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A randomized controlled trial evaluating school-based mindfulness training on internalizing problems in Chinese rural left-behind children: Exploring the potential mechanism of intervention effects

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A randomized controlled trial evaluating school-based mindfulness training on internalizing problems in Chinese rural left-behind children: Exploring the potential mechanism of intervention effects

Abstract

This randomized controlled trial aimed to evaluate the effectiveness of a school-based mindfulness training program on internalizing problems among Chinese rural left-behind children (RLBC) and to explore potential underlying mechanisms. A total of 102 RLBC (age = 12.86 ± 0.56) in the experimental group received a 10-week school-based mindfulness intervention, while 109 RLBC (age = 12.73 ± 0.54) in a wait-list control group received no intervention. Trait mindfulness, internalizing problems, self-compassion, and perceived stress were assessed at pre-test, post-test, and a 10-week follow-up. Results indicated that: (1) Compared to both pre-test scores and the wait-list control group at all time points, the experimental group showed significant reductions in perceived stress and internalizing problems at post-test. Conversely, scores for trait mindfulness and self-compassion significantly increased at post-test and follow-up for the experimental group. (2) Analyses revealed a significant direct effect of trait mindfulness on internalizing problems, as well as significant simple and chain mediating effects of self-compassion and perceived stress. The findings suggest that school-based mindfulness training can enhance trait mindfulness and self-compassion, buffer perceived stress, and alleviate internalizing problems in Chinese RLBC. Furthermore, the effect of trait mindfulness on internalizing problems appears to be multiply mediated by self-compassion and perceived stress.

Highlights

- School-based mindfulness training significantly reduced internalizing problems in Chinese rural left-behind children, with gains sustained at 10-week follow-up.
- The intervention increased self-compassion and buffered perceived stress, which sequentially mediated the relationship between trait mindfulness and internalizing problems, highlighting potential psychological mechanisms underlying mindfulness-based interventions.
- Findings support the feasibility of school-based mindfulness programs for vulnerable youth in rural China, though small-to-moderate effect sizes warrant further research with active controls and longitudinal mediation designs.

Keywords Internalizing problems · Trait mindfulness · Self-compassion · Perceived stress · Rural left-behind children · School-based mindfulness training

Childhood and adolescence are periods marked by rapid physical, cognitive, and socio-emotional development. Worldwide, navigating these multifaceted changes can pose significant challenges to mental health, and internalizing problems are among the most prevalent psychopathological concerns during this developmental stage (Merrell, 2008). Internalizing problems are typically characterized as maladaptive patterns of over-regulated or, at times, under-regulated cognition and emotion that are primarily directed inward (Merrell & Gueldner, 2010). These problems commonly encompass symptoms of anxiety, depression, social withdrawal, and somatic complaints. Large-scale epidemiological studies suggest a substantial number of children and adolescents experience clinically significant or sub-threshold internalizing problems (Merikangas et al., 2010), with some evidence pointing to rising trends, particularly in certain contexts and populations (e.g., Muris et al., 2020). This period of development is therefore recognized as one of heightened vulnerability to the onset of such

problems (Hankin et al., 2015). The concern is well-founded, as internalizing problems are associated with significant functional impairment across multiple life domains (Felton et al., 2017; Balazs et al., 2013) and represent a major risk factor for suicidal ideation and behavior-leading causes of mortality in this age group (Kessler et al., 2012). Beyond the profound personal toll, these conditions also carry substantial societal and economic costs.

