, and anger of an Iranian general population from September 22, 2020 to April 14, 2021.

Participants, Sampling, and Sample Size

The study population consisted of all residents of Kerman City in southeast Iran. The study sample consisted of all citizens living in Kerman City who met the inclusion criteria. The

following were among the inclusion criteria: (1) participants must be at least 18 years old, (2) participants must have basic reading and writing skills, and (3) participants must not have any psychiatric disorders. Exclusion criteria were met if more than 10% of the questions on each questionnaire were not completed.

The convenience sampling method was used. Questionnaires were distributed in both electronic and paper formats. The electronic form was distributed *via* email or popular Iranian social networks (WhatsApp, Telegram, etc.). For the paper form, we divided the city into four districts according to the municipal divisions, and each district was treated as a cluster. Then, shopping malls, parks, recreation areas, and streets were considered as the research settings.

Using the Cochran's formulas, 384 samples were estimated ($\alpha = 0.05$, $d = 0.05$, $Z = 1.94$). Considering dropouts, 470 questionnaires were distributed. Twelve questionnaires were excluded from the study regarding confounding information and missing values. Finally, 458 questionnaires were subjected to analysis.

Measurements

Demographic Characteristics Form

Demographic Characteristics Form consisted of questions about age, gender, marital status, educational level, occupation, income, prior knowledge of the mindfulness concept (yes/no), and use of any methods of mindfulness (yes/no).

Relaxation/Meditation/Mindfulness Tracker t-Persian Version

The RMM Trackers are a series of broadband self-report inventories of relaxation, meditation, and mindfulness. The RMM Tracker t (trait) is a dispositional or trait inventory used to assess how often one experiences different RMM states. It consisted of 25 specific RMM states divided into five levels of mindfulness (Mindful Basic Relaxation; Mindful Quiet Focus; Mindful Awakening; Mindful Deepening; and Mindful Transformation/Transcendence) and one dimension of Mindful Transcendent Positive Emotion.

The RMM Tracker t items are scored on a 13-point Likert scale (never/do not understand item = 0, once a year = 3, once a month = 6, once a week = 9, and about every day = 12). The item scores of each level are added together and divided by the number of items in that level. The higher the score in each level, the higher and more positive the level of that characteristic (Smith, 2019a).

The Persian version of RMMt consists of 23 RMM states. There are 23 specific RMM states, which are divided into three dynamic and interacting levels. Level 1—Mindful Love, Thankfulness, and Transcendence includes the RMM states of loving, caring, compassion, thankful, sense of something greater, prayerful, clear, awake, aware, happy, optimistic, beautiful, trusting, fantasy, interested, curious, fascinated, meaning, purpose, and direction (10 items). Level 2—Relaxation includes the RMM states of being unbothered, easy, effortless, quiet, refreshed, at ease, at peace, far away, physically relaxed, pleasant mind wandering, centered, and grounded (9 items). Level 3—Mindful Deepening includes the RMM states of going deeper, spaciousness, expansiveness, observer, and "spiritual" or "mystical" (4 items). The content and construct validities of the Persian version of RMMt have been confirmed. In addition, the Cronbach's alpha values of the three levels were 0.93, 0.91, and 0.80, respectively (Malakoutikhah et al., 2021).

The Freiburg Mindfulness Inventory-Short-Form-Persian Version

FMI has proven to be an effective psychometric tool for assessing mindfulness in both clinical and non-clinical populations. Buchhold et al. designed the FMI in 2001, which consisted of 30 items. Later, Walach et al. developed the short form (14 items: with two dimensions of the presence and the acceptance) which was more suitable for use in the general population. The FMI-SF items are scored on a 4-point Likert scale (rarely = 1 to almost always = 4). The minimum and maximum scores are 14 and 56, respectively. A higher score indicates that you are more mindful (Walach et al., 2006).

Ghasemi Jobaneh et al. found that in an Iranian population, the validity and reliability of FMI-SF were acceptable. In addition, according to the confirmatory factory analysis, the Persian version of FMI-SF was unidimensional (GhasemiJobaneh et al., 2015).

The General Health Questionnaire

The GHQ is used to measure psychological distress in a variety of settings. It is a 60-item self-report questionnaire. There are shorter forms in 12, 20, 28, and 30 items. The GHQ assesses an individual's mental state in the past month. The GHQ-12 consists of 12 items, six of which are positive and six of which are negative. The items are scored using a 4-point Likert scale (all items coded as 0-1-2-3). The minimum and maximum scores would be 0 and 36, respectively. The higher the score, the higher the psychological distress (Goldberg, 1972, 1988).

Namjoo et al. found that the content validity index and content validity ratio of the GHQ-12 in an Iranian population were 0.92 and 0.96, respectively. Cronbach's alpha coefficients were also reported to be 0.82 (Namjoo et al., 2017) and 0.85 by Rahmati et al. (Najarkolaei et al., 2014).

The Trait Anxiety Section of the State–Trait Anxiety Inventory

Spielberger et al. developed STAI in 1970 as tool for measuring trait–state anxiety. This questionnaire includes two separate self-assessment scales, each with 20 items, for a total of 40 items. The trait scale measures an individual's general and normal emotions. All items are scored on a 4-point Likert scale from "1 = Not at All" to "4 = Very Much" with higher scores indicating greater anxiety (Spielberger et al., 1983a).

Rabiee et al. (2007) reported the reliability of the STAI as 0.89. In addition, Mehram reported the reliability of STAI based on Cronbach's alpha coefficients as 0.90 and the validity for state and trait anxiety as 0.95 and 0.99, respectively (Mahram, 1993).

The Trait Anger Section of the State–Trait Anger Expression Inventory-2

Spielberger et al. designed STAXI in 1983 to assess the severity of different states of anger (Spielberger et al., 1983b). Based on studies from 1995 to 1999, STAXI was changed and revised into STAXI-2. The STAXI-2 was designed for two purposes: (1) evaluating anger factors in order to distinguish between normal and abnormal personality; (2) providing averages of various anger factors that contribute to medical problems. The STAXI-2 consists of 57 items divided into three sections. Each section measures state anger, trait anger, and anger expression and control. Each item is scored on a four-point Likert scale (Spielberger, 1999).

Asghari et al. (2008) reported the internal consistency coefficients of STAXI-2 $\geq$ 0.73 in university students based on Cronbach's alpha coefficients. Khodayarifard et al. reported the reliability of STAXI-2 based on Cronbach's alpha coefficients ranging from 0.60 to 0.93; for the trait anger section, Cronbach's alpha coefficients was 0.83 (Khodayari-Fard et al., 2010).

Data Collection and Data Analysis

Google forms were used to create and distribute the questionnaire's online form. Ten participants checked the online form in terms of resolving the problems. Nearly 160 participants completed the online form and the rest answered the paper form.

SPSS version 22 was used for data analysis. Frequency, percentage, mean, and standard deviation were used to describe the participants' characteristics. Pearson correlation coefficients were used to determine the correlation between RRMt-P, FMI-P, GHQ, anxiety, and anger scores because their distributions were normal. Multiple linear regression with stepwise method was used to determine the power of RMMt-P and FMI-P in predicting GHQ score, anxiety, and anger. In addition, as the Persian version of FMI is unidimensional, we only used the total score for predicting the GHQ, anxiety, and anger scores. A significance level of 0.05 was considered.

ETHICAL CONSIDERATION

The code of ethics was obtained from the Ethics Committee of Kerman University of Medical Sciences (Ethical Code: IR.KMU.REC.1398.673). In addition, Dr. Smith authorized the translation and use of RMM. Before the inclusion of participants into the study, the researcher presented them with a consent form that included the following information: (1) the study purpose and objectives; (2) the information confidentiality; and (3) the anonymous participants, who can withdraw from the study at any time.

RESULTS

The mean age of the participants was 34.37 ± 10.79 year. The majority of the participants was female, married, employed, and had academic education. The majority of the participants had no knowledge of mindfulness and did not use any methods of mindfulness.

Descriptive Statistics for Main Study Variable

The mean scores for the first, second, and third levels of RMMt-P were 7.04, 7.08, and 6.72, respectively, all of which were higher than the scale's midpoint of 6. The mean score of the FMI-P was 32.56, which was lower than the scale's midpoint of 35. The mean score of the GHQ was 14.17, which was less than the scale's midpoint of 18. The mean score of the anxiety was 48.76, which was less than the scale's midpoint of 50. The mean score of the anger was 23.36, which was less than the scale's midpoint of 25 (**Table 1**).

Correlation Coefficient Matrix

The FMI-P score had a significant negative correlation with general health and anxiety but not with anger. RMMt-P levels 1 and 2 had significant negative correlations with general health, anxiety, and anger. The third level of RMMt-P had a significant negative correlation with general health, and anxiety but not with anger (**Table 2**).

Multiple Regression

The FMI-P predicted 0.05% of GHQ variance while the first and third levels of RMMt-P predicted 0.145%. RMMt-P Level —Mindful Love, Thankfulness, and Transcendence, was a better predictor of general health (**Table 3**).

TABLE 1 | Summary of descriptive statistics for main study variables ($n = 458$).

Variable		Mean	Standard deviation
General health		14.17	4.28
Anxiety		48.76	6.16
Anger		23.36	4.44
FMI-P-total score		32.56	4.68
RMMt-Persian scales	RMMt-P level 1—mindful love, thankfulness, and transcendence	7.04	2.08
	RMMt-P level 2—relaxation	7.08	2.02
	RMMt-P level 3—mindful deepening	6.72	2.21

TABLE 2 | Correlation coefficient matrix for main study variables.

Variable		General health	Anxiety	Anger
FMI-P-total score		−0.24(<0.001)	−0.44(<0.001)	0.02(0.70)
RMMt-Persian scales	RMMt-P level 1—mindful love, thankfulness, and transcendence	−0.37(<0.001)	−0.42(<0.001)	−0.23(<0.001)
	RMMt-P level 2—relaxation	−0.29(<0.001)	−0.34(<0.001)	−0.10(0.03)
	RMMt-P level 3—mindful deepening	−0.20(<0.001)	−0.22(<0.001)	−0.07(0.15)

The FMI-P predicted 0.19% of anxiety variance, while the first and third levels of RMMt-P predicted 0.195%. RMMt-P Level 1—Mindful Love, Thankfulness, and Transcendence was a better predictor of anxiety (**Table 4**).

The FMI-P predicted 0.0% of anger variance, while the first, second, and third levels of RMMt-P predicted 0.08%. RMMt-P Level 1—Mindful Love, Thankfulness, and Transcendence was a better predictor of anger (**Table 5**).

DISCUSSION

The purpose of this study was to compare the two scales, RMMt-P and FMI-P, for predicting general health, anxiety, and anger in an Iranian adult population. Mindfulness is a concept that emphasizes the significance of self-consciousness and refers to an immediate experience in the present moment as well as a non-judgmental approach to the mind's process. Mindfulness denotes an increase in awareness of all mental contents, including cognition, perception, physical sensation, and so on (Baer, 2011).

Many communities in the fields of psychology and psychiatry have considered mindfulness in recent years. Following the publication of studies on mindfulness-based intervention (MBI; Hulsbosch et al., 2020) and mindfulness-based stress reduction (MBSR; Thomas et al., 2017), there was an increase in research in this area. Researchers' attention has been drawn to practical and effective tools in order to measure and evaluate mindfulness. Various scales in the literature assess mindfulness processes in various ways. The Freiburg Mindfulness Inventory (FMI), for example, indicates a broad understanding of mindfulness. The FMI30 (the first published version of the FMI) was discovered to assess the level of mindfulness from various perspectives (Walach et al., 2006). In a general population without a history of meditation, a short version of FMI (14 items) was studied, and it was discovered that FMI14 assessed mindfulness as a one-dimensional and narrowband structure (Walach et al., 2006).

TABLE 3 | Comparison of the linear regression models of RMMt-P and FMI-P for predicting general health.

Variable		B	SE	β	t	P	95% CI for B	Adjusted R^2
General Health	Constant	21.18	1.37		15.50	<0.001	18.49–23.86	0.05*
	FMI-P-total score	−0.22	0.04	−0.24	−5.18	<0.001	−0.30 – −0.13	
	Constant	19.03	0.68		28.18	<0.001	17.71–20.36	0.145**
	RMMt-P level 1- mindful love, thankfulness, and transcendence	−0.10	0.01	−0.49	−7.64	<0.001	−0.13 – 0.08	
	RMMt-P level 3 - mindful deepening	0.08	0.03	0.17	2.59	0.01	0.02–0.15	

*SE, Standard error; CI, Confidence intervals. *F = 26.83, p < 0.001; **F = 39.63, p < 0.001.*

TABLE 4 | Comparison of the linear regression models of RMMt-P and FMI-P for predicting anxiety.

Variable		B	SE	β	t	P	95% CI for B	Adjusted R^2
Anxiety	Constant	67.70	1.82		37.29	<0.001	64.13–71.26	0.19*
	FMI-P-total score	−0.58	0.06	−0.44	−10.54	<0.001	−0.69 – −0.47	
	Constant	56.72	0.94		60.10	<0.001	54.86–58.57	0.195**
	RMMt-P level 1- mindful love, thankfulness, and transcendence	−0.17	0.02	−0.58	−9.26	<0.001	−0.21 – −0.14	
	RMMt-P level 3 - mindful deepening	0.15	0.04	0.21	3.37	0.001	0.06–0.24	

*SE, Standard error; CI, Confidence intervals. *F = 111.09, p < 0.001; **F = 56.40; p < 0.001.*

TABLE 5 | Comparison of the linear regression models of RMMt-P and FMI-P for predicting anger.

Variable		B	SE	β	t	P	95% CI for B	Adjusted R^2
Anger	Constant	22.81	1.46		15.63	<0.001	19.94–25.67	0.00*
	FMI-P-total score	0.02	0.04	0.02	0.38	0.70	−0.07 – 0.10	
	Constant	25.68	0.76		33.78	<0.001	24.19–27.17	0.08**
	RMMt-P level 1- mindful love, thankfulness, and transcendence	−0.10	0.02	−0.48	−5.95	<0.001	−0.14 – −0.07	
	RMMt-P level 2 – relaxation	0.09	0.04	0.17	2.40	0.02	0.02–0.16	
	RMMt-P level 3 - mindful deepening	0.04	0.02	0.16	2.01	0.045	0.001–0.08	

*SE, Standard error; CI, Confidence intervals. *F = 0.14, p = 0.70; **F = 13.45; p < 0.001.*

Smith developed the RMM Tracker t as a broadband scale to assess the dimensions of mindfulness across the full range of mindfulness and relaxation modes, while the RMM 25 measures relaxation, meditation, and mindfulness (Smith, 2021). When compared to questionnaires that assess mindfulness in one-dimensional and narrowband structures, such as FMI, it measures mindfulness in more dimensions with a broadband scale. However, research has shown that mindfulness is one of the potential health mediators. According to Keng et al. (2011) mindfulness has positive psychological effects such as increasing subjective wellbeing, reducing psychological symptoms and emotional reactivity, and regulating and improving various behaviors associated with mental health and higher levels of life satisfaction. The majority of aspects of mindfulness was related to the experience of meditation as well as psychological symptoms (Malakoutikhah et al., 2021) and wellbeing (Baer et al., 2008). These findings in mindfulness are consistent with the findings of the current study. The RMMt-P and FMI-P scales were found to be positively correlated with general health and negatively correlated with anxiety in the current study.

In a review of the literature, mindfulness as measured by the narrowband scale of FMI was found to be predictive of general health. Dashti et al. used the FMI to study mindfulness and discovered that quality of life, physical, mental, and social health improved in cardiovascular patients who were more mindful (Dashti et al., 2018). Dehghan et al. used the FMI to assess mindfulness in cancer patients and discovered that higher levels of mindfulness were associated with higher quality of life and lower perceived stress (Dehghan et al., 2020). According to Asgari and Shafiee (2017), measuring mindfulness with the FMI predicted 24 percent variances in quality of life of the older people, and increasing mindfulness increased quality of life of the older people.

We could not find a study that looked at the effect of RMMt on general health because of its novelty. The Five Facet Mindfulness Questionnaire (FFMQ), a broadband mindfulness questionnaire, includes five skills of observing, describing, acting with awareness, non-judging inner experience, and non-reactivity to inner experience, which may predict psychological symptoms and wellbeing (Baer et al., 2008). According to Kabat-Zinn theory (Kabat-Zinn, 2013), increased self-awareness as a result of mindfulness aids in the balance of positive and negative emotions, coping strategies for dealing with life challenges, mood, and stress management, and thus leads to an increase in people's emotional and social dimensions. Mindfulness possibly acts as an inhibitor of mental activities leading to anxiety, anger, or negative thoughts in general (Vuong and Napier, 2015).

Furthermore, mindfulness allows people to perceive their lives more effectively and to feel more at ease with themselves. Such cognitive and emotional changes can aid in the improvement of people's health.

The current study found that the RMMt-P and FMI-P were both negatively related to anxiety. Consistent with the current study's findings, Hulsbosch et al. (2020) used the FFMQ, a broadband mindfulness questionnaire similar to the RMM, and demonstrated that mindfulness could reduce distress in pregnant women. Furthermore, Navarro-Haro et al. found that it reduced anxiety in patients with anxiety symptoms and generalized anxiety disorder (GAD; Navarro-Haro et al., 2019) as well as social anxiety disorder (Koszycki et al., 2016).

Dashti et al. used FMI as a narrowband scale to assess mindfulness and discovered that cardiovascular patients who were more mindful had lower levels of depression, anxiety, and stress (Dashti et al., 2018). These results have also been confirmed in patients under hemodialysis (Dehghan et al., 2021b). Furthermore, Conversano et al. showed that using the MAAS as a narrowband scale to assess mindfulness was the best predictor of psychological distress in people with COVID-19 disease. As a result, mindfulness training has the potential to be an effective intervention in preventing the onset of post-traumatic stress disorder and the occurrence of chronic mental disorders (Conversano et al., 2020).

In contrast to the current study's findings, Dehghan et al. (2021a) showed that the study of mindfulness with the FMI scale was not associated with COVID-19 anxiety in cancer patients. However, high levels of mental and physical anxiety, as well as concern about COVID-19, have been observed in cancer patients, causing difficulties in their lives (Dehghan et al., 2021b). The conditions caused by COVID-19 disease, which can cause high levels of anxiety and stress in people (Zakeri et al., 2021), may affect the findings of Dehghan et al. (2021b). Therefore, additional research is required, particularly in critical situations. Furthermore, Blanck et al. (2018) found that regular and simple mindfulness-based interventions were beneficial even when not integrated into larger therapeutic frameworks; however, it had small and moderate effects on anxiety (Blanck et al., 2018). Blanck et al., however, did not specify the type of questionnaire used to assess mindfulness. Due to the broad concept of mindfulness, the current study focused on the type of mindfulness questionnaire (narrowband and broadband), which is significant and unprecedented. Therefore, given the variable range of mindfulness questionnaires, special consideration should be given to the type of questionnaire in future studies.

According to a review of the literature, mindfulness is an effective intervention and treatment for many conditions, including stress, anxiety, and depression, regardless of the type of questionnaire (narrowband and broadband). According to the findings, the Short-Form Mindfulness-Based Stress Reduction can help reduce individuals' anxiety and improve quality of life and mental health (Smith et al., 2015). Increasing mindfulness through a Mindfulness-Based Cognitive Therapy (MBCT) program improves psychological wellbeing, psychopathology, and anxiety and concern (Ruths et al., 2013). Some studies have shown that mindfulness can be considered an effective tool against many public health problems (Vuong et al., 2022).

The current study found that the RMMt-P had a negative correlation with anger, whereas the FMI-P scale did not. Consistent with the findings of the current study, Světlák et al. (2021) measured mindfulness in students using the FFMQ as a broadband scale and found that mindfulness reduced perceived stress, the frequency and severity of negative effects, and increased self-compassion (Světlák et al., 2021), all of which can reduce people's anger.

According to the current study's findings, measuring mindfulness with the Mindful Attention Awareness Scale (MAAS) as a one-dimensional and narrowband scale is negatively related to general aggression, physical aggression, anger, and self-harm in adults (Yusainy and Lawrence, 2014). Zubair et al. (2018) used the MAAS to assess mindfulness and found a positive relationship between mindfulness and mental wellbeing in Pakistani and Russian students. These findings indicate that people who are more mindful and aware of their surroundings have better problem-solving skills, implying that mindfulness can adjust people's mental performance and reduce anger.

According to the findings of some studies, when a person can understand his thoughts without passing judgment or reacting to them, he achieves a state of comfort and relaxation in unpleasant situations. Relaxing in an unpleasant situation reduces stress and promotes wellbeing. Mindfulness alleviates the psychological and physical symptoms of anxiety by relaxing and assists the individual in overcoming anger by adopting a new perspective, focusing on the source of stress, reducing anxiety, increasing stress resistance, and coping skills (Kabat-Zinn, 2013). This finding may point to a relationship between mindfulness and a correct understanding of our interactions and behaviors with others. Shepherd discovered that mindfulness improved people's reflection on interpersonal behaviors and attitudes toward themselves and others. Mindfulness promotes honest reflection on issues, onset of positive actions regarding people's behavior, and assists them in understanding how to behave with others (Shepherd, 2020).

In the current study, only RMMt-P Level 1 (Mindful Love, Thankfulness, and Transcendence) was found to be the best predictor of anxiety, general health, and anger when compared to RMMt-P and FMI-P. Smith (2019a) pointed to four specific cases in the RMM level 1 "Mindful Basic Relaxation" that all aim to reduce aversive stimulation, improve general health, and alleviate anxiety and anger. RMM 1 includes "Far Away." The practicer feels detached from the stresses of everyday life and free of anxiety and concern. RMM 2 is "Physically Relaxed," which refers to experiences of decreased muscle tension and increased breathing relaxation. RMM 3 "At Ease/At Peace" refers to the release of stress or mental distress. When the practicer feels relaxed again, RMM 4 "Refreshed" occurs. RMM 10 (Unbothered) also refers to a judgment-free attitude, which involves lowering one's judgment about negative thoughts or feelings that can cause anxiety and concern (Smith, 2019b).

According to Davis and Hayes (2011), mindfulness and meditation have numerous benefits, including improved emotional skills such as emotion regulation, decreased reactivity, increased flexibility and processing speed, and increased self-insight, morality, intuition, and fear management (Davis and Hayes, 2011). According to the findings of this study, mindfulness practice may be beneficial to people's health. Understanding and measuring these experiences, on the other hand, are related to various dimensions of mindfulness states that should be taken into account in future research. Analyzing questionnaires and paying attention to the type of questionnaire used to discover different dimensions of mindfulness might also be beneficial in order to understand mindfulness better.

In comparing the predictive power of the RMMt-P and FMI-P scales, the current study found that the RMMt-P was a better predictor of general health and anger than the FMI-P. However, no difference in anxiety prediction was found between the RMMt-P and FMI-P scales. According to a review of the literature, the relationship between mindfulness and the FMI-P as a narrowband scale predicted 15% of variances in quality of life (Dehghan et al., 2020) and 24% of variances in quality of life of older people (Asgari and Shafiee, 2017).

RMMt did not have a comparable study. The FFMQ, a broadband mindfulness questionnaire similar to RMMt, could show 16 percent variances in quality of life of patients with multiple sclerosis (MS; Schirda et al., 2015) and predict 27 percent variances in quality of life of cancer survivors living with chronic neuropathic pain (Poulin et al., 2016). These findings suggest that the FFMQ, like the RMMt, has better predictability as a broadband mindfulness questionnaire.

According to Geise's (2019) study, it is importance to use broadband mindfulness measures that assess for other facets of mindfulness, like transcendence and fantasy, outside of the traditional scales of presence, acceptance, and awareness. Using a narrowband mindfulness questionnaire gives a one-factor mindfulness score. Given the diverse range of experiences that can be associated with mindfulness, the use of a single-factor score may miss some important levels and characteristics of mindfulness. Factors that are actually related to mindfulness but due to the lack of attention may have limited the possibility of finding more accurate patterns in mindfulness (Geise, 2019). Given that the assessment of mindfulness is still in its infancy, supplementary item-level analyses may prove to be fruitful as well.

