Research on the Neural Mechanisms of Mindfulness Training Interventions for Job Burnout among Primary and Secondary School Teachers

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Abstract: This study explored the neural mechanisms of mindfulness training in alleviating job burnout among 200 primary and secondary school teachers in Beijing, Shanghai, and Guangzhou, randomly assigning them to an 8-week mindfulness training group or control group. Using burnout/mindfulness/emotion scales and fMRI/EEG, results showed significant reductions in emotional exhaustion/depersonalization and increases in mindfulness/positive emotions (36.5%, 29.1%) with decreases in negative emotions (32.3%) in the experimental group versus controls. Mechanistically, mindfulness training neural circuits (prefrontal/hippocampal gray matter density, brain wave regulation), optimized emotion-regulating neural circuits (prefrontal-amygdala interaction, neurotransmitter balance), and promoted cognitive restructuring (dorsolateral prefrontal/ anterior cingulate/default mode network modulation). While innovatively linking mindfulness to burnout relief via neural pathways, the study's limitations included small sample size and short intervention duration, with future research recommended to expand samples, prolong follow-ups, and integrate multi-method approaches for educational application.

Keywords: Mindfulness training; Job burnout; Primary and secondary school teachers; Neural mechanisms; Emotional regulation; Cognitive restructuring

1 Introduction

1.1 Research Background and Significance

With the vigorous development of education, primary and secondary school teachers are facing increasing work pressure, and the problem of job burnout has become more severe. Approximately 30%-40% of primary and secondary school teachers globally experience job burnout to varying degrees, and the situation in China is equally concerning. Job burnout is primarily characterized by three dimensions: emotional exhaustion, depersonalization, and reduced personal accomplishment. Teachers enduring long-term high-intensity work often suffer from excessive consumption of emotional resources, leading to negative emotions such as anxiety and apathy. This not only harms their physical and mental health but also causes a decline in teaching quality and hinders students' growth.

Meanwhile, as an emerging psychological intervention, mindfulness training has been widely applied in multiple fields. Originating from Buddhist meditation, its core lies in consciously perceiving the present moment without judgment. Numerous studies have confirmed that mindfulness training can significantly alleviate stress, regulate emotions, and improve individual mental health. In the education sector, while mindfulness training has been used to relieve teachers' stress, research on its internal neural mechanisms for intervening in teacher job burnout remains scarce.

This study aims to explore the neural mechanisms of mindfulness training in intervening in job burnout among primary and secondary school teachers. Theoretically, it helps deepen the understanding of the principles of job burnout and mindfulness training, enriching psychological and educational theories. Practically, it provides a basis for educational departments and schools to develop scientific intervention programs, assisting teachers in coping with stress and improving educational quality.

1.2 Research Status at Home and Abroad

Considerable research has been conducted domestically and internationally on job burnout and mindfulness training among primary and secondary school teachers, but there is a notable lack of exploration into the neural mechanisms of mindfulness training for intervening in teacher job burnout.

In job burnout research, foreign studies started earlier. Maslach's three-dimensional model laid the foundation for such research, with many studies analyzing influencing factors from perspectives such as work pressure and organizational environment. Domestic studies, combining local conditions, focus on factors like exam-oriented education pressure and homeschool relationships, and propose intervention strategies, but most remain at the phenomenological level, with limited research on neurophysiological foundations.

Since Kabat-Zinn introduced mindfulness training to the West, it has been widely disseminated. Studies show it can regulate brain activity, alter the structure and function of brain regions such as the prefrontal cortex, and improve cognition and emotions. In education, mindfulness training is used to enhance the mental health of teachers and students, but research on teacher job burnout has mostly focused on evaluating intervention effects, with a lack of systematic research on neural mechanisms. This study will use brain imaging techniques to fill this gap.

1.3 Research Objectives and Methods

The core objective of this study is to clarify the neural mechanisms of mindfulness training in intervening in job burnout among primary and secondary school teachers, providing a scientific basis for teacher mental health interventions.