In China's rural communities, a specific subgroup known as rural left-behind children (RLBC) has garnered considerable attention from researchers and policymakers. RLBC are typically defined as children under 18 years of age whose parent(s) have migrated for work for more than six months, leaving them behind in their rural hometowns under the care of one parent, grandparents, or other relatives (Duan et al., 2017; Wang & Lin, 2021). Estimates from 2015 placed their number at over 40 million (Duan et al., 2017). Due to the unique challenges associated with parental migration, such as separation, potential caregiver instability, and emotional deprivation. RLBC are at an elevated risk for mental health difficulties. These challenges are not just abstract; for example, an RLBC might begin and end each day without the direct support of a parent, balancing a heavy load of household chores—such as cooking, cleaning, or caring for younger siblings—before or after school, all while managing academic pressures alone. The absence of parental support can make navigating emotional setbacks or academic setbacks more isolating and stressful, compounding their vulnerability. Research consistently indicates they experience higher rates of internalizing problems, including anxiety and depression, compared to their non-left-behind peers (e.g., Liu et al., 2016; Tang et al., 2018). For instance, one study reported an internalizing problem incidence of 15.19% among RLBC, contrasted with a 6.2% rate in the general child population (Hu et al., 2018). These problems not only compromise individual well-being but also impose a considerable burden on families and communities (Wang et al., 2023).

Consequently, developing and testing effective, accessible interventions to prevent and mitigate internalizing problems in this population is a public health priority.

Schools are increasingly recognized as pivotal settings for delivering mental health promotion and early intervention services, offering advantages such as reduced stigma, systematic implementation, and broad reach (Stephan et al., 2007). Among the array of available approaches, mindfulness-based interventions (MBIs) have emerged as a promising "third-wave" cognitive-behavioral approach for youth. Rooted in ancient contemplative practices but operationalized as a secular, modern psychological training, mindfulness involves paying attention to present-moment experiences with an attitude of openness, curiosity, and acceptance (Kabat-Zinn, 2003). A growing body of research, predominantly from Western contexts, suggests that school-based MBIs can effectively reduce internalizing symptoms in adolescents (e.g., Zoogman et al., 2015; Fung et al., 2019). In China, where mindfulness has deep cultural roots but was reintroduced as a secular intervention more recently, preliminary studies show promise. School-based mindfulness programs have been associated with reduced psychological stress, learning burnout, and improved emotional resilience among Chinese students (e.g., Lei et al., 2022; Zheng et al., 2022). However, despite the high need, empirical research on applying MBIs specifically to RLBC remains scarce, with only a few studies targeting outcomes like examination anxiety (Deng et al., 2022). Furthermore, it is important to acknowledge that the evidence base for mindfulness with youth is not unequivocally positive; some systematic reviews and meta-analyses report mixed or modest effects, highlighting the importance of carefully examining for whom and under what conditions these interventions work (e.g., Carneiro, et al., 2025; Galla, et al., 2024; Johnson, et al., 2024). This study aims to contribute a rigorous, context-specific investigation to this evolving literature.

A critical step in advancing the field involves elucidating how MBIs might confer benefits. Understanding these mechanisms is essential for refining interventions and personalizing their delivery (Kazdin, 2007). A primary pathway is through the cultivation of trait mindfulness- a dispositional capacity for present-moment awareness and non-judgment. Trait mindfulness is considered a psychological resource and a protective factor against psychopathology. Its effects on internalizing problems may be both direct and indirect, mediated through other cognitive-affective processes. Two promising candidate mediators are self-compassion and perceived stress.

Self-compassion, defined as treating oneself with kindness and understanding during times of failure or suffering, seeing one's experiences as part of the common human experience, and holding painful feelings in balanced awareness (Neff, 2003), is closely linked to mindfulness. MBIs often lead to increases in self-compassion (Baer et al., 2012), which in turn has been identified as a protective factor against the development and maintenance of internalizing symptomatology (Zeller et al., 2015; Yu, et al., 2020). Separately, stress is a well-established risk factor for internalizing problems (McLaughlin & Hatzenbuehler, 2009). MBIs appear to reduce perceived stress- the subjective appraisal of life situations as overwhelming and uncontrollable- and this reduction may be one route through which they alleviate internalizing symptoms (Bluth & Eisenlohr-Moul, 2017). Importantly, these pathways may be interconnected. For example, mindfulness may foster self-compassion, which could enhance stress resilience, thereby reducing internalizing problems—a potential chain of mediation (Luo et al., 2019). However, it is worth noting that while perceived stress is a robust predictor of internalizing problems and is targeted by many interventions, it is conceptually and empirically distinct; it represents a cognitive-affective appraisal of external demands rather than the internalized symptom clusters (e.g., anxiety, anhedonia) that define internalizing disorders (Wright, et al., 2023).