However, a review of the findings reveals that, in addition to the type of mindfulness questionnaires used, the type of patients and the type of quality of life questionnaire (multiple choice) used can all have an impact on the findings. We also could not find a study on the RMMt scale, so we turned to similar broadband mindfulness questionnaires (FFMQs), which can help interpret the results. Another point to consider is that we did not find a study on general health and instead used quality of life results, which have health dimensions that should be considered in future studies. The current study is the first of its kind, and because there have not been any other studies like it, further discussion in this area is not possible. As a result, future research should examine and compare two types of narrowband and broadband mindfulness questionnaires in terms of predicting general health, anxiety, and anger.

As a formal statement of shortcomings should keep authors and the public from overstating a study's claims (Vuong, 2020), our study has a number of limitations which should mentioned. First, the questionnaires' self-report nature limited the results and may have influenced the results of specific evaluations. Second, there are few studies on the RMMt as broadband mindfulness questionnaires. Third, the current study is one of the first to review and compare narrowband and broadband mindfulness questionnaires, according to the literature review. As a result, future research should consider

factors influencing results, such as study time and target population. In the present study, most of the participants were female, employed, and married, this may raise the possibility that conclusions from this population are not acceptable to other groups in the other regions. Therefore, care must be taken in interpreting the results. In the present study, the FMI questionnaire has been used to compare with RMM for predicting the variables. It is suggested that other similar questionnaires such as FFMQ be used in future studies. Since only two of the tools were compared, the conclusion should be interpreted with caution. Our study describes the comparison between these two questionnaires (RMM and FMI) to predict some health-related issues. However, it is not possible to say with certainty that better prognosis actually leads to clinical benefit, so care should be taken in interpreting the results and considering them in future studies.

CONCLUSION

The current study looked at RMMt-P and FMI-P to see if they could predict general health, anxiety, and anger in the general adult population. RMMt-P and FMI-P both predicted general health and anxiety, indicating a relationship between mindfulness, general health, and anxiety as measured by the narrowband and broadband mindfulness questionnaires. Furthermore, as a broadband mindfulness questionnaire, only the RMMt-P predicted anger. The present study founded that RMMt-P may be a better predictor of general health and anger than FMI-P. However, no difference in anxiety prediction was found between the RMMt-P and FMI-P. However, due to the scarcity of comparable studies in this area, future research should review and compare the narrowband and broadband mindfulness questionnaires in predicting general health, anxiety, and anger. These findings suggest that the type of questionnaire used in the study of mindfulness is important, but more research is needed to determine the extent of these relationships.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Kerman University of Medical Sciences (Ethical Code: IR.KMU.REC.1398.673). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AM, MZ, and MD designed the study. AM and MZ wrote the manuscript. MD provided critical feedback on the study and statistical analysis, and inputted to the draft of this manuscript. AM collected the data. All authors contributed to the article and approved the submitted version.

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Adverse Childhood Experiences, Mindfulness, and Grit in College Students in China

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This study investigated the effect of ACEs and COVID-19 on grit and whether this effect is mediated by mindfulness. Although current scholarship has found that adverse childhood experiences (ACEs) have harmful consequences to individuals across the life span, less is known about the relationship between ACEs and grit. Grit is predictive of educational success and subjective wellbeing. A cross-sectional online survey administered to junior and senior students from 12 universities spread across China was conducted from September 20, 2020 to October 5, 2020. The universities were selected from geographically diverse regions of China to ensure a diverse sample. We received 1,871 completed responses from 2,229 invited students. The survey response rate was 83.9%. The results indicated that ACEs had significantly negative effects on grit, while mindfulness had significantly positive effects on grit. Once controlling for level of mindfulness, the effects of ACEs on grit largely reduced and became insignificant. The findings of this research indicate that mindfulness has a significant mediational effect on the relation between ACEs and grit and call for mindfulness-based interventions for enhancing grit for the population at risks.

Keywords: adverse childhood experience, college students, emerging adults, grit, mindfulness

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INTRODUCTION

Globally, almost two-thirds of youth have identified experiencing at least one adverse childhood experience (ACE) (Carlson et al., 2019). Over 20% of study participants in the original ACE study conducted in the United States reported experiencing three or more ACEs (Center for Disease Control and Prevention [CDC], n.d.). ACEs are categorized into three categories of events–abuse, neglect, and household challenges–that occurred within an individual's first 18 years of life (CDC, n.d.). ACEs include harmful acts perpetrated against children, as well as familial and socioenvironmental influence that surround children. In their groundbreaking study, Felitti et al. (1998) found that ACEs are predictive of several social and health issues in adulthood. Since then, the effects of ACEs have been studied in individuals at various phases of the human life span (Brown et al., 2010; Isohookana et al., 2013; Crandall et al., 2020; Elmore et al., 2020). Parental incarceration, for example, has been reported to create significant challenges for children and families, such as maintaining parent-child relationships, throughout childhood and adolescence (Correa et al., 2021). As well, the co-occurrence of multiple ACEs is a risk factor for a myriad of health conditions, including diabetes, chronic lung disease, depression, and suicidality, as well as risky behaviors like early sexual initiation and violence perpetration (see Hughes et al., 2017 for review).

Given the deleterious effects of ACEs, it comes as no surprise that the attention of scholars has increasingly been directed at constructs such as resilience and grit. In the present study, we focus on grit, or "perseverance and passion for long-term goals" (Duckworth et al., 2007, p. 1087). Initially studied as a predictor of academic and professional success (Duckworth et al., 2007), grit has made its way into health and wellbeing studies. For example, grit has a buffering effect for suicidal ideation risk (Kleiman et al., 2013) as well as protective effects against peer victimization and problematic video gaming (Li and Zhu, 2020). Additionally, grit is inversely associated with psychological distress (Datu et al., 2018), substance use (Guerrero et al., 2016), and depression (Musumari et al., 2018). More generally, grit is a strong, positive predictor of subjective wellbeing (Singh and Jha, 2008).

Since grit is predictive of psychological and subjective wellbeing, the field requires understanding on possible points of intervention to enhance grit within vulnerable populations. Studies have identified that parent characteristics (e.g., employment and parenting style) and individual traits (e.g., goal commitment and self-efficacy) may affect adolescents' grit (Guerrero et al., 2016; Datu, 2017; Tang et al., 2019). Mindfulness, a mental state involving purposeful attention and non-judgmental reactions (Kabat-Zinn, 2003), is also a positive predictor of grit (Raphiphatthana et al., 2018). Mindfulness is comprised of two key components: mindful attention and mindful metacognition. The former regulates attention by emphasizing awareness of the present moment, while the latter consists of intentionally detaching oneself from monitoring value-laden thoughts and feelings that may arise (Bishop et al., 2004; Keng et al., 2011; Reina and Kudesia, 2020). Studies have shown that mindfulness can bolster academic performance (Lu et al., 2017; Caballero et al., 2019), improve social and emotional competence (Schonert-Reichl and Lawlor, 2010; Klingbeil et al., 2017), and mitigate emotional and behavioral problems (van de Weijer-Bergsma et al., 2012; Huang et al., 2019).

Recent grit studies center experiences of college students (Bono et al., 2020; Sulla et al., 2022; Yang et al., 2022) during the COVID-19 pandemic, which has presented a major threat to global public health (Ali et al., 2020; Fauci et al., 2020; Wu et al., 2020). Findings showed that stress and psychological distress were high in college students during the pandemic, but grit may serve as a protective factor to reduce the effects of stress and psychological distress on wellbeing and to improve self-efficacy and academic performance (Bono et al., 2020; Sulla et al., 2022; Yang et al., 2022).

In short, previous studies point out the importance of grit for college students during the pandemic, however, there remains a need to examine how ACEs affect grit and whether mindfulness mediates the association between ACEs and grit in college students in China during the pandemic.

Theoretical Framework

The guiding theoretical framework for this study, trauma theory, explains that traumatic experiences may negatively impact psychological wellbeing *via* the development of three symptom clusters (hyperarousal, constriction, and intrusion) (Herman, 1992). The first, hyperarousal, is one of the hallmark symptoms of post-traumatic stress disorder (PTSD). Hyperarousal describes the self-protective activation of an individual's sympathetic nervous system by a traumatic memory. When an individual lives in a constant or chronic state of hyperarousal, they experience a prolonged state of vigilance that is challenging to regulate. Another set of symptoms, called "constriction," may co-occur with hyperarousal. During conscription, an individual may become unresponsive to stimuli. This includes physiological, emotional, and cognitive unresponsiveness. Functionally, this state may be protective, as individuals' unresponsiveness can help them avoid painful trauma responses. At the same time, however, intrusion symptoms can disrupt this state, forcing an individual to relive their traumatic experiences through images and sensations associated with the original experience. Notably, this occurs in nightmares or as flashbacks. These three trauma symptom clusters have been reported to disrupt individuals' schemas about safety and trust by challenging their senses of control, connection, and meaning in life (Herman, 1992; Briere, 2019).

Contextualizing ACEs within trauma theory (Herman, 1992), this study positions ACEs as traumatic events that can have significant and persistent consequences throughout one's life (Herrenkohl et al., 2013; Weder et al., 2014; Bryan, 2019; Mosley-Johnson et al., 2019). Individuals with ACEs may experience constriction by dissociating from triggering circumstances to cope with overwhelming reactions based in a state of hyperarousal. Long-term dissociation may affect individuals' mindfulness through the restriction of awareness and attention to the current moment (Bishop et al., 2004; Zerubavel and Messman-Moore, 2015; Bolduc et al., 2018). As Herman (1992) suggests, trauma can leave individuals without a strong sense of connection to others or of meaning in life, overlapping with the common depressive symptom of diminished passion in life. Along the same lines, trauma is associated with escalated risky behaviors (e.g., substance use and delinquency), which can reduce one's sense of perseverance when achieving goals and ambitions. Both, passion and perseverance are key dimensions of grit which may be negatively associated with ACEs. Therefore, ACEs are expected to reduce individual grit through the reduction of mindfulness. We hypothesized that ACEs would be negatively associated with grit in Chinese college students and that this relation would be mediated by a negative relation between ACEs and students' mindfulness. We further hypothesized that the categories of ACEs may be differentially associated with the two dimensions of grit. Specifically, based on past findings by Datu et al. (2016) and Datu (2017), it was expected that abuse and neglect would be negatively associated with perseverance of effort.

MATERIALS AND METHODS

Data and Sample

Data came from an anonymous online survey administered to junior and senior students in universities in China. The

inclusion criteria were that participants had to be (a) social science students and (b) in their junior or senior year of college. The sample was limited to junior and senior students to assess the experiences of students who had attended university for at least 1 year prior to the pandemic. The sampling procedure was designed to reach a large and geographically diverse sample that would be sufficient to conduct multivariate analysis. Twelve leading universities were selected across the northern, eastern, southern, western and central regions of China. Once universities were selected, we reached out to each schools' social science department, yielding a sampling frame of 2,229 students. In September 2020, all 2,229 students were invited to participate in the study, with reminders for survey completion sent out 3 and 7 days after the initial invitation. Students were informed that participation was voluntary and could be discontinued at any time. Surveys were closed in early October 2020. We received 1,881 responses. After excluding incomplete cases, the final analytic sample contained 1,871 students. The survey response rate was approximately 83.9%. This study was approved by the research review committee at one of the co-authors' university and included an informed consent process.

Measures

Grit

Grit was measured using Duckworth and Quinn's (2009) 8-item Short Grit Scale (Grit-S). The scale is comprised of two subscales: *perseverance of effort* and *consistency of interests*, hereafter referred to simply as *perseverance* and *consistency*. In collectivist contexts (e.g., the Philippines; China), only perseverance of effort may be salient to grit (Datu et al., 2016). Perseverance is demonstrated by an individual striving harder to accomplish their goals, despite challenges and hardships, while consistency of interests is demonstrated by steady long-term interest in a project or goal. Grit-S items ask about respondents' intrapersonal competencies and the degree to which they can maintain interest, focus, and perseverance for extended periods. Negatively worded items were recoded so that higher scores would be indicative of greater levels of grit. Average item scores, ranging 1–5, were computed to represent grit and subscale scores. In this study, the scale had a Cronbach's alpha of 0.72. The perseverance and consistency subscales had Cronbach's alpha values of 0.83 and 0.69, respectively.

Mindfulness

We measured mindfulness using the Mindful Attention Awareness Scale (MAAS) (Brown et al., 2011). The 15-item scale asks participants to indicate frequencies at which they experience different behaviors, thoughts, and behaviors over the course of the past 4 weeks. Respondents could answer 1 (almost never) to 6 (almost always). Item scores were reverse-coded so that higher scores were representative of greater mindfulness. Responses were summed to represent the mindfulness score, ranging 14–90. The Chinese version of MAAS has been found to be valid and reliable for Chinese populations (Deng et al., 2011; Huang et al., 2019). In our study, the Cronbach's alpha was 0.90.

Adverse Childhood Experiences

Adverse childhood experiences were measured by the ACE questionnaire (CDC, n.d.). 10 items measured the occurrence of ACEs in three categories–abuse (3 items), neglect (2 items), and household challenges (5 items)–prior to age 18. The sum of affirmative answers represented the ACE score; higher scores indicate more ACEs. We also calculated scores by ACE categories.

Socioeconomic Characteristics

We collected information on students' age, sex, ethnicity, household registration (HR), and proximity to COVID-19. Students were also asked to report on their parents' marital status and educational attainment, as well as number of family members they had, family income in the last year, and whether their family received welfare in the last year. We measured *proximity to* COVID-19 by asking students to indicate whether they knew of any family members or friends who had tested positive for or died as a result of COVID-19. Finally, we considered that each college's characteristics may affect students' grit and accounted for this by controlling for college-fixed effects.

Analyses

Analyses began with descriptive analysis to examine the distribution of our variables of interest. This was followed by ordinary-least-square (OLS) regression analysis, which estimated the net effects of our independent variables on grit, controlling for socioeconomic characteristics. The following equation represents the analytic model:

$$Y_i = \alpha_i + \beta_1 * \chi_i + C_i + \varepsilon_i,$$

where Y i is subject i's grit; α_i is the individual constant; χ is a vector of subject i's mindfulness, ACEs, and socioeconomic characteristics; C_i is the college-fixed effects of subject i's college, taken to be constant across individual colleges; β is a vector of regression coefficients; and ε_i is the cross-section error component. By incorporating a term for college-fixed effects, this analytic model controls for differences across the 12 colleges from which we sampled. Analyses were conducted using STATA software 16.0.

RESULTS

Descriptive Statistics

Results of descriptive statistics for the variables of interest and socioeconomic characteristics are presented in **Tables 1**, **2**, respectively. The sample had an average grit score of 3.07 (*SD* = 0.44). Perseverance and consistency scores averaged 3.28 and 2.86, respectively. On average, the students in our sample had a mindfulness score of 59.61 (*SD* = 10.84). Scores ranged from 15 to 90. 35.16% of the sample reported having experienced at least one ACE, while 8% reported that they had experienced at least three. The sample had an average ACE score of 0.69 (*SD* = 1.28). Subscale score averages are also presented in **Table 1**.

Female students comprised two-thirds of the sample, which is reflective of the social science student population across Chinese

TABLE 1 | Level of grit, mindfulness, adverse childhood experience, and COVID-19 infection.

	Mean (S.D.)
Grit (1–5)	3.07 (0.44)
Perseverance (1–5)	3.28 (0.72)
Consistency of effort (1–5)	2.86 (0.63)
Mindfulness (15–90)	59.61 (10.84)
Adverse childhood experience (%)	
Occurrence (No = 0, Yes = 1)	35.16
Three types or more	8.44
Adverse childhood experience (0–10)	0.69 (1.28)
Abuse (0–3)	0.28 (0.63)
Neglect (0–2)	0.15 (0.41)
Household challenge (0–5)	0.26 (0.61)

N = 1871.

TABLE 2 | Descriptive statistics of socioeconomic variables.

	Mean (S.D.)
Gender (%)	
Female	66.97
Male	33.03
Age	20.62 (0.96)
Household registration (%)	
Rural	38.70
City, rural before	8.93
City	52.37
Grade (%)	
Junior	60.72
Senior	39.28
Ethnicity (%)	
Han	89.36
Others	10.64
Parent marital status (%)	
Married	89.04
Separated	0.80
Divorced	6.89
Widowed	2.35
Others	0.91
Parent highest education achievement (%)	
Elementary school and below	6.90
Junior high school	28.11
High school	25.17
College and above	39.82
Family income	90990 (122030)
Welfare status	
No	74.72
Yes	25.28
Number of family members	3.87 (1.16)
COVID-19 infection in family and friends (%)	
No	99.14
Infected	0.48
Dead	0.37
College (%)	
College 1	7.11
College 2	9.57
College 3	6.25
College 4	10.85
College 5	10.15
College 6	7.06
College 7	6.41
College 8	11.54
College 9	11.12
College 10	2.46
College 11	6.89
College 12	10.58

N = 1871.

academic institutions. The sample's average age was 20.62. Nearly 90% of the sample was of Han ethnicity. About half (52.37%) held city HR, followed by rural HR (38.60%), and city with prior rural HR (8.93%). Most students (89.04%) reported that their parents were married. 6.89% reported that their parents were divorced. About 40% reported that their parents' highest educational attainment was college and above, followed by junior high school (28.11%), high school (25.17%), and elementary school (6.9%). Family income averaged at 90,990 RMB, or about 13,580 USD, in the past year (*SD* = 122,030 RMB or 18,170 USD). About one-quarter of the sample reported that their families were recipients of social welfare (e.g., low-income assistance and food subsidies) in the past year. Students had an average of 3.87 family members. Due to low occurrence of students reporting having family or friends who had been infected with COVID-19 (0.5%) or who had died of COVID-19 (0.4%), we aggregated both to create a single category for analysis. Students from each college ranged from ranged from 2.5 to 11.5% of the analytic sample, reflecting the size of the student body in their respective schools.

Multivariate Analyses

Table 3 presents standardized estimates of grit, estimated by OLS regression and predicted by two different models. Model 1 includes ACE scores and student socioeconomic characteristics. We added mindfulness in Model 2 to test its mediational effect. The results of Model 1 show that ACEs are a significant and negative predictor of grit ($B = -0.09$). Grit was also positively associated with age. The adjusted R-square of Model 1 was 0.03 and increased to 0.18 in Model 2. In Model 2, mindfulness was a significant predictor of grit ($B = 0.41$), while the ACE estimate lost statistical significance. Other estimates produced by Model 2 are similar to those of Model 1. The increase in adjusted *R*-square values between the models, coupled with the large estimate of mindfulness, suggests that much of the variance in grit within the sample was associated with students' mindfulness and that mindfulness fully mediated the effects of ACEs on grit.

We conducted several tests of robustness, the results of which are displayed in **Table 4**. These tests differ from those of **Table 3** in that we utilized different specifications of the ACE variable each time: total ACE score (Specification 1, same as the one in **Table 3**); any ACE occurrence (Specification 2); and occurrence of three more ACEs (Specification 3). Specifications 4, 5, and 6 regressed the ACE categories–abuse, neglect, and

TABLE 3 | Regression analysis of grit.

	Model 1			Model 2		
	B	S. E.	P	B	S. E.	P
Adverse childhood experience (Score)	−0.09	0.01	***	0.00	0.01	
Mindfulness	—	—		0.41	0.01	***
Female	0.04	0.02	+	0.04	0.02	+
Age	0.10	0.01	**	0.07	0.01	**
Household registration: city, rural before	−0.03	0.04		−0.03	0.04	
Household registration: city	0.03	0.03		0.01	0.03	
Junior	0.01	0.03		0.01	0.02	
Han	0.00	0.03		−0.01	0.03	
Married	−0.02	0.03		0.01	0.03	
Junior high school	−0.01	0.04		−0.02	0.04	
High school	0.01	0.05		−0.01	0.04	
College and above	0.02	0.05		−0.02	0.05	
Family income	−0.03	0.01		−0.02	0.01	
Welfare status	0.03	0.03		0.03	0.02	
Number of family members	−0.02	0.01		−0.01	0.01	
COVID-19 infection in family and friends	−0.01	0.11		0.03	0.10	
College fixed effects	Yes			Yes		
Adjusted *R*-square	0.03			0.18		

*N = 1871. +p < 0.10, **p < 0.01, ***p < 0.001.*

TABLE 4 | Robust tests of adverse childhood experiences (ACE) on grit.

	Model 1			Model 2		
	B	S. E.	P	B	S. E.	P
ACE Scale						
Specification 1						
ACE (Score)]	−0.09	0.01	***	0.00	0.01	
Mindfulness	–	–		0.41	0.01	***
Specification 2						
Any occurrence	−0.09	0.02	***	−0.02	0.02	
Mindfulness	–	–		0.41	0.01	***
Specification 3						
Three or more occurrences	−0.07	0.04	**	−0.02	0.03	
Mindfulness	–	–		0.41	0.01	***
Three dimensions						
Specification 4						
Abuse	−0.09	0.02	***	−0.02	0.02	
Mindfulness	–	–		0.41	0.01	***
Specification 5						
Neglect	−0.06	0.02	**	0.00	0.02	
Mindfulness	–	–		0.41	0.01	***
Specification 6						
Household challenge	−0.04	0.02		0.02	0.02	
Mindfulness	–	–		0.41	0.01	***

*N = 1871. **p < 0.01, ***p < 0.001.*

household challenges, respectively–onto grit. Each iteration of the analysis included the controls used in the previous models. For simplicity, **Table 4** presents only standardized estimates of ACE and mindfulness, as all other estimates were similar to those reported in **Table 3**. In Specifications 1–5, ACEs negatively affected grit, but when mindfulness was added, these estimates were no longer statistically significant. Any occurrence (Specification 2) and the occurrence of three or more ACEs (Specification 3) had negative effects on grit in Model 1 ($B = -0.09$ and -0.07, respectively). These estimates lost statistical significance in Model 2. Here, mindfulness was a significant and positive predictor of grit ($B = 0.41$). Similarly, analyses using Specification 4 and Specification 5 found that abuse and neglect negatively affected grit ($B = -0.09$ and -0.06, respectively), but in Model 2, mindfulness fully mediated these effects. Specification 6, household challenges, had no significant effects on grit in Model 1.

Tables 5, **6** present robustness tests regressing each grit subscale (perseverance and consistency, respectively) on ACEs. Compared to the estimates using overall grit, ACEs had larger effects on perseverance ($B = -0.16$ for Specification 1). As in previous models, mindfulness had large effects on perseverance ($B = 0.50$ for Specification 1), but, unlike previous models, it did not fully mediate the effects of ACEs. The ACE estimate reduced by 63% between the models but remained significant for Specification 1 ($p < 0.01$). Estimates for Specifications 2 and 3 reduced similarly and were both marginally significant ($p < 0.10$) in Model 2. Among the ACE categories, mindfulness only fully mediated neglect's effect on perseverance. In **Table 6**, ACE score and household challenges had significant positive effects on consistency ($B = 0.07$ and 0.10, respectively), but all other specifications and mindfulness did not have any significant effects on consistency.

TABLE 5 | Robust tests of grit subscale–perseverance.

	Model 1			Model 2		
	B	S. E.	P	B	S. E.	P
ACE Scale						
Specification 1						
Adverse childhood experience (Score)	−0.16	0.01	***	−0.06	0.01	**
Mindfulness	–	–		0.50	0.01	***
Specification 2						
Any occurrence	−0.12	0.04	***	−0.04	0.03	+
Mindfulness	–	–		0.50	0.01	***
Specification 3						
Three or more occurrence	−0.10	0.06	***	−0.04	0.05	+
Mindfulness	–	–		0.50	0.01	***
Three dimensions						
Specification 4						
Abuse	−0.13	0.03	***	−0.04	0.02	+
Mindfulness	–	–		0.50	0.01	***
Specification 5						
Neglect	−0.10	0.04	***	−0.02	0.04	
Mindfulness	–	–		0.50	0.01	***
Specification 6						
Household challenge	−0.14	0.03	***	−0.07	0.03	**
Mindfulness	–	–		0.50	0.01	***

*N = 1871. +p < 0.10, **p < 0.01, ***p < 0.001.*

TABLE 6 | Robust tests of adverse childhood experiences (ACE) on grit subscale–consistency of interests.