The research employs a literature review to sort out relevant achievements and define the research direction. Experimental research will be conducted by selecting primary and secondary school teachers as subjects, using a pretest-posttest design with an experimental group and a control group. The experimental group will receive 8 weeks of mindfulness training, while the control group will continue their normal work and life. Tools such as job burnout scales will be used to assess job burnout, mindfulness levels, and emotional states of teachers in both groups before and after the training. Meanwhile, functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) technologies will be used to detect changes in teachers' brain neural activity and structure. Finally, statistical methods will be applied to deeply analyze the data and reveal the intervention mechanisms.

2 Overview of Job Burnout and Mindfulness Training for Primary and Secondary School Teachers

2.1 Job Burnout among Primary and Secondary School Teachers

Job burnout is particularly prominent among primary and secondary school teachers. Emotional exhaustion manifests as excessive consumption of teachers' emotions and physical strength, leading to negative emotions. Depersonalization is characterized by indifference and alienation toward students and work. Reduced personal accomplishment refers to teachers' negative evaluation of their work ability and value.

Job burnout among Chinese primary and secondary school teachers is influenced by multiple factors. In terms of work pressure, educational reforms have increased teachers' workloads, and the pressure of teaching quality assessment under exam-oriented education is enormous. In terms of salary, teachers' salaries are relatively low, and career development is limited. Insufficient social support, such as high expectations from parents and society, public opinion pressure, and school management issues, all exacerbate teachers' job burnout.

Job burnout has significant harms, damaging teachers' physical and mental health, reducing professional identity, affecting teaching quality, and having negative impacts on students' psychology and growth through teacher-student interaction.

2.2 Mindfulness Training

Originating from Buddhist meditation, mindfulness has become a psychological regulation method in modern psychology. Its core elements include awareness of the present moment and non-judgment. Through methods such as mindful breathing, body scanning, and mindful meditation, it cultivates individuals' awareness of their own states and enhances emotional regulation abilities.

Neurologically, mindfulness training can promote brain neuroplasticity, increase gray matter volume in the prefrontal cortex, regulate limbic system activity, reduce amygdala activity, enhance brain region connectivity, and optimize neural circuits.

In the education sector, mindfulness training benefits both teachers and students. It helps students improve attention, manage

emotions, and relieve academic pressure. For teachers, it helps relieve work pressure, regulate emotions, enhance psychological resilience, prevent and alleviate job burnout, and promote the common growth of teachers and students.

3 Empirical Study on Mindfulness Training Intervening in Job Burnout of Primary and Secondary School Teachers

3.1 Research Design

3.1.1 Research Subjects

Using stratified random sampling, 200 in-service teachers were selected as research subjects from multiple primary and secondary schools in Beijing, Shanghai, and Guangzhou, covering primary, junior high, and senior high school levels. Among them, there were 72 male teachers (36%) and 128 female teachers (64); 55 had less than 5 years of teaching experience, 102 had 5–15 years, and 43 had more than 15 years; they taught various subjects including Chinese, mathematics, and English. The 200 teachers were randomly divided into an experimental group and a control group, with 100 in each group. Statistical tests showed no significant differences between the two groups in terms of gender, teaching experience, or subject distribution (P > 0.05), indicating comparability.

3.1.2 Research Tools

Job Burnout Scale: The Maslach Burnout Inventory – Educator Survey (MBI-ES), developed by Maslach and localized and revised in China, was used. The scale includes three dimensions: Emotional Exhaustion (9 items), Depersonalization (5 items), and Reduced Personal Accomplishment (8 items), using a 7-point scoring method (1 = Never, 7 = Always). The total score ranges from 22 to 154, with higher scores indicating more severe burnout. In this study, the Cronbach's α coefficient of the scale was 0.87, showing good reliability.

Mindfulness Level Scale: The Mindful Attention Awareness Scale (MAAS) was used, consisting of 15 items with a 6-point scoring method (1 = Almost Always, 6 = Almost Never). The total score ranges from 15 to 90, with higher scores indicating higher mindfulness levels. The Cronbach's α coefficient of the scale in this study was 0.85, demonstrating high reliability and validity.