The present study had two primary objectives. First, it aimed to evaluate the effectiveness of a school-based mindfulness training program in alleviating internalizing problems among Chinese RLBC, using a randomized wait-list controlled design. We hypothesized that participants receiving the mindfulness training would show greater reductions in internalizing problems compared to the control group. Second, the study sought to explore the potential mediating roles of self-compassion and perceived stress in the relationship between trait mindfulness (the presumed primary change mechanism of the training) and internalizing problems. We hypothesized that self-compassion and perceived stress would partially mediate this relationship, both independently and sequentially.

Methods

Participants

Participants were recruited from a rural junior middle school in Hunan Province, China. The inclusion criteria were: (1) voluntary participation with guardian consent; (2) age between 11 and 15 years; (3) both parents identified as farmers with a rural household registration; (4) one or both parents having migrated for work; (5) continuous separation from the migrant parent(s) for at least six months; and (6) no reported history of severe physical or mental illness.

The required sample size was estimated using G*Power 3.1 (Faul et al., 2009). For a repeated-measures ANOVA (within-between interaction), with an assumed effect size of $\eta^2 = 0.25$, $\alpha = 0.05$, and power $(1-\beta) = .90$, the minimum theoretical sample size was 206. Accounting for an estimated 10% attrition, we aimed to recruit 227 participants.

Out of 296 students initially assessed, 228 who met all criteria were enrolled. Participants were randomly assigned to either the experimental group (n = 114) or the wait-list control group (n = 114).

Randomization was performed by an independent researcher using a computer-generated sequence with block randomization (block size of 4) to ensure balanced group sizes over the recruitment period. Group allocation was concealed until after the completion of baseline assessments. The study was approved by the affiliated institutional ethics review board. Informed consent was obtained from all participants, their guardians, and school authorities.

Measures

Demographic data

Demographic data collected were gender (male, female), age, grade, parents have been away from home for more than six months currently (father, mother, father and mother), rural left-behind student (yes, no), only one-child or not (yes, no), physical condition (good, common), academic performance (excellent, average, poor).

Trait mindfulness

Trait mindfulness was assessed using the Chinese version of Mindful Attention Awareness Scale (MAAS) (Chen et al., 2012). Brown and Ryan believe that the focus of mindfulness should be on concentration and maintaining awareness, so the MAAS items focus on attention and awareness (Brown & Ryan, 2003). The scale is a self-report measure including 15 items rated on a scale of 1-6, with "1=almost always" and "6=almost never". The scale's total score indicates trait mindfulness level; the larger the score, the higher the level of trait mindfulness. The Chinese version of MAAS is highly reliable, valid, and suitable for the Chinese mainland (Black et al., 2012). Cronbach's α in this study was 0.830.

Internalizing problems

The assessment of internalizing problems was conducted using the Chinese Version of Achenbach Youth Self-Report-2001 Version (YSR-2001-CV) (Wang et al., 2013). This scale consists of 119 items, divided into eight sub-scales: anxiety/depression, social withdrawal, somatic complaints, social problems, thought problems, attention problems, delinquent behavior, and aggressive behavior. Additionally, an "Other Problems" sub-scale can provide information on adolescents' emotional and behavioral issues beyond the aforementioned eight factors (Achenbach et al., 2001). While the full YSR is a well-validated instrument, this study utilized the 33 items comprising the Anxiety/Depression, Withdrawal/Depression, and Somatic Complaints sub-scales to create a composite internalizing problems score. The scale employs a 3-point scoring system (0 = no such manifestation, 1 = mild or occasional manifestation, 2 = significant or frequent manifestation). The scores for each factor and dimension are calculated by summing the scores of their constituent items, with higher scores indicating more severe symptoms. The overall scale's Cronbach's α is 0.940 (Wang et al., 2013). The Cronbach's α for this composite in the current sample was 0.915.