	Model 1			Model 2		
	B	**S. E.**	***P***	**B**	**S. E.**	***P***
ACE Scale						
Specification 1						
Adverse childhood experience (Score)	0.07	0.01	**	0.07	0.01	**
Mindfulness	–	–		0.01	0.00	
Specification 2						
Any occurrence	0.02	0.03		0.02	0.03	
Mindfulness	–	–		0.00	0.00	
Specification 3						
Three or more occurrence	0.01	0.05		0.01	0.05	
Mindfulness	–	–		0.00	0.00	
Three dimensions						
Specification 4						
Abuse	0.02	0.02		0.02	0.02	
Mindfulness	–	–		0.00	0.00	
Specification 5						
Neglect	0.03	0.04		0.03	0.04	
Mindfulness	–	–		0.00	0.00	
Specification 6						
Household challenge	0.10	0.03	***	0.10	0.03	***
Mindfulness	–	–		0.00	0.00	

*N = 1871. *p < 0.05, **p < 0.01, ***p < 0.001.*

DISCUSSION

This study sought to investigate how ACEs affect grit in a sample of college students during the COVID-19 pandemic. We hypothesized that ACEs would be negatively associated with grit and that mindfulness would mediate this relationship. Our ACEs hypothesis was supported by the results, though the findings revealed that the extent of the effects on grit differed by ACE specification, as indicated by robustness tests. Analyses by ACE category indicated that abuse and neglect had strong effects on grit overall, while household challenges did not. This study indicates that ACEs have a small to moderate effect on grit. Regression analyses including mindfulness revealed that all specifications no longer predicted grit. This is consistent with past findings that have found that mindfulness predicts grit (Raphiphatthana et al., 2018).

The significant effects of abuse and neglect on grit may be explained by decreased sense of relatedness, defined as the extent to which a person feels accepted by social partners, including parents (Datu, 2017). Trauma theory (Herman, 1992) posits that trauma can lead to negative self-appraisal and feelings of rejection. These can in turn reduce an individual's sense of relatedness and, therefore, grit. Previously, Datu et al. (2016) suggested that perseverance of effort may be more relevant than consistency of interests in the collectivist contexts of Asian cultures. Indeed, all ACE specifications had significant negative effects on perseverance, and when mindfulness was added to the model, only one specification was no longer significant, while two others were marginally significant. These findings may be explained by the importance of the "context-sensitive self" (Suh, 2007) and relational harmony (Markus and Kitayama, 1991) in collectivistic cultures. Consistency of interests may be irrelevant since individuals are more likely to prioritize fulfilling others' expectations (e.g., those of their parents') over pursuing personal interests. In doing so, individuals may see themselves as maintaining peace within the larger social unit (e.g., a family) in which they are embedded. By contrast, pursuing one's personal interests, which may not align with the family's best interests, may be disruptive to such relationships and can cause conflict. ACEs may negatively affect perseverance of effort *via* mental illnesses like depression (Schilling et al., 2007; Merrick et al., 2017), which can manifest in symptoms like avolition and anhedonia (Price and van Stolk-Cooke, 2015). Moreover, traumatic events can lead to low self-esteem (Stern et al., 1995), and perceived lack of competence may discourage individuals from pursuing goals when faced with adversity.

Household challenges had no significant effect on overall grit but positively estimated consistency of interests ($B = 0.10$), even when mindfulness was added. This may be a result of disrupted relationships caused by dysfunctional home environments. An individual may choose to pursue personal interests rather than tend to expectations of others due to perceived lack of acceptance and lower sense of relatedness (Datu, 2017).

Our findings, contextualized within the central values of filial piety and family in East Asian culture, suggest a number of research and practice implications for researchers and social service professionals who study and work with children and families, especially those with similar cultural traditions. Research on ACEs may benefit from understanding not just the psychological traits that ACEs can affect but also the moderators and mediators of these relations, particularly those that involve the family. For example, family functioning has been found to moderate the relation between ACEs and adolescent health and emotional wellbeing (Balistreri and Alvira-Hammond, 2016; Scully et al., 2020). Other research has found family functioning to be a mediator of mental health problems in children and adolescents. In our study, we found direct relations between ACEs and grit, although these relations varied by grit subscales. This finding may guide future family research to examine how family relationships, as well as individuals' perceptions and appraisals of these relationships, are affected by ACEs and whether this relation mediates the relation between ACEs and grit. Finally, these results extend the work of grit scholars who have studied the construct outside of the Western context in which it was originally derived. By showing that only the perseverance of effort dimension was salient for this sample, we highlight that the originally theorized dimensions of grit may lack cross-cultural conceptual equivalence in Chinese college students (Hui and Triandis, 1985). That is, grit, with its current paradigmatic definitions and dimensions, may not necessarily have the same meaning across college students of cultural groups. Grit was originally theorized in the individualistic United States American context (Duckworth et al., 2007). Future grit research may thus explicitly examine the family-centered social and cultural norms in China and how individuals' personal sense of relatedness to those around them and how the concept of

saving face may lead them to prioritize perseverance of effort over personal interests.

Meanwhile, for social service providers who work with families in which children or adolescents have experienced ACEs, this study points to the utility of mindfulness interventions to mitigate the effects of ACEs on grit. While mindfulness in practice with individuals has proliferated significantly in past decades (Creswell, 2017), the integration of mindfulness in family therapy has been less common (Brody et al., 2018; Beaudoin and Maclennan, 2020). Brody et al. (2018) argued for the integration of mindfulness in family therapy with adolescents because of mindfulness's ability to promote emotion regulation. We add onto this by reflecting that mindfulness also mediates the relation between ACEs and grit and emphasizing the need for mindfulness interventions in practice with children and adolescents who have experienced emotional abuse and/or neglect.

LIMITATIONS

This study has several limitations. First, cross-sectional data can only approximate associative relations; a longitudinal design can better examine the causal relations of ACEs, grit, and mindfulness. Second, unobserved variables (e.g., academic stressors and peer support) could affect students' grit but were not included in the study, thus affecting our estimates. Third, the sample consisted of only social science students, many of whom are female (as indicated by our sample, which was two-thirds female). The extent to which our findings can be generalized to other students, such as those from male-dominated fields, like science and technology, is unknown and requires further research. Fourth, our study may not have found effects of COVID-19 proximity on grit due to measurement error, as data were dependent on students' recall. The COVID-19 infection rate had stabilized in China since April 2020 (Zhong and Wang, 2020), 5 months prior to the time of data collection. Research in countries where COVID-19 continues to affect daily life is warranted. Last, due to self-reporting, data were subject to reporting errors. In collectivistic cultures, face-saving may be prioritized when discussing family matters (Eriksson et al., 2017) which may be perceived as shameful. Future studies may consider applying triangulation during data collection. Despite these limitations, the present study expands upon existing grit literature.

CONCLUSION

Our study examines how ACEs may predict grit during emerging adulthood and a pathway by which this occurs. Results indicated that ACEs negatively affect grit–particularly the perseverance of effort dimension–through mindfulness. This study's strengths include its expansive tests of robustness, which provided further insight into how ACEs affect each grit dimension differently and how the effect of ACEs on grit may differ according to various specifications. Since grit is a predictor of academic and professional success and subjective and psychological wellbeing, individuals who have experienced ACEs may struggle in several domains of life from adolescence into adulthood. Our results suggest the necessity of mindfulness-based interventions to buffer the negative effects of ACEs on grit, especially for those who have experienced abuse and neglect. Such interventions can improve self-esteem (Thompson and Waltz, 2008; Randal et al., 2015), as well as resilience (Huang et al., 2019, 2020; Cheung et al., 2020), which has been found to be positively related to grit (Meyer et al., 2020). Although mindfulness interventions have yet to be examined for their effects on grit specifically, past literature has found that mindfulness and grit are positively associated (Raphiphatthana et al., 2018), and our study indicates that it is through mindfulness that ACEs affect grit. Our findings thus set up future research to continue building on our knowledge of grit, including its antecedents within family processes and dynamics, along with possible ways to bolster it in vulnerable populations.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Review Committee, School of Public Administration, Guangdong University of Foreign Studies. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

SC, BT, and CH: conceptualization, methodology and software, validation, formal analysis, and writing—original draft preparation. BT and CH: resources, investigation, and data curation. All authors contributed to the article and approved the submitted version.

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The Impact of Baseline Mindfulness Scores on Mindfulness-Based Intervention Outcomes: Toward Personalized Mental Health Interventions

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A growing body of evidence has portrayed mindfulness as a useful tool for dealing with a broad range of psychological problems and disorders. This has created the impression that mindfulness-based interventions (MBIs) can be used to treat nearly all psychological difficulties, in all cases. Nonetheless, little research has been done on how individual differences may contribute to intervention outcomes. The goal of this study was to evaluate the role of baseline mindfulness on participants' outcomes by examining three prior Randomized Controlled Trials that addressed the impact of MBIs on mental health and mindfulness measures. The participants were 164 people, aged between 12 and 45, from both clinical and non-clinical samples. Our findings indicate that at least two thirds of the change produced by these interventions in terms of mindfulness scores can be predicted by the baseline scores of the same variables. We also found that many trajectories are not only strongly influenced by the initial status of the participants, but also by the intervention performed, as attested to by the significant interactions found. These results stress the need to continue doing research in a way that considers the diversity of participants' trajectories, increasing the room for intervention improvements aligned with a more personalized health care model.

Keywords: baseline, mindfulness-based interventions, personal trajectories, RCTs outcomes, mental health

INTRODUCTION

Meditation has been defined as "a family of complex emotional and attentional regulatory strategies developed for various purposes, among them the cultivation of well-being and emotional balance" (Lutz et al., 2008). Even though meditation is originated in the Eastern culture, in recent decades it has been widely practiced in the West, where it has been adopted as a way of improving the quality of life. Many secular practices have been derived from it, mainly oriented

toward addressing specific mental health problems in modern society, such as stress, anxiety and depression (Dakwar and Levin, 2009).

In the West, mindfulness meditation is the most popular and scientifically studied meditation technique. Mindfulness has been defined from a scientific perspective, on an operational level, as "paying attention in a particular way: on purpose, in the present moment and non-judgmentally" (Kabat-Zinn, 1994). By maintaining this non-elaborative stance, the ongoing flow of sensory, cognitive and affective events which arise in the mind are acknowledged and accepted as they are (Bishop, 2004; Lutz et al., 2005). A mindful state of mind is an inherent capacity of human being, that could be present as a trait, that is to say, as an everyday life disposition or stable tendency to be mindful (Brown and Ryan, 2003). This Mindfulness disposition can be further developed or enhanced through the practice of several meditation techniques (Ricard et al., 2014).

Among others forms, mindfulness can be cultivated through structured courses (usually composed of weekly group sessions) where contemplative skills (e.g., attentional training) are taught and discussed. The interventions which are based on the formal training of mindfulness (e.g., Mindfulness-Based Stress Reduction [MBSR] or Mindfulness Based Cognitive Therapy [MBCT]) have been label as mindfulness-based interventions (MBIs) (Howarth et al., 2019). Over the last 10 years, mounting evidence has presented mindfulness as a useful tool for dealing with a number of psychological problems (e.g., stress, anxiety, depression) (Shonin et al., 2013) and also as an intervention capable of fostering attentional and emotion regulation qualities (Tang et al., 2015). This has created the impression that mindfulness is useful for treating almost all psychological difficulties, for everyone. Nonetheless, little research has been done on how individual differences may contribute to intervention outcomes. Considering that averages may hide potentially hazardous trajectories, and that mindfulness researchers may have failed to report adverse effects of interventions (Joiner, 2017; Britton, 2019), it is critical to assess individual trajectories considering certain attributes measured before intervention.

In the last 5 years, a considerable number of studies on MBIs have reported negative findings when assessing their effects (Britton, 2019). These negative findings may be derived from differences in construct operationalization, issues with control group set-up, or inadequate cultural measurements (Davidson and Kaszniak, 2015). Even the role of individual differences such as personality traits (Harnett et al., 2016) and mindfulness measured prior to intervention (Tortella-Feliu et al., 2020) may play a relevant role in the results of Randomized Controlled Trials (RCTs) of MBIs. For instance, participants with an insecure attachment style benefit more from mindfulness-based stress reduction (MBSR) programs than participants with a secure attachment (Cordon et al., 2009). People's empathy scores predict preferences for loving-kindness, with females tending to prefer loving-kindness more than males (Tang and Braver, 2020). Likewise, non-reactivity and non-judgment of present moment experiences have been found to predict a preference for engaging in open monitoring (Tang and Braver, 2020). Personality differences even explain preferences for specific MBSR techniques (Barkan et al., 2016), which may impact autonomous work and therefore intervention trajectories.

One central aspect which has been neglected is the impact of pre-intervention mindfulness scores, even though some correlational studies have shown a relation between mindfulness scores and psychological distress regulation, depression, anxiety, and stress (Shapiro et al., 2011; Harnett et al., 2016; Tortella-Feliu et al., 2020). This suggests that mindfulness scores prior to an intervention may place participants into different trajectories as a result of the regulation tools that they may use. Nonetheless, experimental studies have yielded contradictory evidence, with some reporting a relevant impact of baseline mindfulness on intervention outcome (Shapiro et al., 2011) and others finding negative or weak results (Tortella-Feliu et al., 2020).

The contradictory results found in the literature can be due to a number of aspects. For example, it is worth pointing out that these assessments did not evaluate the interaction between baseline mindfulness and the tested intervention, which may mask positive results. Also, these studies used baseline mindfulness to predict depression, anxiety, and stress, when in causal terms it is the change in mindfulness due to the intervention that is expected to produce an impact on these variables. Above all, it is also necessary to consider the differences between the instruments used to measure mindfulness as well as sample disparities, all of which may contribute to these discrepancies.

Given that research assessing the impact of baseline mindfulness on participants' trajectories during mindfulness interventions is scarce and non-conclusive, the goal of this study is to evaluate the role of baseline mindfulness on participants' outcomes taking into account previous RCTs of mindfulness and the potential limitations described above (i.e., interaction evaluation, considering mindfulness change as a source of outcome, different mindfulness instruments, and different populations). The results derived from this reassessment of RCTs will contribute to the development of mindfulness interventions adapted to particular group or even individual needs rather than the blind application of the intervention neglecting group characteristics and needs.

MATERIALS AND METHODS

Participants and Design

In this study, we utilized three samples from previous studies that involved MBIs, as well as RCT designs from our research group. 1:1 allocation was used in a simple randomization process (Langer et al., 2010, 2017, 2020). The three samples featured 164 participants aged 12–45 from clinical and non-clinical populations. The control groups were as follows: for University Students (University-MBCT), we used a cinema-forum as an active control group; for School Students (School-MiSP), Education as usual (EAU) was used; and for the first psychotic episode patients, treatment as usual (TAU), standard psychopharmacology, and psychosocial treatments were used (Psychosis-MBCT). The samples were heterogeneous in terms of

the percentage of men and women in each study. The age averages correspond to an adolescents' sample and two samples of young adults. The samples were also diverse in relation to the context in which they were applied. In turn, the studies were implemented at different levels of prevention (i.e., universal and targeted) and treatment (i.e., early intervention) (see **Table 1** for details).

Among the reasons for testing MBIs from an RCT was to test their effect in populations (Psychosis), social contexts (Chile) or experiences (Hallucinations Like experiences, HLEs) with scarce research. Thus, the overall objective for selecting MBIs in relation to other interventions was to provide participants with mind/body strategies that enable them to establish a different relationship with their internal stressful events, thus achieving greater psychological flexibility and a more harmonious relationship with themselves and their peers. Another relevant background for the selection of the MBIs was that they have proven to be well received by adolescents and young people (e.g., Monshat et al., 2013).

Instruments

For Mental Health, the Beck Depression Inventory (BDI) (Beck et al., 1988) has 21 items on depression symptoms experienced over the last 2 weeks. Answers to each item are presented as a 4-point Likert scale from 0 (I do not feel sad) to 3 (I am so sad and unhappy that I cannot stand it). Excellent internal consistency has been reported in Spanish-speaking adolescents (Cronbach's $\alpha = 0.92$) (del Beltrán et al., 2012).

Depression, Anxiety and Stress scale (DASS-21; Lovibond and Lovibond, 1995). In this study, we used the Chilean validation (Antúnez and Vinet, 2012), whose reliability is adequate (Cronbach's $\alpha = 0.91$). This scale is made up of twenty-one items assessing symptoms of depression (seven items), anxiety (seven items), and stress (seven items). Responses are recorded on a scale ranging from 0 ("It didn't happen to me") to 3 ("It happened to me a lot, or most of the time").

For Mindfulness, the Acceptance and Action Questionnaire-II (AAQ-II; Bond et al., 2011), a widely used instrument for assessing Experiential Avoidance (EA; Hayes et al., 1996). EA can be defined as a person's attempts or desires to suppress unwanted internal experiences like thoughts, emotions, memories, or bodily sensations (Hayes et al., 1996). This is a seven-item self-administered scale with seven-point Likert-type response options from 1 (never) to 7 (always). A higher AAQ-II total score indicates a higher level of experiential avoidance. The AAQ-II has been shown to have a unifactorial internal structure (Bond et al., 2011) and has been satisfactorily adapted to multiple cultural contexts and populations [e.g., Greece (Karekla and Michaelides, 2017), Malaysia (Shari et al., 2019), Turkey (Yavuz et al., 2016), China (Zhang et al., 2014), Serbia (Zuljevic et al., 2020)]. In this study, we used the Spanish version of the AAQ-II (Ruiz et al., 2013).

Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). This is a self-reporting questionnaire that describes mindfulness operationally as a multidimensional construct, built on the following five facets: observing, describing, acting with awareness, non-judging of experiences, and non-reactivity to experience. The Spanish version used in this study (Schmidt and Vinet, 2015) exhibits acceptable to good levels of reliability (Cronbach's $\alpha = 0.62–0.86$).

Child and Adolescent Mindfulness Measure (CAMM). The CAMM (Greco et al., 2011) comprises 10 items and a five-point Likert scale ranging from 0 (never true) to 4 (always true), which are used to evaluate mindfulness skills. Greco's original scale has adequate internal consistency (Cronbach's $\alpha = 0.81$) and construct validity. We used the seven-item Spanish version of the CAMM, which has been shown to be more valid and reliable than the 10-item version (García-Rubio et al., 2019).

Intervention

In the first (University students) and third sample (patients with psychosis), we used a reduced or less intense version of the MBCT. In particular, we maintained the structure of each session, but the length of the session and the mindful practices were reduced. The length of each session was approximately 1 h and a half. The meditation practice lengths did not exceed 20–25 min in university students and 10–12 min in patients with psychosis. The interventions included exercises such as guided body scan, sitting and walking meditation, gentle stretching, intentional attention to body sensations, thoughts, and feelings, and take-home exercises. Additionally, every participant received a flash drive or CD with guided mindfulness practice audio recordings and a booklet with the contents of each session.

The ".b curriculum" from the Mindfulness in Schools Project (MiSP; Mindful Nation UK, 2015) was implemented in the second sample (school students) using a workshop format of eight weekly sessions lasting 45 min each. All sessions were conducted during normal school hours and in the students' usual classrooms. During the program (following the MBSR approach), each workshop session was developed around a central theme, making use of specific visual learning aids (slides). In each session, both formal and informal mindfulness exercises are taught. The formal practices are time-limited (approximately 10 min) and are used to train awareness of bodily sensations, emotions, and thoughts. (e.g., body scan, mindful movement, sitting meditation). Informal practices include tooth brushing, mindful eating, and dish-washing, among other activities, which help cultivating present moment awareness in daily life. Moreover, each participant was given a notebook containing a summary of each session and the exercises to be done at home. Audio recordings containing key meditative practices were also provided.

Ethical Approval

The revised RCT were evaluated by an Ethics committee or an Institutional Review Board and all participants have their consent to participate of the studies. The studies were evaluated as follow: University-MBCT (Doctoral thesis AIL; research group HUM 760, Almeria University), School-MiSP (project n° 82130055: Faculty of Psychology of the Pontificia Universidad Católica de Chile), Psychosis-MBCT (project n° 11150846; National Health Service in Valdivia). The RCT with

TABLE 1 | Description of RCTs.

Sample name	Study focus and country	Sample profile (*n*)	Age (*SD*) male %	Instruments	Intervention and control
University-MBCT	Targeted prevention Spain	Undergraduate students with distressing HLE (*n* = 38)	21.31 (2.58) 15.8%	BDI-I AAQ-II	Adapted MBCT vs. Active control group
School-MiSP	Universal prevention Chile	School students (*n* = 88)	13.37 (0.57) 47.72%	DASS-21 CAMM	MiSP vs. EAU (waiting list)
Psychosis-MBCT	Early Intervention Chile	Patients with psychosis (*n* = 38)	23.8 (4.82) 78.9%	DASS-21 FFMQ	Adapted MBCT vs. TAU (waiting list)

Characteristics of participants and studies.

an available registration number is the Psychosis-MBCT study (ISRCTN24327446).

Data Analysis

In order to evaluate the impact of baseline mindfulness on individual treatment trajectories, we first determine how baseline mindfulness affects post-intervention mindfulness scores. This analysis allows us to assess the room for mindfulness change given a certain baseline score. Since the room for change may be a consequence of being in the treatment or control group, we also considered an interaction between both variables. Then, to evaluate the impact on psychological health, we used the change between post intervention and baseline mindfulness to predict the same change in depression, anxiety, and stress according to the information provided by each RCT. Given that we are interested in understanding how baseline profiles affect treatment outcome, in this second step we also include the baseline scores of the dependent variable. For instance, if we are predicting a change in depression score, we also use baseline depression as predictor.

We evaluated baseline mindfulness over individual treatment trajectories in two steps using multiple linear regression. For the first step, we used the change in mindfulness measurements (post minus baseline) available in each RCT as dependent variable and baseline mindfulness scores as predictor. We also included intervention (Mindfulness/Control) as independent variable with an interaction with baseline score. For the second step, we use mental health by means of depression, anxiety, and stress change (post minus baseline; according to RCT availability) as dependent variable. As predictors we included the baseline score of the dependent variable, mindfulness change, and the intervention. Given that the FFMQ present many subscales, we only evaluated the interactions of the change in FFMQ subscales with the baseline score once the model was pruned. We did not evaluate interactions between FFMQ subscales. The same analyses reported for post-treatment scores were also performed with the follow-up data using baseline scores as reference. The procedure was performed independently for all three RCTs: University Students (University-MBCT), School Students (School-MiSP), and first psychotic episode patients (Psychosis-MBCT; see **Table 1** for details).

All tests were evaluated for multicollinearity using the variance inflation factor (VIF). Considering models without interactions, we regarded variables with a VIF < 3 as independent regressors. If VIF > 3, variables were tested separately and the model with the highest R squared was reported. Models were pruned using the backward method. Finally, for the mental health regression models we reported squared R for the full model reported and only using baseline score of the mental health variable evaluated.

In order to facilitate the contrast with the classic analytic approach we also reported all RCT results using Mixed ANOVA with Measurement (Pre, Post) as within participant's variable and Group (Control, Mindfulness) as between participants' variables. We reported averages and standard deviations of all four conditions, sample sizes as well as *p*-values for Group, Measurement, and the interaction. We also included generalized eta squared as effect size index (η^2G; small: 0.01 – $<$ 0.06; medium: 0.06 - $<$ 0.14; large: $\geq$ 0.14; range: [0,1]). All analyses were performed using R (R Core Team, 2019). Plots were performed using ggplot2 (Wickham, 2016), linear modeling diagnostics were assessed using car (Fox and Weisberg, 2011), and mixed ANOVAs were performed using ez (Lawrence, 2016).

RESULTS

Assessing Classic Randomized Controlled Trial Results

When assessing classic RCT analysis results, we can observe how Psychosis-MBCT and School-MiSP presented significant changes in mindfulness which can be attributed to mindfulness interventions. However, this was not the case for the University-MBCT. When we examine in detail the effects of mindfulness intervention on Psychosis-MBCT (**Table 2**), we can notice that for all the impacts are detected through interactions. These interactions depict a masked effect over Group variable; while Control group reduces its mindfulness scores post intervention, Mindfulness interventions increase those scores, meaning that the intervention is working as expected on that regard. The same pattern is Observed for the School-MiSP. For the University-MBCT the same pattern is observed, however, the effect is remarkably low, which produced non-significant results.

When assessing the impact over mental health, we found significant effects of the intervention only for Psychosis-MBCT and School-MiSP. In general, both interventions improve mental health, observed by significant and tendency ($p < 0.1$) results in Measurement (**Table 2**). The only impacts observed due to the mindfulness intervention, are observed in School-MiSP for depression, anxiety, and stress. **Table 2** shows how depression increased in Control group, while decreased in

TABLE 2 | Mixed ANOVA results for the three RCTs.