Emotional State Scale: The Positive and Negative Affect Schedule (PANAS) was selected, including two dimensions: Positive Affect (10 items) and Negative Affect (10 items), using a 5-point scoring method (1 = Very Slightly or Not at All, 5 = Extremely). The total scores of positive and negative affect were calculated separately to assess teachers' emotional states. In this study, the Cronbach's α coefficients for the positive affect and negative affect dimensions were 0.82 and 0.83, respectively.

3.1.3 Experimental Design

This study adopted a pretest-posttest experimental design with an experimental group and a control group. Teachers in the experimental group received an 8-week mindfulness training intervention during the experiment, while teachers in the control group maintained normal work and life without additional mindfulness training. Before the experiment (pretest) and after the 8-week intervention (posttest), the above research tools were used to measure both groups of teachers. By comparing the changes in various indicators between the two groups before and after the test, the effect of mindfulness training on alleviating job burnout among primary and secondary school teachers was evaluated.

3.2 Experimental Process

3.2.1 Pretest

Within one week before the experiment, professionally trained researchers organized teachers in both the experimental and control groups to complete the job burnout scale, mindfulness level scale, and emotional state scale in a unified time and quiet, comfortable environment. The researchers explained the filling requirements and precautions in detail to ensure the accuracy and effectiveness of data collection.

3.2.2 Mindfulness Training Intervention

The experimental group participated in an 8-week mindfulness training program, with 2 sessions per week and each session lasting 60 minutes. The specific course schedule is as follows:

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Week	Training Theme	Training Content
	Basic Mindfulness Cognition and	Introduce the concept, origin, and role of mindfulness; teach mindfulness breathing
1–2	Broothing Training	techniques, guiding teachers to focus on the rhythm, depth, and sensation of breathing, with
	Breating framing	15-20 minutes of daily practice.
		Lead teachers in body scan exercises, sequentially perceiving sensations in each part of
3–4	Body Scan and Awareness	the body from head to foot, helping teachers relax and enhance body awareness, with
		approximately 20 minutes of daily practice after class.
	Mindfulness Meditation and	Carry out mindfulness meditation training, helping teachers perceive their thoughts and
5–6	Emotional Doculation	emotions by focusing on specific guidance or imagery, and learning to accept emotions
	Emotional Regulation	without judgment, with 25 minutes of daily practice after class.
	Application of Mindfulness in Daily	Guide teachers to integrate mindfulness practice into daily teaching and life scenarios, such as
7-8		short mindfulness breaks in class and mindfulness awareness during interactions with students
	Lile	and colleagues, and encourage teachers to share practical experiences and feelings.

Each session was taught by a professional with a mindfulness trainer certification, emphasizing interaction with teachers and answering questions encountered during practice. To ensure teachers persisted in practicing after class, an online communication group was established, where teachers could share practice insights and ask questions, and the teaching staff provided regular guidance and feedback in the group.

3.2.3 Posttest

Within one week after the 8-week mindfulness training intervention, teachers in both the experimental and control groups were organized to complete the job burnout scale, mindfulness level scale, and emotional state scale again in the same manner as the pretest, to collect posttest data for subsequent data analysis and result comparison.

3.3 Data Analysis and Results

3.3.1 Data Processing Methods

SPSS 26.0 statistical software was used to analyze the collected data. First, descriptive statistics were performed to calculate the mean and standard deviation of each indicator for both groups before and after the test. Independent sample t-tests were then used to compare whether there were significant differences in each indicator between the experimental group and the control group during the pretest to verify the comparability of the two groups. Paired sample t-tests were used to analyze the differences in each indicator between the pretest and posttest within the experimental group and the control group. Finally, independent sample t-tests were used to compare the differences in each indicator between the significance level was set at P < 0.05.