Self-compassion

The Chinese short form of Self-Compassion Scale (SCS-CS) (Chen, Yan，& Zhou, 2011) was employed to assess self-compassion. The scale contains 12 items with six dimensions: Self-Kindness, Mindfulness, Common Humanity, Self-Judgment, Isolation, and Over-Identification. The rating of the scale adopts the Likert 5-point scoring method, with "1 = never", "2=occasionally", "3=sometimes", "4=often", and "5=always". The scale's total score indicates self-compassion level; the higher the score, the more self-compassion they experience. The overall scale's Cronbach's α is 0.840 (Chen, Yan &

Zhou, 2011). The Cronbach's α in this study was 0.792.

Perceived stress

The Chinese version of Perceived Stress Scales (PSS) (Yang & Huang, 2003) was employed to assess perceived stress. This scale contains 14 items reflecting feelings of tension and loss of control, divided into two dimensions: tension and loss of control. The rating of the scale adopts the Likert 5-point scoring method, with "0 = never", "1=occasionally", "2=sometimes", "3=often", and "4=always". The scale's total score indicates perceived stress level; the higher the score, the more pressure they experience. The scale's Cronbach's α is 0.891(Yang & Huang, 2003). Cronbach's α in this study's was 0.835.

Intervention program and procedure

The Chinese version of the .b Curriculum of Mindfulness in School Project (MiSP .b) from the "Mindfulness in School Project" (Kirk, 2020) was adopted. The program consists of ten 45-minute weekly sessions delivered by trained facilitators: Introduction to the Mindfulness Course, Playing with Attention, Taming the Wild Heart, Observing Worries, Living in the Present, Observing Activities with Meditation, Taking a Step Back for Boundless Sky, Being Friends with Difficulties, Accepting Beautiful Things, and Integrating into One Lesson. Mindfulness exercises mainly include .b exercises, finger breathing, counting breathing, body awareness, "down to earth, sitting like mountain" meditation, attention "sleepy" exercises, 7/11 breathing exercises, "careful taste" exercises, mindful walking, awareness of inner traffic, ten fingers gratitude exercises, etc.

The program was delivered by trained facilitators who had completed standard 8-week

Mindfulness-Based Cognitive Therapy (MBCT) training and a specific .b curriculum training course. In addition to weekly sessions, participants were encouraged to engage in brief, facilitator-guided daily practices (10-15 minutes) on school days and optional self-practice. Participants completed practice logs recording the content of their daily exercises, frequency, and time.

The wait-list control group received no intervention during the study period but was offered the mindfulness course after all data collection was complete. All primary outcome measures were collected via self-report questionnaires at pre-test (baseline), immediate post-test, and at a 10-week follow-up.

Quality control

In a randomized control design, except for receiving the experimental intervention, the experimental group maintained the same daily life as the wait-list group. The facilitators have fulfilled an 8-week foundational mindfulness-based training and accomplished MiSP. b training. The same facilitators guided the same course section and exercise. In an anonymous form, each participant was given a specific number, which was used as the unique identification in the training and psychological assessment. Psychological assessment and data entry were manipulated by professionally trained personnel. Participants were evaluated in groups at the same time, and unified instruction was used. All participants were required to fill in the questionnaires within 30 minutes. Any errors, omissions, or incorrect entries were checked when recovering the answer paper.

Statistical analysis

Based on Per-Protocol Analysis (PPA), this study employed the repeated measures analysis of variance

(rANOVA) to examine the effectiveness of mindfulness-based training on internalizing problems, trait mindfulness, self-compassion, and perceived stress. When a significant interaction occurred, the source of the significant interaction effect was determined through post-hoc pairwise comparisons. Pearson's correlation was also employed to analyze the relationship between these variables. Ultimately, the effect of trait mindfulness on internalizing problems and the mediating effects of self-compassion and perceived stress were further explored via regression analysis. The demographic differences between the two groups were tested using *t*-tests and χ^2 tests. Missing/incomplete data were processed using the maximum likelihood estimation technique (Enders, 2023). A p-value < 0.05 was considered statistically significant. Data were processed using SPSS 26 (SPSS Inc., Chicago, IL, USA).