Sample	Scale	Subscale	Tau			Mindfulness			Group p (η^2g)	Measurement p (η^2g)	Interaction p (η^2g)
			Pre *M* (±SD)	Post *M* (±SD)	n	Pre *M* (±SD)	Post *M* (±SD)	n			
Psychosis MBCT	FFMQ	Observe	27.79 (±5.09)	24.07 (±7.18)	14	25.4 (±5.91)	26.8 (±6.79)	20	0.929 (≈0)	0.521 (0.003)	0.027 (0.041)
		Describe	26.57 (±5.47)	23.64 (±4.18)	14	25.47 (±5.52)	28.05 (±7.02)	19	0.37 (0.021)	0.784 (≈0)	0.004 (0.056)
		Act Aware	23.71 (±7.02)	26.57 (±5.71)	14	23.75 (±4.53)	24.55 (±6.01)	20	0.556 (0.008)	0.148 (0.021)	0.369 (0.008)
		Non-judge	23.71 (±8.04)	23.93 (±6.39)	14	21.3 (±7.15)	23.75 (±6.13)	20	0.528 (0.009)	0.239 (0.013)	0.394 (0.007)
		Non-React	22.86 (±4.67)	20.36 (±4.62)	14	20.9 (±3.35)	23,0 (±3.95)	20	0.756 (0.002)	0.821 (0.001)	0.017 (0.075)
		Total	124.64 (±18.49)	118.57 (±14.42)	14	117.26 (±16.54)	126.89 (±20.6)	19	0.933 (≈0)	0.319 (0.007)	0.013 (0.048)
	DASS 21	Depression	6.27 (±5.61)	4.2 (±5.44)	15	6.68 (±5.32)	4.82 (±5.58)	22	0.735 (0.002)	0.065 (0.032)	0.923 (≈0)
		Anxiety	5.73 (±4.62)	3.27 (±5.11)	15	6.32 (±5.27)	5.32 (±6.21)	22	0.419 (0.015)	0.059 (0.022)	0.383 (0.005)
		Stress	6.47 (±5.21)	4.13 (±5.25)	15	6.95 (±4.82)	5.27 (±6.08)	22	0.596 (0.006)	0.048 (0.033)	0.738 (0.001)
SchoolMiSP	CAMM		30 (±7.67)	28.07 (±6.78)	73	25.02 (±7.06)	28.17 (±6.99)	41	0.022 (0.025)	0.908 (≈0)	0.008 (0.027)
	DASS 21	Depression	6.93 (±6.40)	10.48 (±7.01)	73	11.59 (±7.54)	8.24 (±6.28)	41	0.216 (0.007)	0.218 (0.006)	2.18e-04 (0.056)
		Anxiety	7.37 (±7.01)	11.08 (±7.78)	73	13.24 (±8.53)	9.46 (±7.88)	41	0.045 (0.017)	0.324 (0.004)	6.81e-04 (0.052)
		Stress	5.78 (±5.79)	8.38 (±6.38)	73	10.73 (±7.80)	7.76 (±7.17)	41	0.026 (0.024)	0.472 (0.002)	0.0016 (0.039)
University MBCT	AAQII		32.45 (±6.23)	30.9 (±8.88)	20	32.84 (±7.47)	33.16 (±6.76)	19	0.535 (0.008)	0.555 (0.001)	0.391 (0.004)
	BDI		3.3 (±2.87)	3.15 (±2.98)	20	3.32 (±3.64)	3.05 (±2.55)	19	0.963 (≈0)	0.604 (0.001)	0.886 (≈0)

Effect sizes (η^2g) < 0.0001 are denoted as ≈0, meaning a negligible effect.

mindfulness group. The same pattern can be observed for anxiety and stress (**Table 2**). Together, this results support that mindfulness interventions can be beneficial. Nonetheless, there is great variability on intervention outcomes, which motivated to evaluate how baseline scores may impact over participants' trajectories.

Baseline Mindfulness and Mindfulness Change

Globally, participants with higher baseline mindfulness scores exhibit fewer changes in Mindfulness scores (**Figures 1A–C**). Consistently for all RCTs and mindfulness scales used during post-intervention and follow-up, baseline mindfulness score is a significant predictor of mindfulness change (**Table 3**). Most regressions explained about 60–75% of the variance in all these conditions. Notably, Adjusted R^2 values are high even in those models where the baseline score is the only regressor. Baseline scores alone can account for 28–76% of data variability. This suggests that baseline scores can explain a large proportion of mindfulness change variability and up to three quarters of total change variability. In global terms, results are consistent despite differences in terms of mindfulness instruments, sample characteristics, control groups, sample sizes, and moment of change assessment.

For the Psychosis-MBCT sample with respect to post intervention changes, Treatment as Usual (TAU) increases about one point on the same scale compared to TAU with mindfulness. This suggests that mindfulness change is not only derived from mindfulness interventions and that, in this case, TAU was more effective in increasing this facet of Mindfulness. In the same sample, also regarding post intervention change, FFMQ Non-Judge exhibited a main effect of treatment with a significant interaction. The interaction is reflecting the different slope between TAU and TAU + Mindfulness, between baseline FFMQ and Non-judge, and between post change FFMQ and Non-judge. Participants with lower baseline scores in this FFMQ facet exhibit similar changes, while participants with high scores in the same facet exhibit higher increments in TAU compared with TAU + Mindfulness. This tendency is also observed in global FFMQ score (**Figure 1A**). This tendency of mindfulness treatment to reduce increases in mindfulness is also observed in the School-MiSP sample at follow-up, when Mindfulness exhibited a significant negative effect joined by a significant interaction. This interaction reflects the same effect described above, where differences in signs are due to using Mindfulness

instead of control group as reference. So, independently of the sample and the moment when the treatment impacts on Mindfulness change, the Mindfulness treatment group presented less change compared to the control groups.

Assessing Depression, Anxiety, and Stress Change

In this second step of linear modeling, we used the dependent variable baseline score as predictor of itself. For instance, we used baseline stress to predict the change in stress. We also included the treatment and the change in mindfulness scores as regressors. All regression models indicated that the baseline scores were significant (**Table 4**). Overall, the higher the score, the higher the reduction in such score (**Figures 1D–F**). Most regression models explained about 70–85% of the change in dependent variables. Including Group and change in mindfulness related variables increase the explained variance of these models 8.7% on average (SD: 5.9), with a maximum of 19% and a minimum of 1%, meaning that baseline scores explain far more variability than intervention itself. The effect of baseline scores was consistent regardless of sample characteristics, control group differences, sample sizes, and moment of change assessment.

Regarding the contributions of mindfulness change, in all School-MiSP's models, at post-intervention and follow-up, it had a positive effect reducing the scores. The only exception was the University-MBCT sample, which did not exhibit any significant differences that can be attributed to the change in the AAQ-II. Importantly, many of the regression models which revealed a main effect of mindfulness change also had interactions. These main effects can be interpreted as population average differences, while the interaction indicates a difference in slopes. Thus, a negative interaction means that MT treatments resulted in a stronger association between baseline scores and change in those scores compared to the Control group, meaning that participants exhibited more MT change even when controlling for baseline.

For the Psychosis-MBCT at Post-intervention, FFMQ observe had a beneficial effect on stress and depression change after controlling for the baseline scores of both. For anxiety, FFMQ act aware exhibited a beneficial effect. At Follow-up, only depression had an effect besides baseline scores, along with treatment (with an interaction effect). For the School-MiSP sample, we found that a change in CAMM was a significant predictor of post intervention changes in stress, depression, and anxiety. Only depression did not present an interaction, supporting the view that the effect of baseline depression scores on post-intervention depression scores was independent of the intervention conducted. Importantly, the CAMM change during the interventions only predicted stress change at follow-up after controlling for stress baseline scores.

DISCUSSION

The results presented in this article highlight the critical role of the participants' pre-MBI status. Our results indicate that at least two thirds of the change produced by these interventions in terms of mindfulness scores and depression, stress, and anxiety can be predicted by the baseline scores of the same variables. We also found in some subscales that trajectories are not only strongly influenced by the initial status of the participants, but also by the intervention performed, as seen in the significant interactions found. This results support the relevance of considering baseline scores as key elements to understand the individual trajectories of participants, in contrast with only considering population proxies such as average change.

Even more interesting, is the fact that classic approach did not present consistent results with the linear regression models. This means, that once the major source of variance is controlled (initial status of the participant), then treatment efficacy should be addressed. For instance, FFMQ's observe subscale presented a significant interaction suggesting an impact of both, Group and Measurement (**Table 2**). However, Treatment was not a significant regressor when controlling by baseline scores of FFMQ's observe subscale (**Table 3**). Conversely, FFMQ's non-judge subscale presented no effect by means of the mindfulness intervention using the classic approach, but it did present a significant contribution when considering the baseline scores of participants. As such, assessing the baseline scores is not only a matter of considering participants' trajectories, but also to control adequately confounding variables which may explain RCT outcomes. This means that considering baseline scores represent a methodological concern as well.

Considering that we only assessed the baseline scores of the variables that we wanted to predict (i.e., Mindfulness, depression, anxiety, and stress), it is critical to consider other potential aspects which may have driven participants' trajectories. For instance, mindfulness has been positively associated with positive affectivity and conscientiousness, and inversely related to neuroticism and negative affectivity (Borynski, 2007; Fetterman et al., 2010). Lee and Bowen (2015) found that four of the five personality factors of the Toronto Mindfulness Scale (TMS) (Lau et al., 2006) (i.e., Conscientiousness, Extraversion, Agreeableness, and Neuroticism) were significantly associated with Decentering of mindfulness at baseline. Even attachment style has been proposed as a relevant element of participants' trajectories (Cordon et al., 2009). Despite this evidence, interventions are designed and applied without considering how inter-individual differences may play a critical role in patients' trajectories during an intervention.

Participants' Trajectories

One of the possible reasons behind the neglect of trajectories in the literature is the traditional way in which RCTs are analyzed. In **Figure 1**, we included as insert the traditional plot which presents the before and after scores divided by intervention. As **Figure 1** show, it is not possible to infer the association presented in the scatter plots. The main reason is that we assume that an eventual global drop in a boxplot is due to fairly similar changes in all the participants. This bias has been methodologically challenged and considered to be a limitation of the classic mixed ANOVA approach (Barr et al., 2013). Our results, in contrast, suggest that some participants exhibit huge changes while others show minor ones, with some even undergoing negative changes (i.e., undesired effects). Therefore,

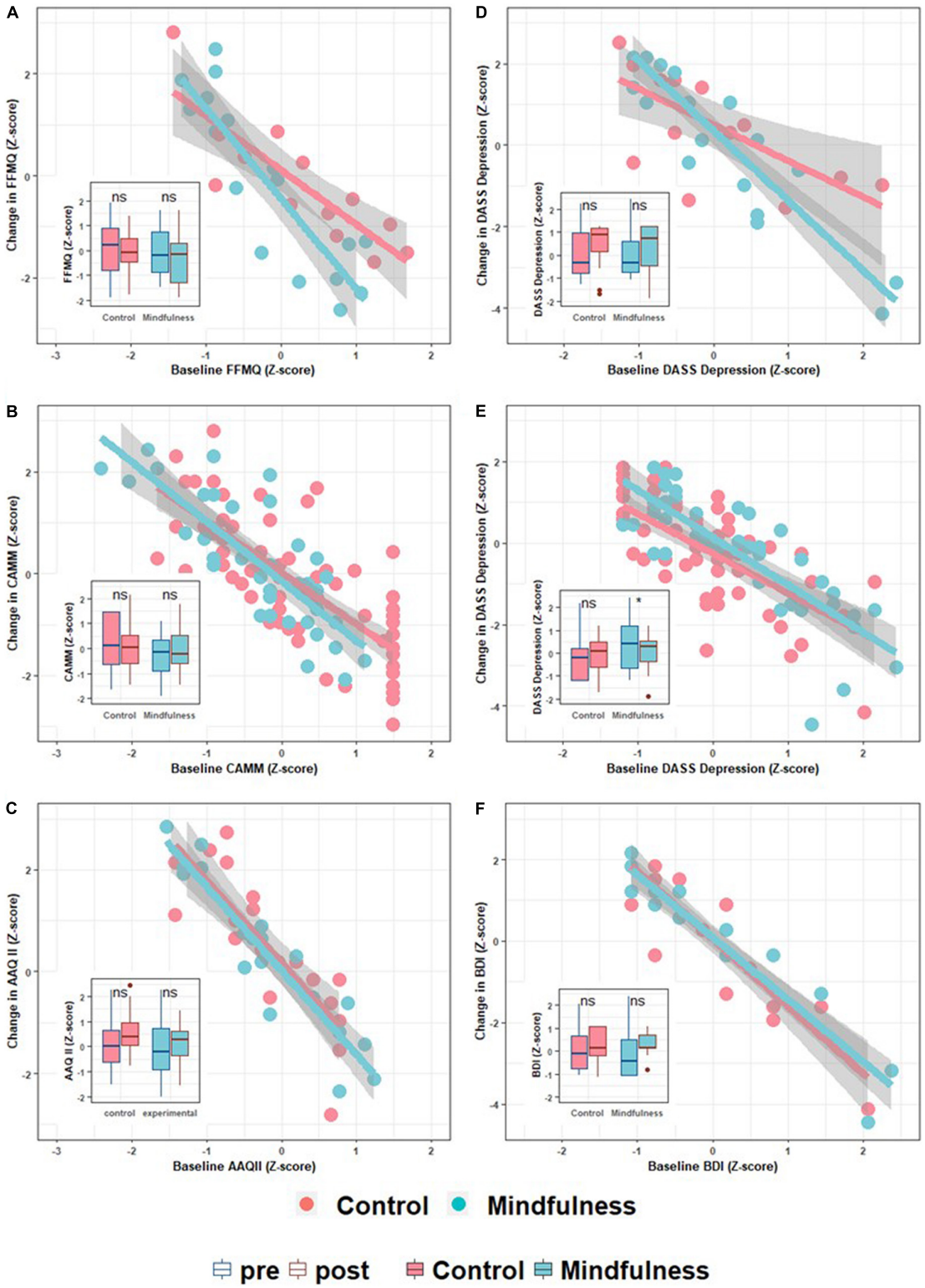

FIGURE 1 | Scatter and boxplots depicting intervention effects. In the scatter plots, the *x*-axis represents the baseline value for a specific variable, while the *y*-axis represents its change (Δ) post intervention. The first column of the panel plots **(A–C)** are mindfulness-related variables, while the second **(D–F)** are psychopathology severity scores. Each row refers to a different sample. The first row is the Psychosis-MBCT sample **(A,D)**, the second row is the School-MiSP sample **(B,E)**, and the last row corresponds to the University-MBCT sample **(C,F)**. All plots are complemented by a boxplot inset depicting group pre- and post-intervention changes. This allows us to present both the participants' trajectories (scatter plots) and the common group-based analytic approach (contrasting averages).

TABLE 3 | Summary of mindfulness multiple linear regression models.

RCT	Change moment	Dependent variables	Baseline score of dependent variable	Treatment: MT	Interaction	Adjusted R^2
Psychosis-MBCT	Post	Δ Observe	−1.54 (±0.19)***			**0.65**
		Δ Describe	−1.67 (±0.15)***	−0.84 (±0.27)**		**0.78**
		Δ Act Aware	−1.38 (±0.17)***			**0.65**
		Δ Non Judge	−1.72 (±0.26)***	−0.70 (±0.32)*	−0.94 (±0.34)*	**0.60**
		Δ Non react	−1.34 (±0.13)***			**0.76**
	Follow-up	Δ Observe	−1.58 (±0.19)***			**0.75**
		Δ Describe	−1.27 (±0.17)***			**0.71**
		Δ Act Aware	−1.43 (± 0.26)***			**0.52**
		Δ Non Judge	−0.91 (± 0.29)**			**0.28**
		Δ Non react	−0.85 (±0.18)***			**0.48**
School-MiSP						
	Post	Δ CAMM	−1.08 (±0.08)			**0.61**
	Follow-up	Δ CAMM	−1.25 (±0.12)***	−0.51 (±0.19)**	−0.55 (±0.19)**	**0.75**
University-MBCT						
	Post	Δ AAQ-II	−1.69 (±0.15)***			**0.75**
	Follow-up	Δ AAQ-II	−1.7 (±0.22)***			**0.70**

*Regression coefficients are presented for each dependent variable. We evaluated the interactions between intervention groups and baseline scores. Blank cells represent tested variables that were removed during pruning. All dependent variables are changes obtained from the subtraction of Post/Follow-up scores from the baseline (Δ). *p < 0.05, **p < 0.01, ***p < 0.001.*

the traditional results report neglects individual trajectories, masking the diversity of trajectories found across participants.

Overall, our results indicate that the initial status of participants is critical to the outcome, regardless of the population sampled and the mindfulness instrument used. In general terms, the participants who had the lowest baseline mindfulness scores improved the most. Similarly, those with the highest stress, depression, and anxiety scores showed the highest drops in symptomatology. These results reflect a room for change phenomenon, as people with the most severe symptoms or the lowest mindfulness scores, depending on the score analyzed, have more room for improvement. Paradoxically, these improvements may lead them to outperform people who started in better conditions. Even more critically, those who start with the lowest symptomatology (or highest mindfulness scores), may even worsen their scores. Importantly, this is a description of what we observed on the results, the actual causes of how and why occurs this phenomenon still required further research to be understand and use in favor of better interventions.

Mindfulness interventions have been widely reported to be beneficial (Shonin et al., 2013; Khoury et al., 2015; Tang et al., 2015; Carsley et al., 2018; Steinebach and Langer, 2019) therefore, our analytic approach should capture these population-level effects which neglect individual trajectories. Under our analytic approach, which considers baseline scores, the population impact of mindfulness, regardless of individual trajectories, is mainly depicted through interactions. These interactions allow us to model a differential slope between mindfulness and control groups (hence the population rationale) with respect to the relation between baseline scores and changes in post-intervention scores. Our results support prior evidence for the benefits of mindfulness, as we found for some subscales linear regression Group effects' and interactions indicating that the trajectory of participants was more beneficial in the mindfulness group compared to controls. This means that, as group average, mindfulness interventions are likely better than the controls. Nonetheless, mindfulness interventions presented a minor impact over the variability of mental health change post intervention (8.7% ± 5.6 of explained variance difference), indicating low benefits.

External Validity: Samples, Instruments, and Interaction

We are not the first group to evaluate the potential contribution of baseline scores to intervention outcomes in RCTs (Shapiro et al., 2011; Tortella-Feliu et al., 2020). The novelty of this study is that it evaluates the role of baseline mindfulness considering interactions while also viewing mindfulness change during interventions as a trigger of their benefits. We also used different populations and different mindfulness instruments. Considering the interaction with treatment, as above mentioned, was relevant to reveal the differences between groups outcomes. This allowed us to detect the widely reported beneficial effect of mindfulness while also including other predictors to tackle individual differences in participants' trajectories. Changes in mindfulness were also a relevant predictor of changes in symptomatology, indicating that it is the trajectory rather than the raw score that we should take into account when trying to predict participants' improvement.

The most relevant difference across the samples used was found in the University-MBCT sample, which used the AAQ-II. In this sample, we observed no relevant contributions of AAQ-II change to BDI change at post-intervention and follow-up. Thus, for this sample, changes during the intervention cannot be attributed to changes in the AAQ-II. In this regard, it is relevant to consider that, despite the widespread use of the AAQ-II as a measure of experiential avoidance (EA) which

TABLE 4 | Summary of mental health multiple linear regression models.

RCT	Change moment	DV	Baseline score of DV	Δ Observe	Δ Describe	Δ Act Aware	Δ Non-judge	Δ Non-react	Treatment: MT	Interaction	Adjusted R^2 (M.H.)	Adjusted R^2 (M.H. and Mind.)
Psychosis-MBCT	Post	Δ Stress	−1.65 (±0.18)***	−0.24 (±0.10)*							**0.66**	**0.72**
		Δ Depression	−1.49 (± 0.16)***	−0.17 (±0.08)*							**0.66**	**0.72**
		Δ Anxiety	−1.54 (±0.15)***			−0.27 (±0.10)*					**0.75**	**0.80**
	Follow-up	Δ Stress	−1.33 (±0.20)***								**0.67**	**NA**
		Δ Depression	−2.15 (±0.20)***			0.20 (±0.08)*			−0.48 (±0.28)	−1.13 (±0.28)***	**0.72**	**0.85**
		Δ Anxiety	−1.35 (0.13)***								**0.81**	**NA**
			Baseline score of DV	**Δ CAMM**					**Treatment: MT**	**Interaction**		
School-MiSP	Post	Δ Stress	−0.60 (±0.11)***	−0.47 (±0.06)***	NA	NA	NA	NA	0.24 (0.15)	−0.31 (±0.15)*	**0.56**	**0.72**
		Δ Depression	−0.77 (±0.09)***	−0.41 (±0.06)***	NA	NA	NA	NA	0.42 (±0.16)*		**0.53**	**0.65**
		Δ Anxiety	−0.52 (±0.11)***	−0.47 (±0.06)***	NA	NA	NA	NA	0.29 (±0.16)	−0.31 (±0.15)*	**0.48**	**0.67**
	Follow-up	Δ Stress	−0.95 (0.12)***	−0.32 (±0.06)***	NA	NA	NA	NA	−0.05 (±0.15)	−0.31 (±0.14)*	**0.81**	**0.86**
		Δ Depression	−1.16 (±0.10)***	−0.24 (±0.06)***	NA	NA	NA	NA			**0.77**	**0.81**
		Δ Anxiety	−1.22 (0.10)***	−0.17 (±0.06)**	NA	NA	NA	NA			**0.81**	**0.82**
			Baseline score of DV	**Δ AAQ-II**					**Treatment: MT**	**Interaction**		
University-MBCT	Post	Δ BDI	−1.5 (±0.10)***		NA	NA	NA	NA			**0.86**	**NA**
	Follow-up	Δ BDI	−1.57 (±0.12)***		NA	NA	NA	NA			**0.87**	**NA**

Regression coefficients are presented for each dependent variable. We evaluated the interactions between intervention groups and baseline scores. Blank cells represent tested variables that were removed during pruning. NA stands for does not apply, meaning that those variables were not tested. All dependent variables are changes obtained from the subtraction of Post/Follow-up scores from the baseline (Δ). In this case, mindfulness predictors are also changes (Δ) produced in the same period of time as the one used in dependent variables. Two adjusted R2, where M.H. stands for baseline of mental health variables as predictors, and M.H. and Mind. stands for R2 including changes in mindfulness and Group as predictors.
$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

correlates with mindfulness (Fledderus et al., 2012), EA has been conceptualized as the opposite of acceptance. Nevertheless, it has been criticized on the grounds that it does not adequately discriminate constructs like neuroticism or general distress (Valencia, 2019).

Despite this difference with the AAQ-II, our results, and those found previously (Shapiro et al., 2011; Harnett et al., 2016; Tortella-Feliu et al., 2020), can most likely be generalized regardless of the sample characteristics and the instrument used to measure mindfulness. Our results support the view that an instrument more closely related to the global construct of mindfulness than the AAQ-II is required to obtain these results. Critically, the impact of baseline scores on trajectory was found in a range of samples from large (such as our School-MiSP sample) to small [such as that of Tortella-Feliu et al. (2020) or our Psychosis-MBCT sample]. In fact, when observing **Figure 1**, the small amount of noise on this association is quite evident, which is also reflected in high adjusted R2 values (**Tables 3**, **4**).

Considering Trajectories During Intervention Planning

Our results support that neglecting initial status of participants is a relevant source of variability which impacts the outcome of intervention. The interventions presented here were beneficial for the population, however, results support that using averages kept us blind to individual phenomena relevant for the outcomes. Even more, it presents how artifactual results can be obtained if ignoring initial participants status. Given these results, it is mandatory to consider individual trajectories at least using initial status of the participants.

Concretely, our results have direct implications for interventions in clinical and non-clinical contexts. In this regard,

given that the Mindfulness trait has been reported to be relatively stable (Rau and Williams, 2016), it is relevant to assess dispositional mindfulness as a part of the standard application of MBIs as well as other psychosocial interventions that have shown to increase mindfulness skills (Xia et al., 2019). Thus, group set up criteria should not only consider participants' diagnosis but mainly their dispositional mindfulness and the severity of their symptomatology.