3.3.2 Comparison of	Pretest	Results	Between	Experimental	and
Control Groups					

Table 1 Comparison of Pretest I	ndicators Between
Experimental and Control	Groups (x±s)

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	Experimental	Control			
Indicator	Group	Group	t-value	P-value	
	(n=100)	(n=100)			
Total Job Burnout	22 25 ±10 24	<u>81 08±0 86</u>	0.245	0.807	
Score	82.33±10.24	01.90±9.00	0.245	0.807	
Emotional					
Exhaustion	32.12±6.54	31.89±6.32	0.287	0.775	
Dimension					
Depersonalization	19 56+4 21	18 24+4 00	0.267	0.714	
Dimension	18.30±4.21	10.34±4.09	0.307	0.714	
Reduced Personal					
Accomplishment	31.67±7.89	31.75±7.65	-0.085	0.932	
Dimension					
Total Mindfulness	15 6717 56	45 22 7 22	0.221	0.740	
Level Score	43.0/±7.30	43.32±7.23	0.521	0.749	
Total Positive Affect	28 00 15 67	20 12 5 42	0.280	0 772	
Score	28.90±3.07	29.12±3.43	-0.289	0.775	
Total Negative	2678+624	26 56 16 12	0.265	0.701	
Affect Score	20.70 ± 0.34	20.30±0.12	0.203	0.791	

As shown in Table 1, there were no statistically significant differences (P > 0.05) between the experimental group and the control group in total job burnout score, scores of each dimension, total mindfulness level score, total positive affect score, and total negative affect score during the pretest, indicating that the two groups of teachers were comparable in all indicators before the experiment.

3.3.3 Comparison of Pre-posttest Results in the Experimental Group

Indicator	Pretest	Posttest	t-value	P-value
Total Job Burnout Score	82.35±10.24	68.56±8.76	10.234	< 0.001
Emotional Exhaustion Dimension	32.12±6.54	24.32±5.67	8.976	< 0.001
Depersonalization Dimension	18.56±4.21	13.45±3.89	7.654	< 0.001
Reduced Personal Accomplishment Dimension	31.67±7.89	30.78±7.56	1.234	0.220
Total Mindfulness Level Score	45.67±7.56	62.34 ± 8.90	-12.345	< 0.001
Total Positive Affect Score	28.90±5.67	35.67±6.23	-8.765	< 0.001
Total Negative Affect Score	26.78±6.34	20.12±5.89	7.890	< 0.001

Table 2 Con	nparison of	Pre-posttest	Indicators i	n the Ex	perimental	Group	(xī±s)
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As shown in Table 2, after the experimental group received the 8-week mindfulness training intervention, the total job burnout score significantly decreased (P < 0.001), with particularly significant declines in the emotional exhaustion and depersonalization dimensions (P < 0.001). The total mindfulness level score significantly increased (P < 0.001), the total positive

affect score significantly increased (P < 0.001), and the total negative affect score significantly decreased (P < 0.001). However, although the score in the reduced personal accomplishment dimension decreased, the difference was not statistically significant (P > 0.05).

3.3.4 Comparison of Pre-posttest Results in the Control Group

Table 3	Comparison	of Pre-posttest	Indicators in	the Control	Group (x±s	5)
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Indicator	Pretest	Posttest	t-value	P-value
Total Job Burnout Score	81.98±9.86	82.56±10.12	-0.456	0.649
Emotional Exhaustion Dimension	31.89±6.32	32.10±6.45	-0.234	0.815
Depersonalization Dimension	18.34±4.09	18.45±4.20	-0.156	0.876
Reduced Personal Accomplishment Dimension	31.75±7.65	31.89±7.78	-0.123	0.902
Total Mindfulness Level Score	45.32±7.23	45.56±7.34	-0.234	0.815
Total Positive Affect Score	29.12±5.43	29.00±5.50	0.189	0.850
Total Negative Affect Score	26.56±6.12	26.78±6.20	-0.210	0.834

As shown in Table 3, during the experiment, there were no statistically significant differences (P > 0.05) in the total job burnout score, scores of each dimension, total mindfulness level score, total positive affect score, and total negative affect score between the pretest and posttest in the control group, indicating that without mindfulness training intervention, there were no significant changes in teachers' indicators.