Results

General demographic information of participants

Figure 1 illustrates the participant flow through the trial. From the 228 randomized participants, 12 in the experimental group and 5 in the control group were excluded from the PP analysis due to incomplete baseline data, withdrawal, or missing post-test/follow-up assessments. The final PP sample consisted of 102 participants in the experimental group and 109 in the wait-list control group. As shown in Table 1, the two groups did not differ significantly on any baseline demographic characteristic ($p > 0.05$).

Common method bias test

Data were collected through self-report questionnaires, and the common method bias was controlled by reverse scoring, anonymity, and confidentiality promises. Additionally, the Harman single-factor test

was employed to assess common method bias. The results indicated that 15 factors had eigenvalues greater than 1, with the variance explained by the first factor being only 15.86%, which was below the critical threshold of 40%. The result suggested that the common method bias did not affect the results of this study.

Analysis of Intervention Effects

The means and standard deviations for all outcome variables across time points are presented in Table 2, and Figure 2 to Figure 5. The results of ANOVAs are summarized in Table 3 and Table 4.

For trait mindfulness, there were significant main effects of Group (F=289.063, p<0.001, η^2p=0.316) and Time (F=39.955, p<0.001, η^2p=0.113), qualified by a significant Group × Time interaction (F=80.023, p<0.001, η^2p=0.203). Post-hoc tests revealed that while the groups did not differ at pre-test (D-value=0.961, p>0.05, Cohen's d=0.157), the experimental group scored significantly higher than the control group at both post-test (D-value=15.945, p>0.001, Cohen's d=2.686) and tracking-test (D-value=7.788, p<0.001, Cohen's d=1.248). Within the experimental group, mindfulness scores increased significantly from pre- to post-test (D-value=12.598 p<0.001, Cohen's d=2.020) and remained stable (though slightly decreased from post-test) at tracking-test, still being significantly higher than pre-test (D-value=4.735 p<0.001, Cohen's d=0.707). The control group showed a small but significant decline in mindfulness from pre-test to post-test (D-value=2.385, p<0.01, Cohen's d=0.411).

For internalizing problems, significant main effects of Group (F=45.069, p<0.001, η^2p=0.067) and Time (F=3.443, p< 0.05, η^2p=0.011) were observed, again with a significant Group × Time interaction (F=8.690, p<0.001, η^2p=0.027). The experimental group reported significantly lower internalizing problems than the control group at post-test (D-value=-7.507, p<0.001, Cohen's d=0.871) and tracking-test (D-value=-7.142, p<0.001, Cohen's d=0.740), but not at pre-test (D-value=-0.625, p>0.05,

Cohen's d=0.062). Within the experimental group, scores decreased significantly from pre- to post-test (D-value=5.873, p<0.001, Cohen's d=0.735) and this reduction was maintained at tracking-test (D-value=4.618, p<0.001, Cohen's d=0.526), while no significant difference between post-test and tracking-test (D-value=-1.255, p>0.05, Cohen's d=0.188). The control group showed no significant difference between the three tests.

For self-compassion, there were significant main effects of Group (F=107.297, p<0.001, η^2p=0.146) and Time (F=33.068, p<0.001, η^2p=0.095), qualified by a significant Group × Time interaction (F=30.873, p<0.001, η^2p=0.090). Post-hoc tests revealed that while the groups did not differ at pre-test (D-value=-0.030, p>0.05, Cohen's d=0.004), the experimental group scored significantly higher than the control group at both post-test (D-value=11.979, p<0.001, Cohen's d=1.607) and tracking-test (D-value=7.705, p<0.001, Cohen's d=0.981). Within the experimental group, self-compassion scores increased significantly from pre- to post-test (D-value=-12.284, p<0.001, Cohen's d=2.035) and remained stable at tracking-test, still being significantly higher than pre-test (D-value=-7.744, p<0.001, Cohen's d=1.063). The control group showed no significant difference between the three tests.