The above considerations can help to generate a tailored intervention while also yielding relevant information for the instructor to guide the intervention group. This can allow the instructor to keep a steady pace by supporting the trajectories of participants with a homogeneous level of mindfulness skills and symptomatology severity. Otherwise, the progress of participants with higher skills and low symptomatology could be diluted, eventually causing them to drop out of the intervention.

In this regard, given our results, it is questionable whether the frequency and duration of mindfulness interventions can be standard for all participants. Thus, short interventions may be appropriate for people with high dispositional mindfulness and mild symptomatology (Howarth et al., 2019), while vulnerable or specific populations may require more support (Langer et al., 2020).

Limitations

Despite the many virtues of our samples from three different RCTs, the procedure presented in this article also has some relevant caveats. The most obvious one is that our results are derived from experimental designs which were not produced to evaluate the impact of baseline status on intervention outcomes. In consequence, there is no proper follow-up during and after the intervention, besides the usual approach. For instance, we do not know if people who had high mindfulness and whose score dropped post-intervention actually experienced a worsening of their situation or if they realized that they were not as mindful as they initially reported. We lack qualitative data supporting insights into these trajectories, which limits the potential measures to be taken in future interventions. Therefore, we advise caution when implementing the suggestions presented above. Our results do support the view that intervention participants have diverse trajectories; however, more research and close follow-up is required to produce exhaustive and safe recommendations capable of informing a personalized approach. Apart from these aspects, the heterogeneity of our samples is a virtue in terms of external validity. Nonetheless, our results are not exactly the same for all the samples, and the reasons for minor discrepancies are obscured by differences in sample characteristics and size. This introduces interpretative and statistical noise which limits the scope of our conclusions. Despite these limitations, this study confirms the need to continue doing research in a way that considers the diversity of participants' trajectories, expanding the room we have for intervention improvements informed by a more personalized approach to treatment.

DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University-MBCT (Doctoral thesis AIL; research group HUM 760, Almeria University), School-MiSP (project no 82130055: Faculty of Psychology of the Pontificia Universidad Católica de Chile), Psychosis-MBCT (project no 11150846; National Health Service in Valdivia). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RV and ÁL: conceptualization. RV: methodology and formal analysis. EL-P: data curation. RV, CB, and ÁL: writing—original draft preparation. RV, CB, EL-P, CS, and ÁL: writing—review and editing. CS: funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Effectiveness of mindfulness-based interventions on empathy: A meta-analysis

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Empathy is essential for human survival and social interaction. Although mindfulness-based interventions (MBIs) have been used to improve empathy in healthy populations, its therapeutic efficacy remains unknown. This study aims to investigate the therapeutic effects of MBIs on empathy in a healthy population and the potential factors affecting the efficacy of MBIs. The literature search focused on PubMed, Embase, Web of Science, Cochrane Library, and CNKI from inception to September 2022. Randomized controlled trials and quasi-experimental studies reporting the effects of using MBIs on empathy in healthy populations were included. A total of 13 studies were included in this review. Results of the meta-analysis showed that MBIs improved empathy (SMD, 0.372, 95% CI, 0.164–0.579, $p = 0.001$) in the healthy population compared with that in the control group. Moreover, results of the subgroup analysis showed that intervention dose (over 24 h vs. under 24 h), format (online vs. offline), and types (different types) were important factors affecting treatment outcomes. This comprehensive review suggests that MBIs are effective treatment for empathy in healthy population. Future research should markedly focus on large-sample, rigorously designed experiments to explore the long-term effects of MBIs on empathy and to elucidate the underlying mechanisms of MBIs. This study provides a reference for the daily application of MBIs.

KEYWORDS

mindfulness, empathy, meditation, randomized controlled trial, meta-analysis

Introduction

Empathy is the ability to share and understand the inner state of others, enabling us to care for them, share knowledge, and work together to achieve goals (Preston and De Waal, 2017). Empathy is essential for understanding the cognitive and emotional processes of others in social settings (Keuken et al., 2011; Krall et al., 2016; Yang et al., 2018). In particular, empathy enhances emotional well-being (Morelli et al., 2015),

greater social relationships (Morelli et al., 2017), and better social health (Zaki, 2020). Empathy also facilitates helping behavior, cooperation, and altruism (Feldmanhall et al., 2015). Impaired empathy is manifested by lacking understanding of the pain and plight of others, difficulty to be impressed, and appearing indifferent in real life, which is common in many psychiatric disorders (Decety and Moriguchi, 2007; Bragado-Jimenez and Taylor, 2012; Schreiter et al., 2013) and chronic pain (Sohn et al., 2016; De Tommaso et al., 2019; Ma et al., 2020; Mu et al., 2021; Zhang et al., 2021).

Although the general population around us are in good physical health, the empathy might be impaired for various reasons, such as stress, workplace violence, and lack of interpersonal interaction. Park et al. (2015) evaluated the relationships between stress and empathy, and found that the two were negatively correlated. Too much stress may be damaging empathy. The overuse of smart technology has led to a lack of interpersonal interaction among college students, and their empathy has declined significantly over the past decades (Konrath et al., 2011). Impaired empathy leads to be indifferent and difficulty in being moved in real life, further affecting normal daily interactions. The empathy of residents and nurses has also been impaired owing to the specificity of their professions. When confronted with the same pain stimulus, physicians rated pain intensity lower, but instead evoked higher emotional stress and empathic fatigue (Gleichgerrcht and Decety, 2014). A meta-analysis study showed that the empathy of clinical nurses also declined over time (Yi et al., 2021). Not only physicians and nurses, but also medical students showed a changing trend in pain empathy, with a significant decrease in empathy as the grade level increased (Neumann et al., 2011; Youssef et al., 2014; Wang et al., 2019). The impaired empathy of residents and nurses may lead to a lack of effective communication between them and their patients, thereby possibly leading to doctor-patient disputes and conflicts. Hence, we need an economical and efficient way to help people with poor empathy or prevent empathy from being damaged.

Mindfulness is a process of consciously engaging in the experience of the present moment (Creswell, 2017), and cultivating awareness of the present moment may help to change deeply ingrained cognitive patterns (Davis and Thompson, 2013). In recent years, mindfulness-based interventions (MBIs) have attracted considerable interest as a safe and effective integrative treatment. Consequently, there has been a significant increase in the number of randomized controlled trial studies on MBIs (Creswell, 2017). MBIs have multiple forms of intervention, such as mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), mindfulness-based relapse prevention (MBRP), Internet and smartphone application mindfulness interventions, and other techniques incorporating mindfulness training (e.g., mindfulness meditation training, dialectical behavior therapy, and integrative body-mind training) (Creswell, 2017). MBIs have been used as a treatment for improving empathy (Can Gür and Yilmaz, 2020; Chen et al., 2021; Orosa-Duarte et al., 2021) and the results are usually positive.

In recent years, there has been a growing trend of meta-analyses in empathy, and most articles have discussed changes in empathy in certain diseases (Coundouris et al., 2020; Vucurovic et al., 2020; Pittelkow et al., 2021; Wright et al., 2021) or particular occupational groups (Abramson et al., 2020; Costa-Drolon et al., 2021; Yi et al., 2021). The evidence above has shown that empathy is impaired in many populations, but meta-analysis studies on how to improve empathy are limited. Some meta-analyses have proposed the use of non-invasive brain stimulation to improve empathy, but it is not convenient enough and is difficult to promote in the general population (Yang et al., 2018; Bahji et al., 2021). Several scholars have demonstrated the effectiveness of meditation for empathy improvement through meta-analysis. Luberto et al. (2018) explored whether or not meditation practices can be used to cultivate prosocial outcomes. The results identified were compared with the blank control or wait-list group, and improvements of empathy, compassion, and prosocial behaviors after meditation intervention are small to moderate. Another research by Kreplin et al. (2018) examining meditation interventions on prosociality in healthy adults has shown that the effect of meditation intervention on compassion and empathy is significant. Mindfulness-based interventions (MBIs) are important part of meditation. Mindfulness-based practices are widely found to have several benefits, including reducing stress, anxiety, and depression, and improving attentional focus, interpersonal relationships, and well-being (Astin, 1997; Brown and Ryan, 2003; Davidson et al., 2003; Kersemaekers et al., 2018; Slutsky et al., 2019). Fox et al. (2014) found that mindfulness meditation may lead to changes in brain structure and function related to emotion regulation, attention, and memory. Empathy might be improved in this way.

To the best of our knowledge, no studies have conducted a meta-analysis of the effect of MBIs on the improvement of empathic abilities. Thus, this study aimed to verify the effects of MBIs on empathy in general populations. Moreover, we explored whether or not the effects of the intervention were related to intervention dose, intervention form, intervention type, occupation, and family practice. We hypothesized that MBIs would have a larger pooled effect on empathy than the control group.

Materials and methods

Protocol and registration

The protocol was registered on PROSPERO (https://www.crd.york.ac.uk/prospero/) with registration number

CRD42022315762. This meta-analysis was reported in line with the PRISMA guidelines and are shown in Supplementary material 1.

Literature search

To identify articles for inclusion in the quantitative analysis, we searched the following databases for relevant studies from the initial availability date to September 2022: (1) Web of Science, (2) EMBASE, (3) Cochrane Library, (4) PubMed and (5) CNKI. The following keywords were searched: "empathy," "mindfulness," and "meditation." No language restrictions were imposed. The search strategy is described in the Supplementary materials 2.

Eligibility criteria

An initial screening of the articles retrieved from the electronic databases was first performed independently by two individuals (i.e., Z-YH and Y-RW). After removing duplicates, titles and abstracts were screened, and articles that did not meet the inclusion criteria were excluded. If relevance was not clear, the full text was read. After screening by two authors, the results will be checked and articles with discrepancies will be resolved through discussion. Agreement of included studies before reaching consensus can be quantified by using kappa statistics (Orwin and Vevea, 2009). If the consensus can't be reached, then the corresponding author will decide whether or not the article meets the inclusion criteria. Detailed inclusion criteria are as follows.

1) Types of participants: Healthy adults (over 18 years), any gender; children or adolescent were excluded; and disease or animal studies were excluded.
2) Types of studies: Parallel or crossover randomized controlled trials (RCTs) or quasi-experimental design.
3) Types of interventions: Mindfulness-based interventions of any type (e.g., MBSR, MBCT).
4) Types of outcome measures: Outcome measures included empathy.
5) Control group: No intervention or waiting list.
6) Studies must contain raw data of interest outcomes or can be extracted from figures and tables.

Exclusion criteria are as follows:

1) Studies published in the form of conference abstracts, case reports, and books.

Data collection

Data extraction for each selected study was completed independently by two evaluators (i.e., Y-TL and JS), and reviewed and revised thereafter by the corresponding author. If the RCTs contained more than two arms, then we collected data from the separate treatment arms. A standard information extraction form was jointly designed by the two evaluators and contained the following aspects: (1) basic information: author, publication year, country of origin; (2) basic characteristics of subjects: occupation, gender, age, sample size, compliance, results; (3) study design: RCTs or quasi-experimental design; (4) intervention and control group parameters: intervention type and format, duration, frequency, and home practice; and (5) outcome assessment: empathy on the baseline and post-therapy with the outcome variables.

If the outcome was expressed only as a graph, then the software Engauge Digitizer 10.8 (Mitchell et al., 2017) (http://markummitchell.github.io/engauge-digitizer/) was used to extract the required data. When the raw data cannot be sufficiently extracted, we contacted the authors of the studies to provide them. RevMan 5.3 calculator was used to convert data to means and SDs when standard errors (SEs), confidence intervals (CIs), or IQRs were supplied rather than means and SDs.

Risk of bias

The methodological quality of each included study will be determined by two authors (i.e., Y-FW and Z-HY) using the Cochrane Risk of Bias tool (Higgins Jpt, 2011). Factors assessed are as follows: (1) random sequence generation; (2) allocation concealment; (3) blinding of participants, outcome assessors, and investigators; (4) incomplete outcome information; (5) selective outcome reporting; and (6) other potential sources of bias. The studies will be judged as low, high, and unclear risk bias based on these factors. Before reaching the consensus, agreement of risk bias will be quantified by kappa statistics (Orwin and Vevea, 2009). Then, the two assessors will reach a consensus through discussion if they have any differences for the risk of bias of these studies. When a consensus cannot be reached between the two evaluators, the corresponding author will give his opinion and consensus of the majority will be adopted.

Data synthesis and analysis

Meta-analysis was performed using Stata v17.0 software (StataCorp, Texas, US) with the metan command. We applied standardized mean differences (SMD) and 95% confidence intervals (CI) to evaluate the effect of MBIs on empathy outcome. Moreover, 95% CI was used to assess dichotomous variables, and $p < 0.05$ was considered a statistically significant

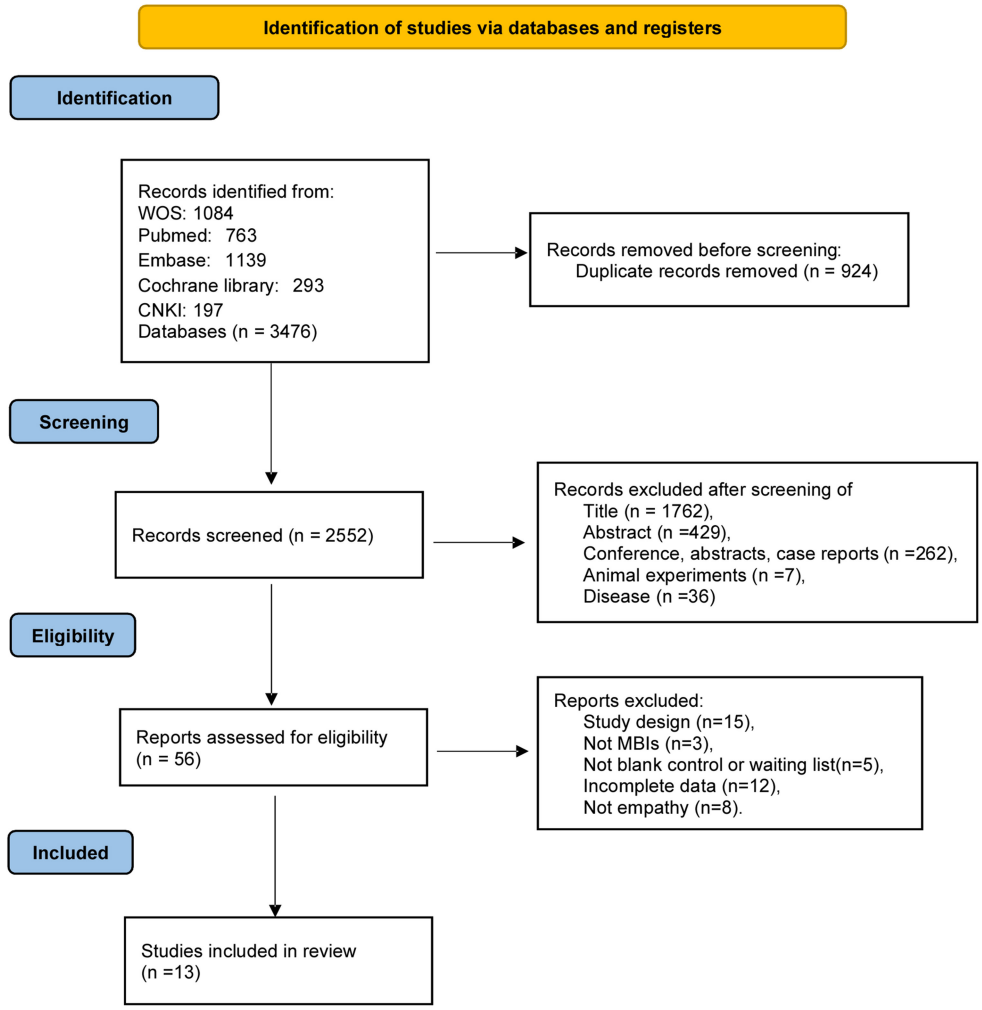

FIGURE 1
PRISMA flow chart of study selection.

difference. I^2 statistic (Higgins et al., 2003) was used to assess whether or not heterogeneity exists between studies. If a high degree of heterogeneity was observed (e.g., $I^2 > 75\%$), then meta-analysis will no longer be performed. Sensitivity analyses will be performed when appropriate to investigate the reasons for heterogeneity. Fixed and random effects models will be used if $I^2 < 50\%$ and $I^2 > 50\%$, respectively. We assessed potential publication bias using funnel plots, and the extent of asymmetry was assessed quantitatively using Egger's test. Asymmetry of the funnel plot was adjusted for using metatrim.

We also analyzed five subgroups to explore the factors influencing the efficacy of MBIs on empathy: intervention dose (over 24 h vs. < 24 h), format of intervention (online vs. offline), type of intervention (different types), occupation (non-medical related occupations vs. medical related occupations), and home practice (home practice vs. no home practice).

Results

Search results

We conducted a literature search and filtering according to the PRISMA guidelines, as detailed in Figure 1. In the preliminary search results, 3,476 articles were retrieved, 924 duplicate articles were removed, and 2,552 articles were removed by title, abstract, and other reasons that did not meet the standard criteria of this review. Thereafter, by evaluating the full text of the excess 56 articles, we excluded 43 studies for several reasons: study design ($n = 15$), not MBIs ($n = 3$), not blank control or waiting list ($n = 5$), incomplete data ($n = 12$), and not empathy ($n = 8$). The current study included 13 studies (15 data) in the meta-analysis.

TABLE 1 Characteristics of the included studies.

Reference	Country	Sample	Mean Age	Gender (M/F)	Interventions	Control group	Intervention dose	Home practice	Compliance	Outcome variables	Results
Asuero et al., 2014	Spain	$N = 78$; health care professionals	$M_{age} = 47$, SD=8.0	6/62	Mindfulness-based psychoeducational intervention	Waiting list	2.5 h once/week × 8 weeks and an intensive 8-hour session	no	78/68	JSPE	+
Can Gür and Yilmaz, 2020	Turkey	$N = 154$; undergraduate nursing students	$M_{age} = 21.08$, SD = 2.18	86/37	MBET	Blank control	1 h twice/week × 8 weeks	yes	154/123	JSPE	+
Centeno, 2020	Filipino	$N = 30$; Psychology Majors	$M_{age} = 20.4$, SD = 0.9	unclear	MBCT	Blank control	2 h twice/week × 8 weeks	yes	30/30	IRI	+
Chan et al., 2021	China	$N = 60$; undergraduate counseling trainees	unclear	20/30	MBCT	Waiting list	2 h twice/week × 8 weeks	yes	60/50	IRI	+
Chen et al., 2021	USA	$N = 106$; doctors	$M_{age} = 38.57$, SD = 7.41	49/57	LKM	Waiting list	1.5 h 3 times/week × 8 weeks; no home practice	no	106/106	JSPE	+
Nadler et al., 2020	Canada	$N = 275$; Company employees	unclear	unclear	online workplace-based mindfulness training	Waiting list	144 ∼ 480 min	no	275/102	MEIA-W	+
Niu, 2020	China	$N = 800$; College students	M_{age} =21.33, SD =2.05	402/398	Buddhist meditation intervention	Blank control	3 h once/week × 8 weeks	no	Not tell	IRI	+
Orosa-Duarte et al., 2021	Spain	$N = 103$; Students of Medicine, Psychology, Nursing, or Nutrition	$M_{age} = 23$, SD =4.16	unclear	mindfulness-based mobile app	Blank control	200 min of sessions	no	103/68	JSPE	+
Orosa-Duarte et al., 2021	Spain	$N = 100$; Students of Medicine, Psychology, Nursing, or Nutrition	$M_{age} = 24$, SD =4.16	unclear	MBSR	Blank control	2.5 h once/week × 8 weeks	yes	100/61	JSPE	−

(Continued)

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TABLE 1 (Continued)

Reference	Country	Sample	Mean Age	Gender (M/F)	Interventions	Control group	Intervention dose	Home practice	Compliance	Outcome variables	Results
Pérula-de Torres et al., 2021	Spain	$N = 126$; tutors and resident intern specialist	$M_{age} = 41.61$, SD = 12.61	unclear	MBSR	Blank control	2.5 h/session × 4 sessions	yes	126/75	JSPE	−
Pérula-de Torres et al., 2021	Spain	$N = 102$; tutors and resident intern specialist	$M_{age} = 41.61$, SD = 12.61	unclear	MBSR	Blank control	2.5 h/session × 8 sessions	yes	102/88	JSPE	+
Shapiro et al., 2011	USA	$N = 30$; Undergraduate students	18 ∼ 24 years	unclear	MBSR	Waiting list	1.5 h once/week × 8 weeks	no	30/30	IRI	+
Shapiro et al., 1998	USA	$N = 78$; medical and premedical students	unclear	unclear	MBSR	Waiting list	2.5 h once/week × 7 weeks	yes	78/73	ECRS	+
Verweij et al., 2018	Netherlands	$N = 153$; residents from all medical, surgical and primary care disciplines	$M_{age} = 31.2$, SD = 4.6	18/130	MBSR	Waiting list	2.5 h once/week × 8 weeks	yes	153/138	JSPE	+
Wallmark et al., 2013	Sweden	$N = 42$; healthy people	Intervention: M_{age} =~~67.6~~ 32.6 SD=11; control: M_{age} =35, SD=15,		Buddhist meditation intervention	Waiting list	75 mins once/week × 8 weeks	yes	42/42	IRI	+

N, number; SD, Standard Deviation; M_{age}, Mean Age; M, male; F, female; MBET, Mindfulness-based empathy training; LKM, Loving-kindness Meditation training; MBSR, Mindfulness-Based Stress Reduction; MBCT, Mindfulness-Based Cognitive therapy; JSPE, Jefferson Scale of Physician Empathy; IRI, The Interpersonal Reactivity Index; ECRS, Empathy Construct Rating Scale; MEIA-W, Multidimensional Emotional Intelligence Assessment. Positive findings (+) indicate significantly greater improvements in the MBIs group compared to the control group, and negative findings (−) indicate no greater benefits of MBIs compared to the control group.

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TABLE 2 Subgroup characteristics of the included studies.

Reference	Occupation	Format of intervention	Intervention dose	Type of intervention	Home practice
Asuero et al., 2014	Medical related majors	Offline	28 h	mindfulness-based psychoeducational intervention	no
Can Gür and Yilmaz, 2020	Medical related majors	Offline	16 h	MBET	yes
Centeno, 2020	Non-medical related majors	Offline	32 h	MBCT	yes
Chan et al., 2021	Non-medical related majors	Offline	16 h	MBCT	yes
Chen et al., 2021	Medical related majors	Offline	36 h	LKM	no
Nadler et al., 2020	Non-medical related majors	Online	144–480 min	Online Workplace-Based Mindfulness Training	no
Niu, 2020	Non-medical related majors	Offline	24 h	Buddhist meditation intervention	no
Orosa-Duarte et al., 2021	Medical related majors	Online	200 min	Mindfulness-Based Emotion Regulation	no
Orosa-Duarte et al., 2021	Medical related majors	Offline	20 h	MBSR	yes
Pérula-de Torres et al., 2021	Medical related majors	Offline	10 h	MBSR	yes
Pérula-de Torres et al., 2021	Medical related majors	Offline	20 h	MBSR	yes
Shapiro et al., 2011	Non-medical related majors	Offline	12 h	MBSR	no
Shapiro et al., 1998	Medical related majors	Offline	17.5 h	MBSR	yes
Verweij et al., 2018	Medical related majors	Offline	20 h	MBSR	yes
Wallmark et al., 2013	Non-medical related majors	Offline	10 h	Buddhist meditation intervention	yes

MBET, Mindfulness-based empathy training; LKM, loving-kindness meditation training; MBSR, Mindfulness-Based Stress Reduction; MBCT, mindfulness-based cognitive therapy.

Study characteristics

We summarized the basic characteristics of the included articles (Tables 1, 2). The included studies were published between 1998 and 2021, with 9 out of 13 studies published in the past 5 years. Three articles each were published in Spain and the US, two in China, and one each in Turkey, Philippines, Netherlands, Sweden, and Canada.

Of the 13 studies (Shapiro et al., 1998, 2011; Wallmark et al., 2013; Asuero et al., 2014; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Centeno, 2020; Nadler et al., 2020; Niu, 2020; Chan et al., 2021; Chen et al., 2021; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021), 12 were randomized controlled studies and 1 was a quasi-experimental design (Centeno, 2020). A total of 2,135 individuals participated in the 13 studies, but gender ratios (Shapiro et al., 1998, 2011; Centeno, 2020; Nadler et al., 2020; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021) and mean age (Shapiro et al., 1998, 2011; Nadler et al., 2020; Chen et al., 2021) were not confirmed in some studies. Study sample sizes were highly variable, ranging from 30 to 800.