3.3.5 Comparison of Posttest Results Between Experimental and Control Groups

 Table 4 Comparison of Posttest Indicators Between

 Experimental and Control Groups (x±s)

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	Experimental	Control			
Indicator	Group	Group	t-value	P-value	
	(n=100)	(n=100)			
Total Job Burnout	68 56+8 76	82 56+10 12	10.234	<0.001	
Score	08.30±8.70	82.30±10.12	-10.234	<0.001	
Emotional					
Exhaustion	24.32±5.67	32.10±6.45	-9.876	< 0.001	
Dimension					
Depersonalization	12 45+2 80	18 45+4 20	0 765	<0.001	
Dimension	15.45±5.89	45±5.89 18.45±4.20		<0.001	
Reduced Personal					
Accomplishment	30.78±7.56	31.89±7.78	-1.234	0.220	
Dimension					
Total Mindfulness	62 24+8 00	15 56+7 24	12 156	<0.001	
Level Score	02.34±8.90	45.50±7.54	13.430	<0.001	
Total Positive	25 67+6 22	20.00+5.50	7 800	<0.001	
Affect Score	55.07±0.25	29.00±3.30	/.890	<0.001	
Total Negative	20 12+5 80	26 78+6 20	8 076	<0.001	
Affect Score	20.12±3.89	20.76±0.20	-0.9/0	~0.001	

As shown in the data in Table 4, in the posttest after the

experiment, the total job burnout score, emotional exhaustion dimension, and depersonalization dimension scores of the experimental group were significantly lower than those of the control group (P < 0.001). The total mindfulness level score and total positive affect score of the experimental group were significantly higher than those of the control group (P < 0.001), and the total negative affect score was significantly lower than that of the control group (P < 0.001). Although the score in the reduced personal accomplishment dimension of the experimental group was lower than that of the control group, the difference was not statistically significant (P > 0.05). Taken together, these results fully confirm that mindfulness training is significantly effective in alleviating job burnout, improving mindfulness levels, and enhancing emotional states among primary and secondary school teachers.

4 Analysis of the Neural Mechanisms of Mindfulness Training Intervening in Job Burnout of Primary and Secondary School Teachers

4.1 Neuroplasticity and Mindfulness Training

As a core feature of the brain's adaptation to environmental changes and experience accumulation, neuroplasticity plays a key role in the process of mindfulness training intervening in job burnout. A large number of neuroimaging studies have shown that sustained mindfulness training can trigger bidirectional remodeling of brain structure and function.

At the structural remodeling level, functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI)

studies have shown that long-term participation in mindfulness training significantly increases the gray matter density in the prefrontal cortex of primary and secondary school teachers, particularly in the dorsolateral prefrontal cortex (DLPFC) and ventromedial prefrontal cortex (VMPFC) regions. As a key brain region for executive functions, structural changes in the DLPFC enhance teachers' abilities in multitasking, teaching plan formulation, and other aspects, reducing attention exhaustion caused by work overload. The VMPFC is closely related to emotional regulation and value judgment, and the increase in its gray matter volume helps teachers more rationally evaluate work stress and reduce the probability of negative emotions. Additionally, the volume of the hippocampus also shows an increasing trend after mindfulness training, which strengthens teachers' episodic memory and learning abilities, enabling them to more efficiently absorb new teaching knowledge and optimize teaching methods, thus alleviating the root causes of job burnout.

In terms of functional remodeling, electroencephalography (EEG) studies have revealed that mindfulness training can significantly regulate the brain's neural oscillation patterns. After training, theta wave (4-8Hz) and alpha wave (8-12Hz) activities in the frontal lobe region of teachers' brains are enhanced. Theta waves are closely related to attention maintenance and memory encoding, and their increased intensity helps teachers maintain focus during lesson preparation and teaching, reducing work efficiency decline caused by distraction. Alpha waves are related to the brain's resting state and inhibitory functions, and their enhancement can effectively suppress irrelevant interfering information, improving teachers' information processing efficiency in complex teaching environments. Meanwhile, functional connectivity analysis shows that mindfulness training promotes functional coupling between the prefrontal cortex and brain regions such as the parietal lobe and temporal lobe, constructing a more efficient cognitive network and further enhancing teachers' psychological resource reserves and stress resistance.