For perceived stress, significant main effects of Group (F=17.728, p<0.001, η^2p=0.027) and Time (F=5.367, p<0.01, η^2p=0.017) were observed, again with a significant Group × Time interaction (F=5.029, p<0.01, η^2p=0.016). The experimental group reported significantly lower perceived stress than the control group at post-test (D-value=-4.574, p<0.001, Cohen's d=0.578) and tracking-test (D-value=-3.563, p<0.001, Cohen's d=0.443), but not at pre-test (D-value=0.114, p>0.05, Cohen's d=0.014). Within the experimental group, scores decreased significantly from pre- to post-test (D-value=4.716, p<0.001, Cohen's d=0.616) and this reduction was maintained at tracking-test

(D-value=3.833, p<0.001, Cohen's d=0.488), while no significant difference between post-test and tracking-test (D-value=-0.882, p>0.05, Cohen's d=0.108). The control group showed no significant difference between the three tests.

Correlational and Mediation Analyses

This study employed the Pearson correlation analysis to explore the relationships between trait mindfulness, internalizing problems, self-compassion, and perceived stress. The findings indicated that trait mindfulness and self-compassion were significantly negatively correlated with internalizing problems and perceived stress (p<0.01), and there were significant positive correlation between trait mindfulness and self-compassion and between internalizing problems and perceived stress (p<0.01). See Table 5.

Based on the correlation analysis, the study further explored the relationship between internalizing problems, trait mindfulness, self-compassion, and perceived stress, with trait mindfulness as the independent variable, internalizing problems as dependent variables, while self-compassion and perceived stress as mediating variables. Firstly, the relationships between demographic variables and the core variables were analyzed, and no significant correlation was found. Therefore, demographic variables need not to be controlled as co-variances when testing the model. Using Model 6 from the SPSS macro model PROCESS plugin 4.2 developed by Hayes (Hayes, 2022), this study examined the mediating effects of self-compassion and perceived stress on the relationship between trait mindfulness and internalizing problems.

The test results of the pathway model of the effect of trait mindfulness on internalizing problems (see Table 6, Table 7, and Figure 6) indicated that trait mindfulness could significantly negatively predict internalizing problems (β=-0.46, t=-12.930, p<0.01). When including the mediating variables

of self-compassion and perceived stress, the predictive effect of trait mindfulness on internalizing problems remained significant (β=-0.24, t=-6.187, p<0.01). Furthermore, trait mindfulness significantly could positively predicted self-compassion (β=0.52, t=2.090, p<0.05) and negatively predict perceived stress (β=-0.17, t=-4.478, p<0.01), and self-compassion also could negatively predict perceived stress (β=-0.47, t=-12.182, p<0.01), while internalizing problems could be predicted negatively by self-compassion (β =-0.19, t=-4.608, p<0.01) and positively by perceived stress (β=0.28, t=7.187, p<0.01).

In the the pathway model, the direct effect of trait mindfulness on internalizing problems and the simple and chain mediating effects of self-compassion and perceived stress were significant, with the bootstrap 95% CI excluding zero. This indicated that trait mindfulness could not only directly affect internalizing problems but also impact on internalizing problems through the mediating effect of self-compassion and perceived stress. This direct effect (-0.24) and mediating effect (-0.22) accounted for 52.17% and 47.83% of the total effect (-0.46), respectively.