Studies included diverse samples: undergraduate students (Shapiro et al., 1998, 2011; Can Gür and Yilmaz, 2020; Niu, 2020; Chan et al., 2021; Orosa-Duarte et al., 2021), healthcare professionals (Asuero et al., 2014; Verweij et al., 2018; Chen et al., 2021; Pérula-de Torres et al., 2021), company employees (Nadler et al., 2020), and Psychology majors (Centeno, 2020). Moreover, 7 out of the 13 studies focused on subjects in medical-related occupations (Shapiro et al., 1998; Asuero et al., 2014; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Chen et al., 2021; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021).

A range of intervention types were employed, and the most commonly used approach was MBSR (Shapiro et al., 1998, 2011; Verweij et al., 2018; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021), two studies used MBCT (Centeno, 2020; Chan et al., 2021) and Buddhist meditation interventions (Wallmark et al., 2013; Niu, 2020), other studies used mindfulness-based psychoeducational intervention (Asuero et al., 2014), mindfulness-based emotion regulation (Orosa-Duarte et al., 2021), mindfulness-based empathy training (MBET) (Can Gür and Yilmaz, 2020), and loving–kindness meditation training (LKM) (Chen et al., 2021). The definitions of these intervention types were provided in the Supplementary materials 3.

Intervention cycle was generally 8 weeks, with 1 or 2 sessions per week of 60–150 min, but the total dose varies from 144 min to 32 h. The control group was the waiting list

(Shapiro et al., 1998, 2011; Wallmark et al., 2013; Asuero et al., 2014; Verweij et al., 2018; Nadler et al., 2020; Niu, 2020; Chan et al., 2021; Chen et al., 2021) or blank control (Can Gür and Yilmaz, 2020; Centeno, 2020; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021).

Empathy was evaluated using the Jefferson Empathy Scale (Asuero et al., 2014; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Chen et al., 2021; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021) and Interpersonal Reactivity Index scale (Shapiro et al., 2011; Wallmark et al., 2013; Centeno, 2020; Niu, 2020; Chan et al., 2021). Shapiro et al. (1998) used Empathy Construct Rating Scale (ECRS) for rating and Nadler et al. (2020) used Multidimensional Emotional Intelligence Assessment (MEIA-W). The former three scales are classical empathy scales that provide an overall level of empathy, and the empathy is only one variable in the latter one scale. However, what the four scales have in common is that higher scores indicate greater empathy.

The most frequently used mode of delivery was offline in an in-person way, which was used by 13 data (Shapiro et al., 1998, 2011; Wallmark et al., 2013; Asuero et al., 2014; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Centeno, 2020; Niu, 2020; Chan et al., 2021; Chen et al., 2021; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021). Two interventions were delivered online (Nadler et al., 2020; Orosa-Duarte et al., 2021). Subjects were asked to do home practice after class in 9 data (Shapiro et al., 1998, 2011; Wallmark et al., 2013; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Centeno, 2020; Chan et al., 2021; Chen et al., 2021; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021) and 6 data had no home practice (Shapiro et al., 2011; Asuero et al., 2014; Nadler et al., 2020; Chen et al., 2021; Orosa-Duarte et al., 2021).

Quality appraisal of literature

The risk of bias assessment of the included literature is shown in Figure 2. The risk of bias in random sequence generation was generally low, and only 1 RCT does not specify or describe the randomization method used (Chen et al., 2021). We judged 8 studies that did not explicitly describe concealment of allocation (Shapiro et al., 2011; Wallmark et al., 2013; Asuero et al., 2014; Verweij et al., 2018; Centeno, 2020; Nadler et al., 2020; Chen et al., 2021; Orosa-Duarte et al., 2021), and the remaining 5 studies were judged to be at unclear risk of bias in this domain (Shapiro et al., 1998; Can Gür and Yilmaz, 2020; Niu, 2020; Chan et al., 2021; Pérula-de Torres et al., 2021). Owing to the specificity of intervention, only 1 study represented the methodology of blinding (Chen et al., 2021) and the remaining 12 studies were according to unsuccessful blinding and assessed at high risk. These studies were judged at high risk of bias because they claimed that assessors were not unsighted (Asuero et al., 2014; Nadler et al., 2020; Chan et al., 2021). Moreover, 6 studies were rated at low risk of bias (Shapiro et al., 1998; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Centeno, 2020; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021) and 4 were rated at unclear risk of bias in this domain (Shapiro et al., 2011; Wallmark et al., 2013; Niu, 2020; Chen et al., 2021). Three articles were rated as high risk in the incomplete outcome data owing to high shedding rates (Nadler et al., 2020; Chen et al., 2021; Orosa-Duarte et al., 2021), and the remaining 10 studies were judged to be at unclear risk of bias in this domain (Shapiro et al., 1998, 2011; Wallmark et al., 2013; Asuero et al., 2014; Verweij et al., 2018; Can Gür and Yilmaz, 2020; Centeno,

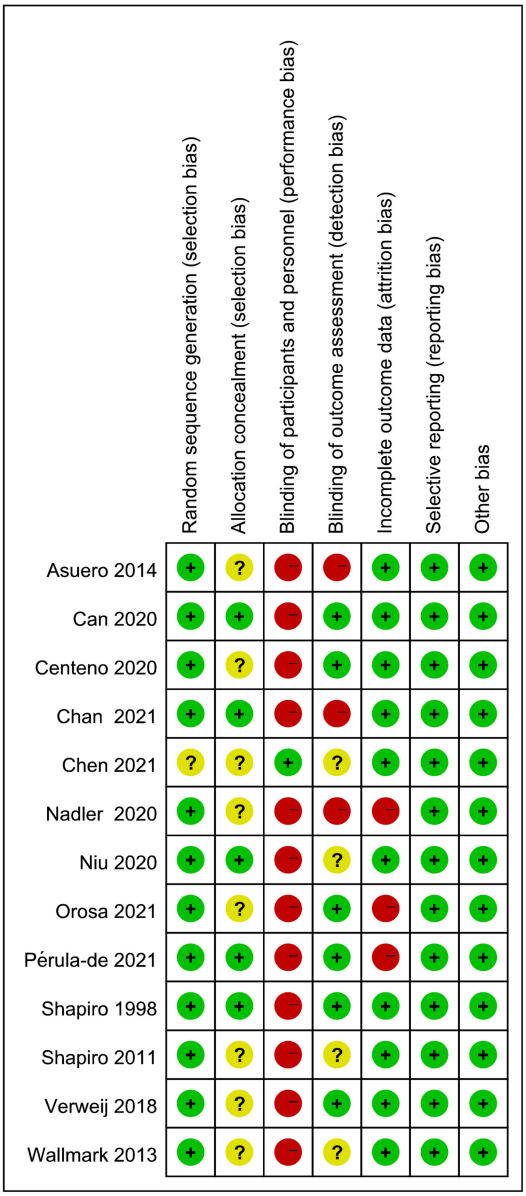

FIGURE 2
Risk of bias assessment across included studies.

2020; Niu, 2020; Chan et al., 2021; Pérula-de Torres et al., 2021). All included articles were rated at low risk of bias in selective reporting and other bias.

Effectiveness of MBIs

Outcomes: Empathy

Adequate data were available from 15 data for analysis. The results of the quantitative analysis showed that the effect size of MBIs on empathy was 0.372 (95% CI, 0.164–0.579, $p = 0.001$) with high heterogeneity ($I^2 = 51.01\%$, $p = 0.001$). This result indicated that MBIs have a significant effect on empathy (Figure 3). However, there was high heterogeneity, and we conducted subgroup analyses based on intervention dose, intervention format, intervention type, occupation, and home practice.

Subgroup analyses: Intervention dose

Intervention dose appears to be an important factor in treatment outcome, and we pooled the duration of the entire intervention cycle into a group with over 24 h and a group with under 24 h. Subgrouping analysis by intervention dose increased the effect size and decreased heterogeneity in the over 24 h subgroup (SMD, 0.735, 95% CI, 0.606–0.863, $p = 0.001$) with heterogeneity ($I^2 = 0.00\%$, $p = 0.500$). Effect size was decreased in the under 24 h group (SMD, 0.273, 95% CI, 0.036–0.510, $p = 0.024$) with heterogeneity ($I^2 = 63.6\%$, $p = 0.002$). Heterogeneity increased as well (Figure 4).

Subgroup analyses: Intervention format

Most of the studies we included were conducted offline in an in-person way, and only two studies explored the effects of online MBIs interventions on empathy. Subgroup analyses found that MBIs are effective in improving subjects' empathy offline (SMD, 0.407, 95% CI, 0.181–0.632, $p = 0.001$) with heterogeneity ($I^2 = 44.87\%$, $p = 0.001$). However, effect size of online MBI intervention was reduced (SMD, 0.150, 95% CI, −0.165–0.465, $p = 0.350$) with heterogeneity ($I^2 = 0\%$, $p = 0.967$) (Figure 5).

Subgroup analyses: Intervention type

We compared the effects of different types of MBIs on empathy, and the results indicated that each type of intervention is able to improve empathy. However, the effects were different across interventions. MBET (SMD, 0.942, 95% CI, 0.569–1.315) and MBCT (SMD, 0.820, 95% CI, 0.352–1.288) were the most effective treatments, in which the effect sizes of both interventions are significantly higher than the total effect sizes. However, this conclusion is unreliable owing to the limited number of studies. Note that MBSR (SMD, 0.115, 95% CI, −0.099–0.329, $p = 0.293$) with heterogeneity ($I^2 = 20.5\%$, $p = 0.279$), which is one of the most used interventions, has a lower effect size compared with the total effect size (Supplementary Figure S1).

Subgroup analyses: Occupation

We divided the included subjects into two populations based on occupation: subjects with non-medical- and with medical-related occupations. Subgrouping analysis by occupation slightly increased the effect size in the non-medical-related occupations subgroup (SMD, 0.472, 95% CI, 0.136–0.809, $p = 0.006$) with heterogeneity ($I^2 = 67.9\%$, $p = 0.008$). The heterogeneity increased in medical-related occupation subjects (SMD, 0.314, 95% CI, 0.060–0.567, $p = 0.015$) with heterogeneity ($I^2 = 66.9\%$, $p = 0.098$). The results of the study indicated that MBIs are effective for empathy in non-medical- and medical-related occupation subjects (Supplementary Figure S2).

Subgroup analyses: Home practice

We explored the effect of home practice on MBI intervention. Subgroup analysis showed that the effect size increased slightly in the no home practice group (SMD, 0.424, 95% CI, 0.135–0.713, $p = 0.006$) with heterogeneity ($I^2 = 69.6\%$, $p = 0.004$). Neither heterogeneity nor effect size changed significantly in the home practice group (SMD, 0.341, 95% CI, 0.049–0.633, $p = 0.022$) with heterogeneity ($I^2 = 69.4\%$, $p = 0.001$) (Supplementary Figure S3).

Publication bias and sensitivity analysis

To test for publication bias in the literature included in the current study, a funnel plot was drawn (Figure 6) to show that the distribution of the studies was relatively symmetrical. Egger's test corroborated this finding ($p = 0.655$), indicating that our results were robust.

Heterogeneity test and sensitivity analysis

We performed a heterogeneity test on the 15 data included in the current study ($I^2 = 51.01\%$, $p = 0.001$), and the results suggested strong heterogeneity. When literature comparisons were removed individually, heterogeneity did not change significantly. We performed a sensitivity analysis to find the reason for the strong heterogeneity. The results indicated that none of the studies had results that would have a considerable impact on the meta-analysis.

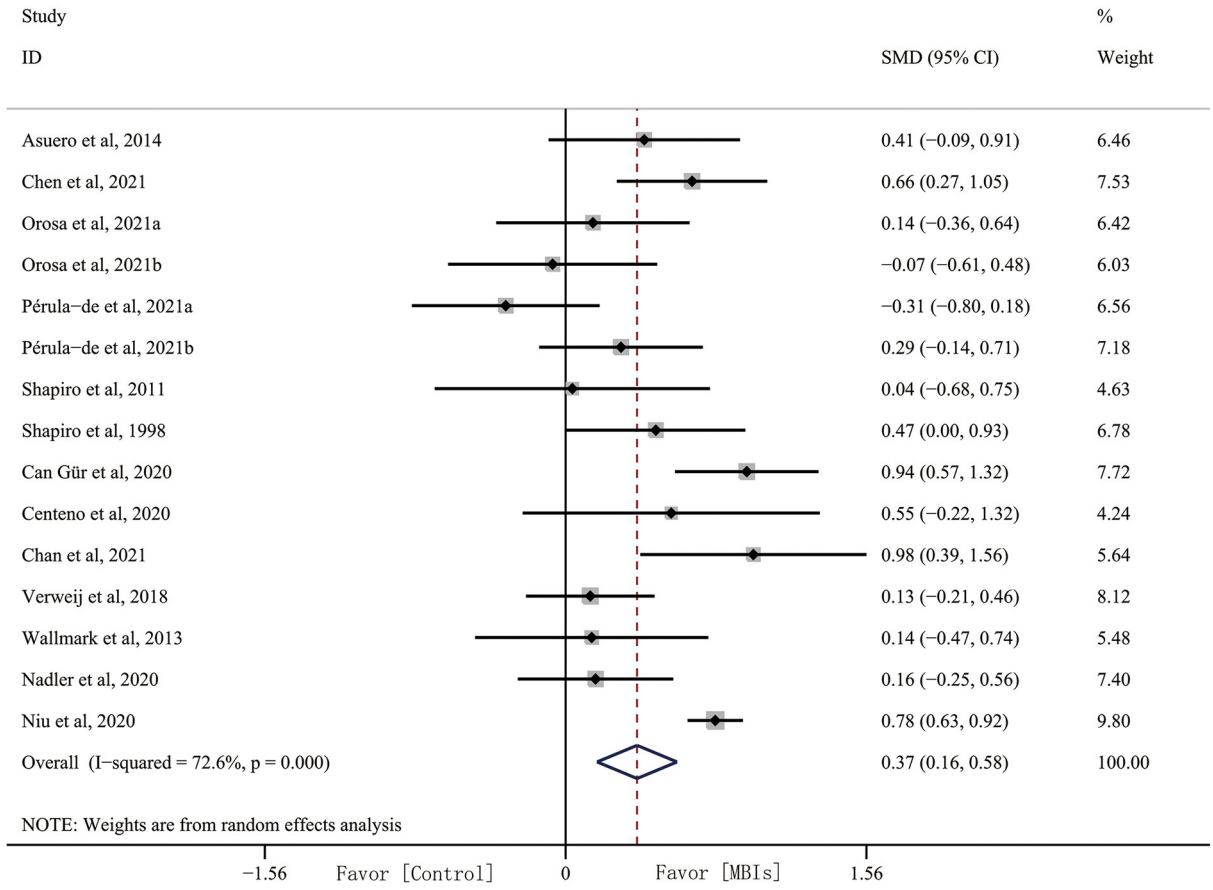

FIGURE 3
Mindfulness-based interventions (MBIs) effects on empathy.

Discussion

This study aims to investigate the effects of MBIs on empathy in a healthy population and the potential factors affecting the efficacy of MBIs. First, meta-analysis was performed on all MBI studies applied to increasing empathy in healthy populations. Compared with the control group, MBIs had a significant improvement in empathy in healthy adults, consistent with the results of Kreplin et al. (2018) and Luberto et al. (2018). Second, the results of the subgroup analysis showed that the intervention dose affects the effectiveness of the treatment, with better outcomes for interventions over 24 h. Each type of intervention was able to improve empathy, but the effects were different across interventions. Effect sizes of MBET and MBCT were significantly higher than the total effect sizes. Limited improvement was shown in MBIs for empathy in the online intervention group. Third, differences in the effectiveness of MBIs were not significant in the subgroup comparisons of occupation and home practice.

The mechanisms by which MBIs affect empathy are not fully understood. This situation can be explored from the perspectives of cognitive neuroscience and emotion regulation. Previous studies have shown that the anterior insula and anterior cingulate cortex (ACC) are the core networks of empathy (Bahji et al., 2021). Evidence based on neuroimaging studies has indicated that MBIs can cause specific brain changes associated with empathy. Hölzel et al. (2007) found that rostral ACC and dorsal medial prefrontal cortex (dmPFC) are activated in both hemispheres during Vipassana meditation. Imaging data showed that the body-mind training (IBMT) group has stronger activity in ACC compared with the same dose of relaxation training (Tang et al., 2009). Farb et al. (2013) found that during interoceptive to respiratory sensations, the MBSR group caused greater activation of the anterior insula than the waiting list and the coupling between dorsomedial PFC and posterior insula was also changed. Weisz and Cikara (2021) hold that emotion regulation also plays an important role in empathy, and enhanced emotional regulation is considered the basis for the effectiveness of mindfulness meditation (Tang et al.,

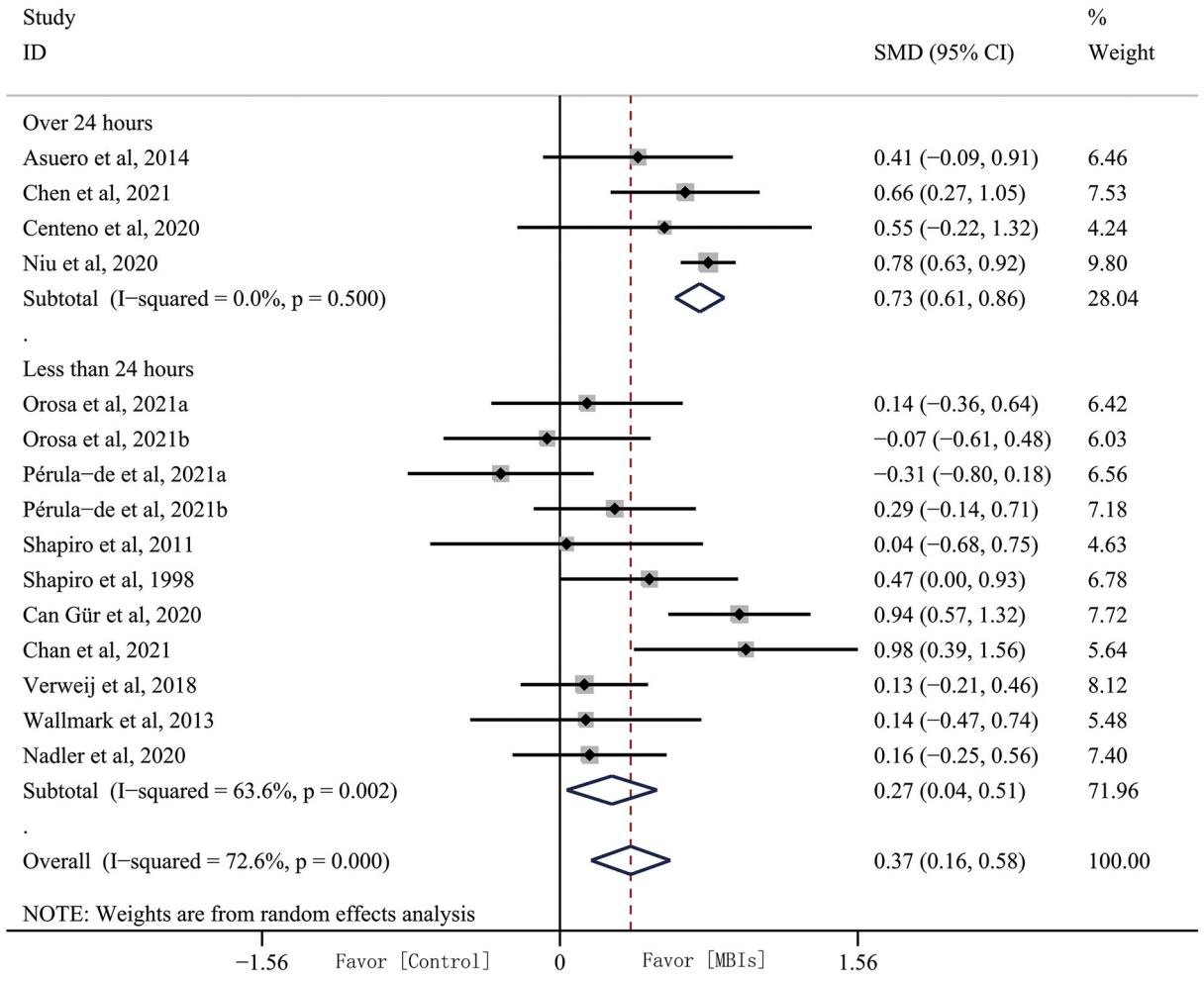

FIGURE 4
Subgroup analyses by intervention dose.

2015). Positive effects of mindfulness meditation on emotion processing may include such aspects as reducing the disturbance of emotions by unpleasant stimuli (Froeliger et al., 2012), reducing difficulties in emotion regulation (Robins et al., 2012), and helping individuals return to an emotional baseline after responding to stressful stimuli (Goleman and Schwartz, 1976). Emotion may be the mediating factor that mediates MBIs to regulate empathy.

Intervention dose

In a subgroup analysis of intervention dose, 4 studies had a total intervention dose of over 24 h and 11 studies had an intervention dose of under 24 h. Effect size of the long intervention group was significantly higher than that of the short intervention group, indicating that subjects in the former had better empathy outcome than those in the latter. We suspect that this result may be caused by the superimposed effect of MBI intervention, which requires a long period to achieve the desired effect. The result is consistent with Berry et al. (2018), who found that a minute of positive meditation develops empathy and increases helpful behavior toward strangers. Moreover, a three-month meditation practice based on thoughtful observation improved performance on empathy and even increased cortical volume in corresponding brain regions. Pérula-de Torres et al. (2021) compared the effectiveness of an abbreviated MBSR training program (2.5 h/session × 4 sessions) in relation to a standard training program (2.5 h/session × 8 sessions) on the levels of mindfulness, self-compassion, and self-perceived empathy in tutors and resident intern specialists. The results showed that only standard MBSR increased the level of empathy. The results of the subgroup analysis fill in the gap in the studies by Weisz and Cikara (2021), in which the effect of MBIs on

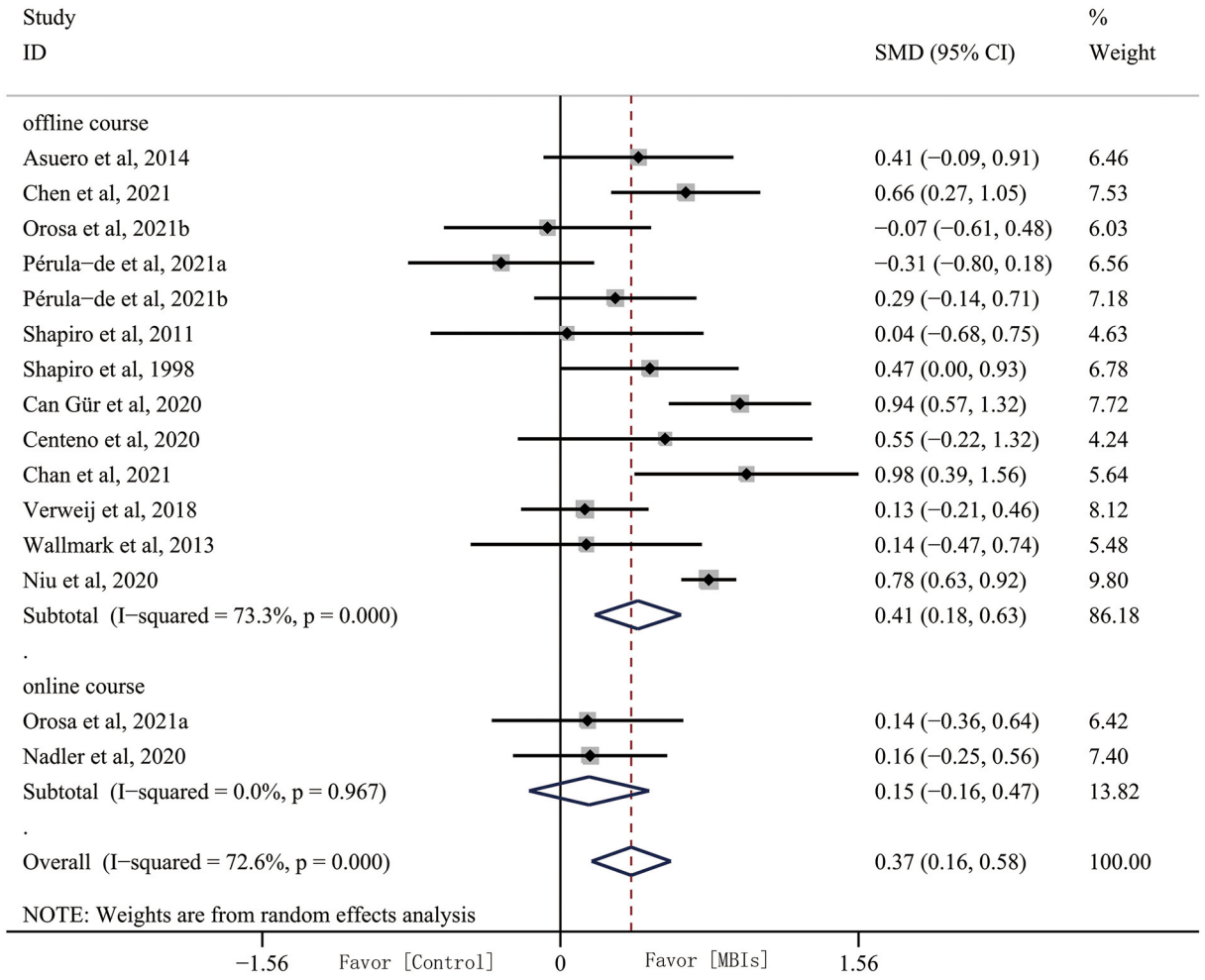

FIGURE 5
Subgroup analyses by format of intervention.

empathy is strongly correlated with the dose of the intervention, with superior effects over 24 h.