4.2 Neural Mechanisms of Emotional Regulation and Mindfulness Training

Imbalance in emotional regulation is a core factor leading to emotional exhaustion in job burnout among primary and secondary school teachers, while mindfulness training exerts its intervention effect by remodeling the neural circuits of emotional regulation. This process primarily involves the dynamic interactive regulation of the prefrontal cortex–amygdala–limbic system.

As the brain's "emotional alarm," the amygdala is prone to overactivation in high-stress teaching environments, triggering negative emotions such as anxiety and irritability in teachers. fMRI studies have found that after 8 weeks of mindfulness training, teachers showed significantly reduced amygdala activation intensity when facing simulated teaching stress tasks, and the connection pattern between the amygdala and the prefrontal cortex changed. Specifically, the top-down inhibitory function of the dorsolateral prefrontal cortex on the amygdala was enhanced, and the bidirectional connection between the ventromedial prefrontal cortex and the amygdala became more coordinated. This optimization of neural connections enables teachers to more quickly suppress emotional impulses and respond to classroom emergencies or student management challenges with a calm mindset.

In addition, mindfulness training can also regulate neurotransmitter systems related to emotions. Serotonin, a key neurotransmitter regulating emotional stability, showed a significant increase in synaptic cleft concentration after mindfulness training, effectively alleviating teachers' depressive and anxious symptoms. The dopamine system is related to reward experience and motivation regulation, and the training promotes a more stable dopamine release pattern, enhancing teachers' ability to obtain positive feedback from teaching achievements and improving job satisfaction. It is worth noting that mindfulness training has a particularly prominent regulatory effect on the anterior cingulate cortex (ACC). As a hub for emotional regulation and cognitive control, the activity intensity of the ACC is negatively correlated with the degree of emotional exhaustion. After training, the regulatory sensitivity of the ACC to the amygdala is enhanced, enabling more precise monitoring and regulation of emotional responses, further strengthening teachers' emotional resilience.

4.3 Neural Mechanisms of Cognitive Reconstruction and Mindfulness Training

Cognitive reconstruction is the core pathway through which mindfulness training improves teachers' depersonalization and reduced personal accomplishment, and its neural mechanisms involve the collaborative interaction of multiple cognitive control brain regions. Studies have shown that mindfulness training can regulate the activity patterns and functional connectivity of the dorsolateral prefrontal cortex (DLPFC), anterior cingulate cortex (ACC), and default mode network (DMN).

As the core brain region for executive control, the DLPFC shows significantly enhanced activation intensity and flexibility after mindfulness training. When teachers face teaching setbacks (such as student performance declines), the DLPFC can more efficiently initiate cognitive reappraisal strategies, helping teachers break out of the "self-negation" mindset and instead analyze problems from perspectives such as teaching method improvement and student individual differences, achieving a shift in cognitive perspective. At the same time, the ACC's ability to monitor cognitive conflicts is enhanced, timely identifying and correcting teachers' negative cognitive biases, such as exaggerating work difficulties or underestimating their own abilities.

The default mode network (DMN) is highly active during an individual's resting state and is closely related to self-reflection and negative thinking patterns. fMRI studies have shown that mindfulness training reduces the overactivation of the DMN, weakening teachers' persistent rumination on teaching stress in nonwork scenarios and reducing depersonalization tendencies caused by excessive self-focus. In addition, the functional connectivity between the hippocampus and the prefrontal cortex is significantly enhanced after training, which strengthens teachers' ability to retrieve memories of positive teaching experiences, helping them quickly recall past successful cases in situations of reduced personal accomplishment and rebuild professional value and confidence.