Intervention format

Kuhlmann et al. (2016) have argued that in-person MBI sessions are limited by the need of experienced therapists, delivery venues, participant schedules, and time-consuming characteristics. An increasing number of studies have explored the use of online MBI sessions in different fields (Champion et al., 2018; Sun et al., 2022). Orosa-Duarte et al. (2021) and Nadler et al. (2020) proposed the use of a cellphone app format for MBI sessions, and the results suggested that online MBI sessions had limited effect on improving the empathy. Given that only two studies were included in this analysis, additional research is needed to validate the effectiveness on empathy. Owing to convenience, effectiveness, and low cost, online MBI sessions provide a new way to promote MBI sessions (Gál et al., 2021). Future studies should focus considerably on online MBI sessions to further determine their positive effects on empathy.

Intervention types

There is a rich variety of intervention types of MBIs, and MBSR was the most applied type of MBIs in the included studies (Shapiro et al., 1998, 2011; Verweij et al., 2018; Orosa-Duarte et al., 2021; Pérula-de Torres et al., 2021). However, the effect sizes for MBSR were lower than the overall effect sizes, suggesting that we can consider other types of MBIs in practice. The results of the subgroup analysis showed differences in the effects of different interventions. The possible reason is the limited number of articles, resulting in insufficient motivation

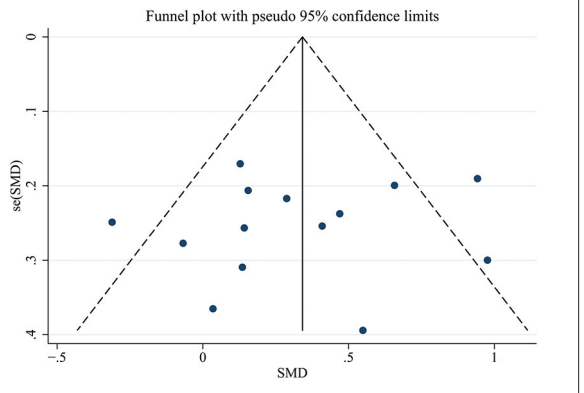

FIGURE 6
Publication bias funnel plots of standard errors and effect sizes of the included studies.

for the analysis. In the future, additional articles of different intervention types on empathy may change this conclusion.

Occupation

Owing to the unique nature of their professions, doctors, nurses, medical students, and other medical-related professionals are faced with considerable stressful situations in their works or studies, including wounds, illnesses, and even death (Williams and Stickley, 2010; Laughey et al., 2021; Pérula-de Torres et al., 2021). Accumulated stress takes a huge toll on their empathic abilities. Imparied empathy may likewise lead to a lack of effective communication between physicians and patients, thereby possibly leading to doctor–patient disputes and conflicts. The results of the subgroup analysis showed that MBIs are effective in improving empathy for medical- and non-medical-related professional subjects, and there are no significant differences between the two groups. Such results suggest that MBIs are worth promoting in a wide range of occupations.

Home practice

After the in-person MBI sessions, subjects were asked to complete certain homework practice to improve the intervention effect of the MBI sessions. However, the results of our subgroup analysis showed that the homework practice did not affect the outcome of the intervention. This outcome appears to contradict the results of the intervention dose subgroup analysis; we speculate that this result may be caused by poor compliance and lack of professional coaching. Accordingly, improving compliance with home practice is also a research direction worth investigating.

Strengths and limitations

For the strengths of this study, the current research is the first meta-analysis on the effectiveness of MBIs on empathy. Compared with previous studies, we included more articles to explore the factors affecting the effectiveness of MBIs by conducting subgroup analysis, thereby providing some references for the generalized application of MBIs. We employed rigorous meta-analytical techniques and assessment, such as sensitivity analyses and assessment of publication bias.

However, there are still some limitations in this study. Firstly, 9 out of 13 studies did not conduct follow-up visit, so we were unable to determine the long-term effects of MBIs on empathy. Future studies could be designed with follow-up programs to explore the long-term effects of MBIs for empathy. In addition, this study did not include gray literature, thereby potentially affecting the results of the meta-analysis. Secondly, the population of this study focused on healthy adults, which may be a limitation for promoting MBIs. Thirdly, as 8 out of 13 included articles did not inform about the sex ratio, and 3 out of 13 did not inform about age (Table 1). The data about gender and age included in the current study were not enough to support subgroup analysis, and subsequent studies can do some exploration based on these issues. Lastly, we only included 13 studies and the quantity of members was moderately minimal. Hence, more articles of high quality and large sample sizes are needed in the future to explore the intervention effects of different populations and different intervention protocols.

Future directions

Previous studies have found that many diseases had empathy disorders, such as psychiatric disorders (Decety and Moriguchi, 2007; Bragado-Jimenez and Taylor, 2012; Schreiter et al., 2013) and chronic pain (Sohn et al., 2016; De Tommaso et al., 2019; Ma et al., 2020; Mu et al., 2021; Zhang et al., 2021). It would be meaningful to see if the extension of MBIs to these subjects could improve their empathy. To our knowledge, there are limited studies on the use of MBIs in the elderly population, and exploring the effects in different populations may be a potential direction for future research.

Conclusions

The present study confirmed the effect of MBIs on the improvement of empathic ability in healthy populations. Subgroup analyses revealed that intervention dose, formats, and types are key factors influencing intervention effects. Future research should markedly focus on large-sample, rigorously designed experiments to explore the long-term effects of MBIs on empathy and to elucidate the underlying mechanisms of

MBIs. We are optimistic that the findings of this study will provide evidence for teachers and physicians to design programs to prevent empathy reduction and identify alternative gaps for future research.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

Conceptualization: Z-YH, Y-RW, and Y-LW. Methodology: Y-RW. Software: JS. Validation: Z-YH and Y-LW. Formal analysis: Z-HY. Investigation: Y-RW and Z-HY. Resources and project administration: Z-YH. Data curation: Y-TL. Writing-original draft preparation and writing-review and editing: Y-RW and Z-YH. Visualization: Y-FW. Supervision: Y-YL and Y-LW. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.992575/full#supplementary-material

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Mindfulness mediates the relationship between positive parenting and aggression, depression, and suicidal ideation: A longitudinal study in middle school students

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Previous research has indicated that parenting factors affect the risk of maladaptive psychological outcomes (e.g., aggression, depression, or suicidal ideation), and that positive parenting is a prospective risk factor for maladaptive psychological outcomes. However, the mechanisms underlying the relationships between positive parenting, mindfulness, and maladaptive psychological outcomes remain unknown, as do the processes that mediate the effect of positive parenting on maladaptive psychological outcomes in adolescents. The objective of the present study was to investigate the longitudinal relationship between positive parenting, mindfulness, and maladaptive psychological outcomes in middle school students, as well as the mediating effect of mindfulness in the relationships between positive parenting and depression, aggression, and suicidal ideation. In this study, 386 middle school children (aged 12–16) were tested three times over a period of 6 months. Positive parenting was assessed at Time 1, mindfulness at Time 2, and depression, aggression, and suicidal ideation at Time 3. Using structural equation modeling, positive parenting was revealed to be longitudinally associated with mindfulness and negatively associated with maladaptive psychological outcomes. More crucially, mindfulness mediated the relationship between positive parenting and maladaptive psychological outcomes. This research provides important insights into how to effectively decrease adolescent maladaptive psychological outcomes and highlights the importance of teaching mindfulness to youths.

KEYWORDS

positive parenting, suicidal ideation, aggression, depression, mindfulness

Introduction

Adolescence is a significant time of growth during which mental health issues can emerge (Polanczyk et al., 2015). The physiological and psychological changes that occur during puberty can trigger major public health problems, such as suicidal behaviors (suicidal ideation or suicide attempts; Xiao et al., 2019; Xu et al., 2022), depression, and aggression (Achenbach, 1991; Achenbach and Edelbrock, 1991; Reitz et al., 2005; Graber, 2013; Archana and Kumar, 2022). Worldwide, suicide is a serious public health problem and a leading cause of death and disability, especially among adolescents (McLoughlin et al., 2015; Xiao et al., 2019; Xu et al., 2022). Suicidal ideation, a key step in the suicide process, is a significant risk factor for youth suicide (Cluver et al., 2015; Franklin et al., 2017). Suicidal ideation is prevalent among Chinese adolescents, with rates ranging between 15.7% (N = 54,640) and 18.2% (N = 20, 475) (Guo et al., 2019; Xiao et al., 2019; Xu et al., 2022). Additionally, depression is significant global public health issue (Ferrari et al., 2013), with incidence rates ranging from 2 to 7% in children and adolescents (Alsaad et al., 2018). Depression, which has been associated with decreased academic performance, family problems, drug abuse, and decreased life expectancy (Murray et al., 2015), is frequently accompanied by a high suicide risk (Murray et al., 2015; Apter and Gvion, 2016). Aggression is defined as behavior intended to hurt oneself or others (Siever, 2008), and is another public health issue, with a frequency of 25% in China (Peng et al., 2022). Several studies have noted that adolescents with more aggressive behavioral tendencies and patterns are more likely to have poorer physical and mental health, scholastic performance, personality development, and social adaption than others (Gini and Pozzoli, 2013; Gini et al., 2013).

Due to the prevalence of aggression, depression, and suicidal ideation in adolescents, research on maladaptive psychological outcomes in the teenage population has frequently concentrated on identifying their causes (Dumais et al., 2005; Augsberger et al., 2018; Lee and Ham, 2018). Increasing evidence has demonstrated that positive parenting can contribute to the prevention of these problems in Western cultural contexts (Boeldt et al., 2012; Smokowski et al., 2015). Despite the extensive reports from Western countries that positive parenting is associated with improved child and adolescent psychosocial and developmental outcomes, the majority of these studies have tested bivariate relationships rather than mediational models, and have not used longitudinal data. According to Social Emotional Learning (SEL) theory (Tolan et al., 2016), positive parenting can enhance children's social and emotional skills, and indirectly foster the development of social-emotional competencies, such as mindfulness, in adolescents. Thus, with a focus on prevention, we used longitudinal methods to investigate the mediating effect of adolescents' mindfulness in the associations between positive parenting, depression, aggression, and suicidal ideation.

While the relationships between positive parenting and depression, aggression, and suicidal ideation have been well-documented in Western countries (Chen and Raine, 2018; Kingsbury et al., 2020), relatively little research has been conducted on this topic in a Chinese environment. A Chinese adage states that "Beating and reprimanding are the signs of love." This demonstrates that, in the context of traditional Chinese culture, controlling or autonomy-restrictive parental practices (e.g., harsh parenting behaviors) are more normative in China (Liu et al., 2021) than in Western contexts. Indeed, these practices are still adopted by approximately 50% of Chinese parents (Wang and Liu, 2014) and thus seem normal and appropriate in the eyes of Chinese adolescents (Chao, 1994; Cheung and Pomerantz, 2011). Shek (2007) found that although Chinese parents are accustomed to scolding their children, screaming at them, and even punishing them for failing to achieve their expectations, Chinese adolescents do not necessary perceive these parenting practices as harsh. It is still unknown whether the positive parenting in the context of Chinese culture will have the same effect as that in Western countries. Given these cultural understandings, it is worth investigating further the relationship between positive parenting and maladaptive psychological outcomes in a Chinese context.

The importance of positive parenting in preventing aggression, depression, and suicidal ideation

Many studies have shown that parental practices are crucial contributors to the emergence and maintenance of adolescents' mental and behavioral problems, including depression (Schwartz et al., 2014), aggression (Hentges et al., 2018), and suicide (Borkowski et al., 2001; Maccoby, 2001; Fotti et al., 2006). According to the family system theory, families are not just groups of people living together, but rather multilevel systems in which the parents play essential roles as both leaders and implementers (Bowen, 1974). Therefore, everyone, especially adolescents, is affected by any change in any element of the system. Following this, then, positive parenting behaviors have been hypothesized to decrease youth depression, aggression, and suicidal ideation (You and Lim, 2015; Kingsbury et al., 2020).

Positive parenting refers to warm, supportive parental behaviors that demonstrate acceptance, praise, and responsibility, including but not limited to nurturing, instructing, listening, expressing approbation, and providing emotional support (Russell, 1996; Chronis et al., 2007; Boeldt et al., 2012; Kingsbury et al., 2020). In addition, any positive component that stems from specific parenting behaviors and beliefs and enters into the parenting environment can be

considered a part of positive parenting (Roskam, 2015). There is considerable evidence that positive parenting is a key buffer against the emergence of depression, aggression (Pinquart, 2017a,b; Nieto-Casado et al., 2022), and suicidal ideation (Kingsbury et al., 2020). Smokowski et al. (2015) found that positive parenting was negatively associated with depression. In another study, Jakobsen et al. (2012) revealed that adolescents who reported parental support had less severe anxiety and depressive symptoms. A significant association between positive parenting and aggressive behavior has also been reported (Chen and Raine, 2018). In particular, aggressive behavior was more common in children who had been exposed to negative parenting styles than in children who had been exposed to positive parenting styles (Lei et al., 2018). More importantly, a substantive body of empirical research has asserted that a supportive family environment could defend against the stresses that lead to suicidal ideation and actions in young people (Zhang and Jin, 1996; Lai and McBride-Chang, 2001). Indeed, family support and connectedness has been shown to reduce the likelihood of suicidal thoughts and behaviors (Sharaf et al., 2009; Purcell et al., 2012).

According to several cross-sectional studies, the presence of parental warmth (Machell et al., 2016), sufficient autonomy support (Shpigel et al., 2012), and efficient communication (Mark et al., 2013) are protective factors against the formation of suicidal thoughts in adolescents. In a more recent longitudinal study, Kingsbury et al. (2020) found that positive parenting was protective against depression, anxiety, and physical and social aggression. Taken together, the evidence points to a strong negative correlation between positive parenting and maladaptive psychological outcomes such as depression, aggression, and suicidal ideation (Purcell et al., 2012; Smokowski et al., 2015; Pinquart, 2017a,b; Chen and Raine, 2018; Nair et al., 2020).

The mediating role of mindfulness

The SEL theory is a model of positive development (Tolan et al., 2016) that describes the process of helping people acquire the "capacity to understand, control, and express one's social and emotional aspects of one's life" (Elias et al., 1997). The SEL model (Tolan et al., 2016) holds that positive parenting can cultivate social and emotional abilities that directly or indirectly contribute to competency development in adolescents by improving the environments that support the development of these abilities in adolescents. Indeed, some studies have shown that positive parenting plays a significant part in the healthy development of adolescents because it supports the acquisition of skills, promotes self-acceptance, boosts self-esteem, and facilitates the formation of secure attachments (Smalls, 2009; Elmore and Gaylord-Harden, 2013). Other studies have shown that children who have secure, stable relationships with their caregivers are also more likely to acquire a greater capacity for mindfulness (Shaver et al., 2007; Pepping et al., 2015; Lucas-Thompson et al., 2021; Nieto-Casado et al., 2022). Parent–child interactions that are marked by warmth, support, and sensitivity are more inclined to foster a secure attachment pattern in the child (Bowlby, 1973). Moreover, those with more secure attachment patterns also tend to be more mindful (Shaver et al., 2007; Sharaf et al., 2009; Pepping et al., 2015; Melen et al., 2017). According to Ryan et al. (2007), this sense of security can help to create the foundation for the maturity of awareness as well as contextual attention. Conversely, difficulties developing mindfulness have been associated with the emergence of an insecure attachment style, which is facilitated by unresponsive or inconsistent relationships between parents and their children (Bowlby, 1973; Pepping et al., 2013; Stevenson et al., 2017).

The association between parenting style and children's behavioral adjustment level has been shown to be mediated by children's behavioral and attentional regulation abilities (Cheah et al., 2009). As such, there is value in exploring mindfulness as a potential competence of adolescents, since it appears that having a loving, autonomous, and communicative family environment during childhood facilitates the development of mindfulness (Ryan et al., 2007), and this development persists into adolescence (Galla et al., 2020). This raises the possibility that adolescents who experience more positive parenting possess stronger skills in mindfulness.

Mindfulness is described as a state of consciousness that is developed through paying attention to the present moment with a non-judgmental attitude (Kabat-Zinn, 2003). A substantial corpus of literature supports the notion that mindfulness promotes health by shielding individuals against the adverse impacts of stress (Creswell and Lindsay, 2014), as well as suicidal thoughts and behaviors (Bentley et al., 2017; Per et al., 2022). There is growing evidence that mindfulness-based interventions (MBIs) are sufficiently effective in enhancing positive emotions and reducing depression, suicidal ideation (Serpa et al., 2014), and aggression (Fix and Fix, 2013). For instance, Zhu et al. (2021) discovered that increasing mindfulness training was associated with low level of depression. Recently, a meta-analysis indicated that MBIs moderately reduced suicidal ideation (Schmelefske et al., 2020) and other psychological outcomes linked to suicide (e.g., depression; Witt et al., 2019). MBIs may also be effective in reducing aggression (Peters et al., 2015; Gillions et al., 2019). For instance, Heppner et al. (2008) found a negative correlation between mindfulness and self-reported aggressiveness, whereby increasing people's mindfulness in an experimental setting resulted in less aggressive behavior. Similar to positive parenting, mindfulness has been shown to prospectively and robustly predict anxiety, depression, aggression, and social impairment (Williams, 2008; Fix and Fix, 2013; Bajaj et al., 2016; Westphal et al., 2021). Considering previous findings, it is plausible that mindfulness could mediate the link between positive parenting and maladaptive

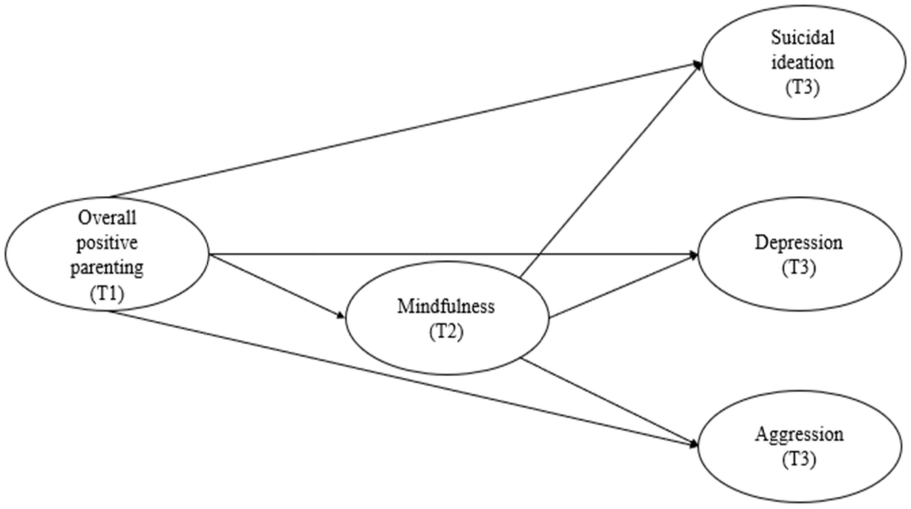

FIGURE 1
A hypothetical model of the effects of overall positive parenting and mindfulness on aggression, depression, and suicidal ideation.

psychological outcomes such as aggression, depression, and suicidal ideation.

Although few studies have directly demonstrated the association between positive parenting and mindfulness, a recent study by Nieto-Casado et al. (2022) found that mindfulness partially mediated the association between parental competency and anxious-depressive symptoms and suicidal ideation. The authors speculated that this mediation effect was due to the fact that mindfulness inhibits the activation of dysfunctional thought patterns and maladaptive coping methods, which are common in individuals with anxious-depressive symptomatology. Based on the SEL model, positive parenting (i.e., the environment) may help individuals to develop skills in mindfulness (i.e., individual competence), which in turn reduce the likelihood of experiencing depression, aggression, and suicidal ideation. If so, it is reasonable to speculate that positive parenting could improve or cultivate mindfulness in adolescents, and, in turn, mindfulness could influence maladaptive psychological outcomes. Individual mindfulness could be promoted through the family environment, and thus decrease maladaptive psychological outcomes. However, considering the Western–Eastern cultural differences in parenting practices, further research into the associations between positive parenting and aggression, depression, and suicidal ideation in China is required. In addition, most studies into parenting style and adolescent maladaptive psychological outcomes have been cross-sectional, which cannot accurately reveal quasi-causal relationships between variables. The current study used a three-wave longitudinal method to explore the associations of positive parenting and mindfulness with maladaptive psychological outcomes in a sample of middle school adolescents.

We used a mediation model (**Figure 1**) to examine the intermediary effect of mindfulness on positive parenting and adolescent maladaptive psychological outcomes. Previous studies have found that socio-demographic factors (e.g., sex, age, household income, and education) are associated with suicidal ideation (Groleger et al., 2003; Grunbaum et al., 2004; Swahn and Bossarte, 2007; Kim et al., 2016; Cabello et al., 2020), depression (Mohammadi et al., 2019), and aggression (Stipek and Miles, 2008). To reduce endogeneity bias, we adjusted for the demographic variables of age, sex, and subjective social status. Based on the existing literature, the following hypotheses were made:

> Hypothesis 1: Positive parenting positively predicts mindfulness.
> Hypothesis 2: Positive parenting and mindfulness negatively predict adolescent suicidal ideation, depression, and aggression.
> Hypothesis 3: The associations between positive parenting and suicidal ideation, depression, and aggression in adolescents are mediated by mindfulness.

Materials and methods

Participants

This study employed a convenience sampling method to recruit middle school students from two schools in

Henan Province, China. A total of 386 students self-reported their perceived positive parenting at Time 1 (T1; October, 2021), 385 students self-reported their mindfulness at Time 2 (T2; December, 2021), and 375 students self-reported their depression, aggression, and suicidal ideation at Time 3 (T3; February, 2022). Sample attrition was $N = 11$. Due to school transfers or incomplete responses, the excluded individuals could not be followed longitudinally. Of the final 375 participants, their average age was 13.48 ± 0.88 years at T1; 192 (51.2%) were male and 183 (48.8%) were female; 105 (28%) were in grade 7 and 270 (72%) in grade 8; 34 (9.1%) were only children and 341 (90.9%) were not.

Procedure

Signed informed consent was obtained from all participants prior to completion of the questionnaire, after approval had been granted by school principals. The students were informed that their participation would have no bearing on the educational options available to them in middle school, and that their participation was entirely voluntary. T1 data collection was performed in October 2021, when adolescents were in grades 7–8; data collection at T2 was in December 2021; and data collection at T3 was performed in February 2022, when students were still in the same grade as they were at T1.

Measures

The positive parenting subscale (time 1)

Positive parenting was measured using the 14-item Emotional Warmth subscale from the Chinese version of the Egna Minnen Beträffande Uppfostran, developed by Perris et al. (1980) and validated by Li et al. (2012). Seven items assess the father's positive parenting (e.g., "My father showed with words and gestures that he liked me") and seven items assess the mother's positive parenting (e.g., "I felt that my mother was proud when I succeeded in something I had undertaken"). All items were rated by participants on a 4-point scale ranging from 1 (almost never) to 4 (always), with higher overall scores indicating higher perceived positive parenting. In this investigation, the Cronbach's α-value was 0.95.

The mindful attention and awareness scale (time 2)

Five questions from the Chinese Version of the Mindful Attention and Awareness Scale (Deng et al., 2012), which was created by Brown and Ryan (2003) and modified by Hülsheger et al. (2013), were used to assess mindfulness. A sample item is "I find myself doing things without paying attention." Each item was scored on a Likert scale ranging from 1 (almost never) to 6. (always). Higher scores indicated greater mindfulness. In this investigation, the Cronbach's α-value was 0.91.

The beck scale for suicidal ideation (time 3)

Adolescent suicidal ideation was measured using the Chinese version (Zhang and Brown, 2007) of the Beck Scale for Suicide Ideation (Beck and Steer, 1991). The scale consists of 19 self-report items, and participants are asked to rate each item on a 3-point scale. Higher scores indicate a greater tendency toward suicidal ideations. In this investigation, the Cronbach's α-value was 0.90.

The patient health questionnaire (time 3)

Depression was measured using the Chinese version of the Patient Health Questionnaire (PHQ-9; Wang et al., 2014), which is a widely used instrument and consists of nine items. Participants rated each item on 4-point Likert scale ranging from 1 (not at all) to 4 (nearly every day), on the basis of how much a symptom had bothered them over the last 2 weeks. The PHQ-9 has very high levels of both reliability and construct validity (Kroenke et al., 2001). In this investigation, the Cronbach's α-value was 0.89.

The Chinese version of the Buss–Perry aggression questionnaire (time 3)

The Chinese version of the Buss–Perry Aggression Questionnaire (BPAQ) is a valid and accurate indicator of adolescent aggression that is based on empirical research (Maxwell, 2007). This self-report scale assesses the following four different dimensions of aggressive behavior: physical aggression, verbal aggression, anger, and hostility. All items are assessed on a Likert scale ranging from 1 (not at all like me) to 5 (completely like me). Higher overall scores represent more aggression. In this investigation, the Cronbach's α-value was 0.90.

Family socioeconomic status

Information on each participant's family socioeconomic status (family SES; i.e., the annual family income, highest parental occupation, and highest educational level achieved by parents) was collected from adolescents using questions in line with the Program for International Student Assessment (OECD, 2012). The standard scores of these three variables were analyzed using principal component analysis, and the factor scores were saved as family SES scores. The family SES scores in this study ranged from −2.39 to 2.58, whereby higher scores indicated a higher family SES.

Data analyses

In the first step, we assessed bivariate Pearson's correlation coefficients for the key variables. In the second step, we performed structural equation modeling with the maximum likelihood estimator (Muthén and Muthén, 1998-2017) to test our hypothetical model (see **Figure 1**). Given that there was

a strong association between positive parenting of the father and mother, the overall positive parenting was calculated by combining the positive parenting items into two parcels using a domain-representative technique to prevent exaggerated measurement errors due to many latent variable items (Little et al., 2002). Similarly, the BPAQ and PHQ-9 items were grouped into three and four parcels, respectively, using a domain-representative technique (Little et al., 2002). A full information maximum likelihood estimator was used to address the missing data issue, which is the suggested strategy for dealing with missing random data (Enders, 2010). Sex (male = 1), age, and family SES were entered in the structural equation models as covariates. The comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA) were used to assess the adequacy of the model. CFI and TLI values greater than 0.95 and RMSEA values less than 0.06 indicate a good model fit, whereas CFI and TLI values greater than 0.9 and RMSEA values less than 0.08 indicate a satisfactory model fit (Hu and Bentler, 1999; Marsh et al., 2005). In the third stage, we employed bootstrap techniques with 5,000 samples and 95% confidence intervals to examine various mediation effects (Shrout and Bolger, 2002).

Results

Associations between study variables

The means and standard deviations of all variables, as well as the bivariate correlations between variables, are reported in **Table 1**. Overall positive parenting was positively correlated with mindfulness ($r = 0.28$, $p < 0.001$), and both overall positive parenting and mindfulness were negatively correlated with suicidal ideation, depression, and aggression ($r = -0.35$ to -0.16, all $p < 0.01$).

Pathway analysis

The hypothetical model showed a good fit to the data (CFI = 0.977, TLI = 0.973, RMSEA = 0.039, 90% confidence interval = [0.030, 0.047]), and all factor loadings of the latent variables were significant and above 0.60. Sex, age, and family SES did not predict suicidal ideation, depression, or aggression. **Figure 2** and **Table 2** present the direct and indirect effects. Overall positive parenting positively predicted mindfulness ($\beta = 0.29$, $p < 0.001$), negatively predicted suicidal ideation ($\beta = -0.26$, $p < 0.001$) and depression ($\beta = -0.12$, $p = 0.03$), and did not significantly predict aggression ($\beta = -0.06$, $p = 0.314$). Mindfulness negatively predicted suicidal ideation ($\beta = -0.18$, $p = 0.004$), depression ($\beta = -0.29$, $p < 0.001$), and aggression ($\beta = -0.37$, $p < 0.001$). All the indirect effects of overall positive parenting on suicidal ideation ($\beta = -0.05$, $p = 0.012$), depression ($\beta = -0.08$, $p = 0.001$), and aggression ($\beta = -0.11$, $p < 0.001$) *via* mindfulness were significant, as zeros were present in the bias-corrected bootstrap 95% confidence intervals.

Discussion

While numerous studies have identified negative associations between positive parenting and depression, aggression, and suicidal ideation in adolescents, we know relatively little about the role of mindfulness as a mechanism underlying these relationships, particularly in a Chinese context. Furthermore, previous studies have generally been cross-sectional, which makes it difficult to make causal inference. The current study fills this gap in the literature by investigating whether mindfulness mediates the relationships between positive parenting and depression, aggression, and suicidal ideation. This is also the first study to take a longitudinal perspective in exploring this in a Chinese context. Several important and novel findings were revealed. First, positive parenting was positively associated with mindfulness longitudinally. Second, positive parenting and mindfulness were both negatively correlated with depression, aggression, and suicidal ideation. Moreover, mindfulness measured at T2 partially mediated the relationship between positive parenting at T1 and depression and suicidal ideation at T3, and fully mediated the relationship between positive parenting at T1 and aggression at T3.

Positive parenting positively predicts mindfulness

As the highlight of our study, positive parenting was positively correlated with mindfulness, as predicted in Hypothesis 1. To the best of our knowledge, this is the first investigation to show that positive parenting is correlated with mindfulness using a longitudinal study design. This finding is consistent with another study, which revealed that parental competency was positively associated with adolescent mindfulness (Nieto-Casado et al., 2022). Another study has suggested that the origins of mindful attention and awareness lie in relationships between caregivers and their children (Ryan et al., 2007). According to the family system theory (Bowen, 1974), positive parenting is a family environment resource that can support adolescents' development of personal competences and help children to establish healthy attachment bonds with their caregivers. The family system theory highlights the significance of the family system for the development of mindfulness, and suggests that mindfulness may be influenced, at least in part, by family relationships and experiences (Bowen, 1974). For example, dispositional mindfulness was lowest among adolescents who reported frequent/intense

TABLE 1 Descriptive statistics and correlations between variables.

	M	*SD*	1	2	3	4	5
1. Overall positive parenting	2.71	0.80	0.95	0.28***	−0.28***	−0.20***	−0.16**
2. Mindfulness	4.14	1.34		0.91	−0.22***	−0.30***	−0.35***
3. Suicidal ideation	1.27	0.44			0.90	0.64***	0.44***
4. Depression	1.62	0.73				0.89	0.57***
5. Aggression	1.91	0.79					0.90

Coefficient alphas are listed in the diagonal of the table. $^{**}p < 0.01$; $^{***}p < 0.001$.

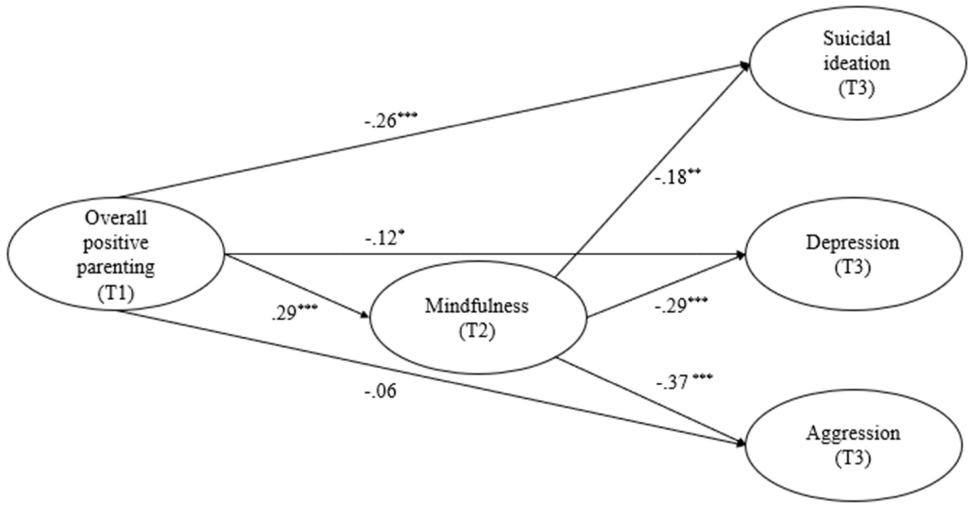

FIGURE 2
The longitudinal mediating role of mindfulness in the association between adolescent overall positive parenting, suicidal ideation, depression, and aggression, with standardized coefficients. Results of covariates (i.e., sex, age, and family SES) are not shown for the purpose of simplicity.

TABLE 2 Results of direct and indirect effects of the hypothetical model.

Variable/Paths	β	*B*	*SE*	*p*	95% CI
Direct effects					
Overall positive parenting → Mindfulness	0.29	0.42	0.09	< 0.001	0.19, 0.39
Overall positive parenting → Suicidal ideation	−0.26	−0.09	0.03	< 0.001	−0.39, −0.12
Overall positive parenting → Depression	−0.12	−0.11	0.05	0.03	−0.23, −0.01
Overall positive parenting → Aggression	−0.06	−0.05	0.05	0.314	−0.17, 0.07
Mindfulness → suicidal ideation	−0.18	−0.04	0.02	0.004	−0.30, −0.06
Mindfulness → depression	−0.29	−0.17	0.04	< 0.001	−0.40, −0.16
Mindfulness → aggression	−0.37	−0.20	0.04	< 0.001	−0.49, −0.23
Indirect effects					
Overall positive parenting→ Mindfulness → Suicidal ideation	−0.05	−0.02	0.01	0.012	−0.10, −0.02
Overall positive parenting → Mindfulness → Depression	−0.08	−0.07	0.02	< 0.001	−0.13, −0.04
Overall positive parenting→ Mindfulness → Aggression parenting	−0.11	−0.09	0.02	< 0.001	−0.17, −0.06

β, standardized coefficient, B, non-standardized coefficient; SE, standard error; CI, confidence interval.

interparental conflict and lowest-quality relationships with their mothers (Lucas-Thompson et al., 2021). In line with this, the experience of positive, supportive warmth from caregivers has been reported to create a sense of security that helps adolescents develop an attentiveness to their own experiences (Parker et al., 2015), which assists the development of a set of cognitive-emotional patterns that promote open, receptive, non-judgmental awareness and attentiveness to whatever circumstances may present themselves (Caldwell and Shaver, 2015). Recently, Lan (2022) reported that parental warmth

is more likely to promote positive parent–child connections characterized by affectionate and cooperative interactions. Additionally, children who grow up in warm and supportive families are more likely to internalize their parents' values, which in turn enhances their capacity to self-regulate (Carlo et al., 2011; Ngai et al., 2018). Moreover, positive parenting, which entails a balanced approach to offering warmth, respect, autonomy, communication, and support without disregarding acceptable degrees of control and regulation, has been found to increase children's level of adjustment competence (Schofield et al., 2014). In other words, positive parenting facilitates the development of positive relationships with adolescents, which in turn helps to cultivate mindfulness abilities.

Positive parenting and mindfulness negatively predict adolescent suicidal ideation and depression

The correlation results showed that positive parenting and mindfulness were both longitudinally negatively associated with depression and suicidal ideation, while only mindfulness was negatively associated with aggression longitudinally, which supports Hypothesis 2, as well as the results of earlier studies (Bamaca-Colbert et al., 2018; Zhu et al., 2021). Some studies have found that positive parenting is linked to a reduced risk of depression (Feng et al., 2009; Clayborne et al., 2021), suicidal ideation, and behavior (Lai and McBride-Chang, 2001), and aggressive behavior (Chen and Raine, 2018) in adolescents. A negative relationship between mindfulness and depression has also been reported in several studies (Christopher and Gilbert, 2010; Bajaj et al., 2016; Kircaburun et al., 2019; Al Harbi et al., 2021; Sharma and Kumra, 2022). Furthermore, a growing body of research has shown that MBIs can effectively reduce depression and aggression (Kriakous et al., 2021; Rezakhani and Vakili, 2021) in both clinical and non-clinical populations (Williams et al., 2000; Williams, 2008).

Nonetheless, our results do not fully support Hypothesis 2, in that we found no direct effect of positive parenting on adolescent aggression. However, this does not refute the notion that positive parenting affects the development of aggression. It is worth noting that previous studies on the relationship between positive parenting and aggression have produced mixed results, including non-significant results in cross-cultural studies. For example, in a juvenile sample of 11–12 year olds (51% boys, 80% African Americans), Chen and Raine (2018) found a negative relationship between positive parenting and aggression among those who matured early, but not among those who matured on time/late. However, another study presented different results, whereby positive parenting was unrelated to aggression in early maturing girls (mean age = 11.25 years; Mrug et al., 2008). Moreover, Yaman et al. (2010) found no main effect of positive parenting on the prediction of toddler aggression. As suggested by meta-analysis findings from Rothbaum and Weisz (1994), the relationship between parenting quality and child aggression may be weaker in toddlers and preschoolers than in older children. In addition, a separate meta-analysis found that the association between positive parenting and reduced aggression was strongest among college students, moderate among seniors, and minimal among middle and elementary school students in China (Lei et al., 2018). The reasons for these contradictory findings could lie in the use of different instruments for measuring outcomes, or in the demographic makeup of the study population (Lei et al., 2018).

There are various explanations for the present result of no direct effect of positive parenting on adolescent aggression. As opposed to depression and suicidal ideation, the aggression we measured, which includes physical aggression, verbal aggression, anger, and hostility, was related to interpersonal interactions. First, the effect size of correlations between positive parenting and aggression was small ($r = -0.16$, $p < 0.01$). Given that mindfulness mediated the relationship between positive parenting and aggression, positive parenting had no direct influence on adolescent aggression. Second, there may be some factors (peer friendships, the environment, etc.) that account for the indirect relationship between positive parenting and aggression. For instance, Hartup and Stevens (1997) posited that the influence that parents exert over children's behavior decreases as peer relationships and friendships grow more salient and relationships with parents become less important on entering adolescence. Third, individual characteristics (such as emotional regulation or hostile attribution biases) could influence the indirect relationship between positive parenting and aggression (Kawabata et al., 2011). This result may also be explained by the idea that positive parenting promotes socio-cognitive traits such as emotion management, self-confidence, and social competence, all of which can help to prevent the emergence and maintenance of aggression (Kawabata et al., 2011). For instance, previous studies have indicated that children who are exposed to positive parenting are provided with a socializing situation that promotes their ability to regulate emotions and social competence, both of which may be linked to a lower incidence of aggressive behavior (Parke et al., 1992; Zhou et al., 2002).

Adolescent mindfulness mediates the relationship between positive parenting and suicidal ideation, depression, and aggression

We found that mindfulness mediated the effect of positive parenting on adolescent depression, aggression, and suicidal ideation, which supports Hypothesis 3. More specifically, the mediation effect was only partial due to the direct effects of

positive parenting on depression and suicidal ideation in the structural model. However, mindfulness completely mediated the association between positive parenting and aggression. Mindfulness can be defined as an awareness of our thoughts, feelings, physical sensations, and surrounding environment on a moment-to-moment basis. Being mindful is associated with openness, non-judgment, awareness, friendliness, acceptance, compassion, and kindness (Baer et al., 2019), and can reduce rumination and the frequency of both depressive symptoms (Moreira and Canavarro, 2018) and suicidal outcomes (Hargus et al., 2010; Nieto-Casado et al., 2022). Recent work has demonstrated that mindfulness partially mediates the correlations between parental competence and both anxious-depressive symptoms and suicidal ideation in adolescents (Nieto-Casado et al., 2022). The SEL model can be used to explain the role of mindfulness as a mediator in the association between positive parenting and adolescent depression, aggression, and suicidal ideation identified in this study (Tolan et al., 2016). During parent–child interactions, a supportive, encouraging, and warm parent is more likely to model sensitivity and attentiveness to the adolescent, which can create a safe and supportive environment that conveys to the adolescent that they are loved and accepted (World Health Organization [WHO], 2007; Juffer et al., 2012). Adolescents who feel that their parents accept them are more inclined to interact with the world in a more mindful way. Mindfulness can foster a more profound and long-lasting awareness of being engaged with whatever is occurring in the present moment, with a recognition that every moment, whether positive or negative, is temporary and will be promptly replaced by a new experience (Kabat-Zinn, 2003). To put it another way, mindfulness promotes greater acceptance and less reactivity to whatever is taking place on physical, cognitive, affective, and behavioral levels, and also increases flexibility and accuracy in one's perception about what is taking place in the present moment (Duncan et al., 2009). From this perspective, adolescents who have higher levels of mindfulness are better able to remain open and responsive to their current negative experiences rather than judging, ignoring, or minimizing them, which in turn makes them less prone to suffer depression or suicidal ideation (Kabat-Zinn, 2003; Wallace and Shapiro, 2006; Coffey et al., 2010).

The current study also found an indirect association between positive parenting and aggression, which was fully mediated by mindfulness in adolescents. A key aspect of mindfulness is being aware of one's own impulses and realizing that they are transient, which strengthens an individual's ability to resist action until the impulse has passed (Katz and Toner, 2013). This means that adolescents with high levels of mindfulness are more likely to have a deeper comprehension of their cognitive and behavioral processes, and are able to learn to respond more intentionally and consciously rather than reactively or automatically (Kabat-Zinn, 2003). In this case, flexibility and awareness can help them see other possibilities or options, rather than seeing aggression as the only viable response. Some studies have painted a negative picture of Chinese parenting, characterizing it as overbearing and even hostile (Chao, 1994). However, adolescents living in families with positive parenting may learn to regulate their negative emotions in adaptive ways by observing their parents' behavior. This can result in more psychosocial adjustment, which may decrease the likelihood of mental health problems.

These findings are largely congruent with SEL theory (Tolan et al., 2016), which argues that parents can have long-lasting positive impacts on their children. Namely, adolescents cumulatively learn more self-awareness, self-management, and relationship skills from their parents' positive support, which they are able to put into practice as they gain more freedom to act. We speculated that when children feel that they are cared for, encouraged, supported, and accepted through their parents' behavioral style, they foster the capacity to accept themselves and their own emotional state. In other words, positive parenting may help to cultivate mindfulness in adolescents, and this mindfulness could mitigate depression, aggression, and suicidal ideation.

Implications and recommendations

First, evidence from this study bolsters the public health emphasis on improving and encouraging positive parenting skills for better adolescent mental health. The present findings suggest that it is necessary to develop a positive parent–child relationship to foster positive adolescent development. Hence, schools or governments could offer education or training that provides parents with information about positive parenting, as well as the skills they need to parent effectively, which would promote positive development and reduce negative outcomes for youths. The second important point is that our model's emphasis on the importance of mindfulness suggests that positive parenting practices can cultivate mindfulness, which would result in greater improvement in mental health. Moreover, whether the parenting practice is positive or not, mindfulness interventions could improve the consequences of parenting practice.

Limitations and future research

Despite the numerous strengths of this longitudinal study, some limitations must be noted. First, all of the data came from participants' subjective reports; future studies should incorporate other forms of evidence (such as reports from teachers and classmates) to bolster the reliability of our results. Future studies could also overcome this limitation by using multi-source data collection methods or experimental method

designs to test our theoretical models and determine the causal relationships between variables. Second, participants were Chinese middle school students, so our results are not generalizable to Chinese adults. Third, while this research examined the mediation role of mindfulness in the link between positive parenting and maladaptive psychological outcomes, individual factors, such as adolescent resilience (Kaniušonytė and Laursen, 2022), may also mediate the effects of positive parenting on adolescent mental health. Therefore, future studies should focus on additional protective factors that might also play a mediating role in the link between positive parenting and adolescent mental health. Fourth, despite our use of longitudinal data, the time interval between the measurement waves was only 2 months. This may not be sufficient to detect the wave-to-wave influence of the constructs on one another. Future studies should explore the influence of positive parenting and mindfulness in multiple waves at longer time intervals to clarify how mindfulness mediates the effects of positive parenting and maladaptive psychological outcomes. Fifth, a longitudinal design enabled us to test mediation effects in a more rigorous manner than for cross-sectional designs. However, each variable was measured only once, and so our results could lack stability (Cole and Maxwell, 2003). Future studies should collect all variables at all waves and use a three-wave cross-lagged analysis to verify the model proposed in this study. Intervention studies investigating whether mindfulness changes aggression/depression/suicidal ideation in adolescents would also clarify the issue of directionality. In future research, we will use intervention or experimental methods to directly explore the relationship between independent variables (mindfulness) and dependent variables (depression, aggression, and suicidal ideation).

Conclusion

This is the first study to examine the longitudinal relationship between positive parenting and mindfulness, aggression, depression, and suicidal ideation in a sample of Chinese middle school students. The current study expands on previous work and provides important insights that enhance our understanding of these relationships. Given that positive parenting may increase adolescents' level of mindfulness, this mechanism could facilitate the design of depression and suicide intervention and prevention programs.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The datasets used and/or analyzed during the current study are available from the corresponding authors on reasonable request. Requests to access these datasets should be directed to corresponding authors.

Ethics statement

This study had been approved by the academic committee of Zunyi Medical University. Written informed consent to participate in this study was provided by the participants or their legal guardian/next of kin.

Author contributions

YS, WS, and ZL designed the study. WS and ZL collected the data. HT, ZL, QZ, and GL analyzed and interpreted the data. YS drafted the manuscript. LH, YG, HT, and ZL revised the manuscript critically for important intellectual content. All authors agreed to be accountable.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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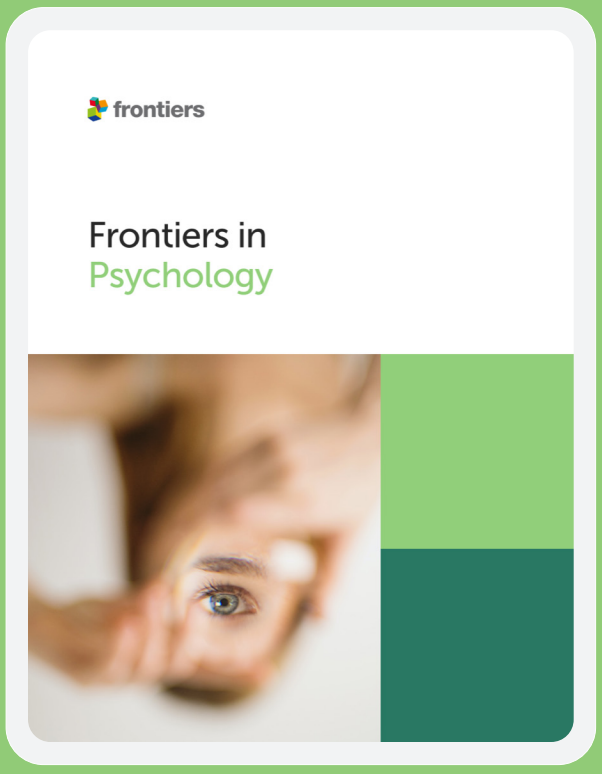

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