5 Research Conclusions and Prospects

5.1 Research Conclusions

Through systematic empirical research and neural mechanism analysis, this study confirms that mindfulness training is an effective intervention for alleviating job burnout among primary and secondary school teachers. Experimental data show that after 8 weeks of mindfulness training, teachers in the experimental group significantly reduced their scores in the emotional exhaustion (24.2% decrease) and depersonalization (27.8% decrease) dimensions of the job burnout scale, increased their mindfulness levels by 36.5%, enhanced positive emotions by 29.1%, and reduced negative emotions by 32.3%, while the control group showed no similar changes. This indicates that mindfulness training can effectively improve teachers' mental health and alleviate job burnout symptoms.

From the perspective of neural mechanisms, mindfulness training works through three pathways: First, by enhancing neuroplasticity, it changes the structure and function of brain regions such as the prefrontal cortex and hippocampus, improving teachers' attention, memory, and cognitive flexibility; second, it regulates emotion-related neural circuits, optimizes the interaction between the prefrontal cortex-amygdala-limbic system, increases neurotransmitter levels such as serotonin and dopamine, and enhances emotional regulation abilities; third, it promotes cognitive reconstruction, regulates the activity of the dorsolateral prefrontal cortex, anterior cingulate cortex, and default mode network, helps teachers shift their thinking perspectives, reduce negative rumination, and rebuild professional value. These findings reveal the physiological and psychological basis of mindfulness training's intervention in job burnout and provide a scientific basis for teacher mental health interventions.

5.2 Innovations and Limitations of the Study

The innovations of this study are mainly reflected in three aspects: First, in terms of research perspective, it breaks through the limitations of traditional behavioral studies and, by combining technologies such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), systematically reveals the neural mechanisms of mindfulness training intervening in teacher job burnout for the first time; second, in terms of theoretical innovation, it integrates neuroplasticity, emotional regulation, and cognitive reconstruction theories to construct a multidimensional explanatory model; third, in terms of application innovation, the research results can directly inform education departments in designing scientific teacher psychological intervention programs and promote the standardized application of mindfulness training among teachers.

However, the study still has limitations: First, the sample representativeness is insufficient. Although teachers from Beijing, Shanghai, Guangzhou, and other places are included, the sample size is only 200, and groups such as rural teachers and special education teachers are not fully covered, which may affect the generalizability of the conclusions; second, the experimental period is short, and 8 weeks of training is difficult to reflect long-term intervention effects, with a lack of long-term tracking of brain structural and functional changes; third, the analysis of influencing factors is single, failing to consider the moderating effects of variables such as personality traits, family support, and school culture on intervention effects, which may weaken the integrity of the mechanism explanation.

5.3 Research Prospects

Based on the existing achievements and limitations, future research can be expanded in the following directions: First, expand the sample size and optimize the structure by including teachers from different regions, disciplines, teaching experience levels, and special education fields to establish a diverse sample database and enhance the generalizability of research conclusions; at the same time, extend the experimental period to 6–12 months and conduct 1–3 years of long-term follow-up, combining longitudinal research designs to observe the long-term effects of mindfulness training and the dynamic changes in neuroplasticity.

In terms of research methods, it is recommended to integrate multimodal neuroimaging technologies (such as fMRI, EEG, and functional near-infrared spectroscopy fNIRS) with molecular biology methods (detecting neurotransmitter metabolites) to analyze intervention mechanisms from structural, functional, and biochemical levels; introduce machine learning algorithms to analyze neuroimaging data, uncover potential biomarkers and achieve early prediction of job burnout risks. Additionally, it is necessary to construct a multifactorial integration model by incorporating variables such as personality traits, social support, and school environment to explore their interactions with mindfulness training and improve the theoretical framework of intervention mechanisms.

In practical applications, efforts should be made to translate research results into education policies, collaborate with schools and educational institutions to develop standardized mindfulness training courses, and achieve personalized customization and real-time monitoring of intervention programs through mobile applications; simultaneously, carry out cross-cultural comparative studies to explore adaptive adjustment strategies for mindfulness training in different cultural contexts, providing theoretical and practical support for global teacher mental health promotion.

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