Discussion

Effectiveness of school-based mindfulness group training on internalizing problems

The present study represents one of the first randomized controlled trials to empirically evaluate a school-based mindfulness intervention for internalizing problems among Chinese RLBC. The findings indicate that the 10-week mindfulness program led to statistically significant reductions in self-reported internalizing problems and perceived stress, alongside increases in trait mindfulness and self-compassion, compared to a wait-list control group. Crucially, a portion of these gains persisted at the 10-week follow-up for internalizing problems and perceived stress, suggesting a degree of

medium-term sustainability. This aligns with a growing, though sometimes inconsistent, body of literature supporting the potential of MBIs for youth mental health (Zoogman et al., 2015). However, a nuanced reading of our data is essential. The effect sizes, while significant, were predominantly in the small-to-medium range. This raises important questions about the clinical significance of these changes for a non-clinical, community sample of RLBC. Are these reductions meaningful in their daily lives? While our study cannot definitively answer this, the positive shifts are encouraging.

It is also critical to contextualize these positive findings within the broader, mixed evidence base on youth MBIs. Recent systematic reviews and well-powered trials have highlighted that effects are not universally positive and can depend heavily on implementation quality, participant factors, and context (Saunders et al., 2025; Nagpal, & Radliff, 2024; Preisig, & Neuenschwander, 2025; Carneiro, et al., 2025; D' Souza, & Smyth, 2025). Our study adds a data point suggesting that for this specific vulnerable subgroup—RLBC in a Chinese rural setting—a carefully adapted school-based program can yield benefits. However, we did not assess potential adverse effects, a noted gap in some MBI research. The slight but significant decline in mindfulness and self-compassion scores from post-test to follow-up in the experimental group is noteworthy. It hints that the initial boost may wane without continued practice, pointing to the potential need for "booster" sessions or integrating mindfulness more deeply into the school ecology to maintain benefits.

The mechanism of mindfulness-based training impacting internalizing problems

The second aim was to explore potential psychological mechanisms. Our cross-sectional path analysis at post-test supports a plausible model where the cultivation of trait mindfulness is associated with reduced internalizing problems both directly and indirectly through a sequential pathway of increased self-compassion and subsequently reduced perceived stress. This model integrates several established

theoretical strands. First, it reinforces the role of trait mindfulness as a foundational psychological resource cultivated by MBIs and a robust correlate of well-being (Krägeloh et al., 2019; Tomlinson et al., 2018).

More specifically, the strong link between mindfulness and self-compassion is well-documented (Birnie et al., 2010). Mindfulness, with its emphasis on non-judgmental awareness, may create the mental space necessary to replace self-criticism with self-kindness—a core component of self-compassion (Neff, 2003). Our finding that self-compassion served as a mediator is consistent with emerging research positing it as a key "active ingredient" in MBIs (Gu et al., 2015; Kuyken et al., 2010). It suggests that for RLBC, who may experience feelings of abandonment or self-blame related to their parents' migration, learning to treat themselves with more kindness and understanding could be particularly therapeutic (Yu, et al., 2020).

Furthermore, the chain through perceived stress makes intuitive sense. Self-compassion has been shown to buffer stress reactivity by promoting a more balanced emotional response to difficulties (Ferrari et al., 2019). For RLBC facing the chronic, albeit often distal, stressor of parental absence and the associated uncertainties, this internal shift in coping style—from potential self-judgment to self-support—may lessen the subjective appraisal of daily hassles as overwhelming. Since perceived stress is a potent predictor of internalizing symptoms (Schneider et al., 2021; Wright, et al., 2023), this reduction forms a logical final link in the pathway to symptom alleviation.

However, we must exercise considerable caution in interpreting this mediation model causally. A major limitation, as noted, is the use of concurrent post-test data to test a process that implies temporal precedence. It is equally plausible that reductions in internalizing problems lead to less stress and more self-compassion, or that all constructs change together as part of a unified therapeutic process.

Therefore, we present this model not as a confirmed causal chain, but as a preliminary, empirically supported hypothesis that aligns with theory and warrants rigorous future testing with multiple, temporally spaced assessments (e.g., measurement burst designs) to better disentangle directionality.

Unexpected findings and contextual nuances

Two unexpected patterns merit discussion. First, the wait-list control group showed a small but significant decline in trait mindfulness over time. While speculative, this could reflect the natural stressors of the academic year progressing without any compensatory resilience training, subtly eroding baseline levels of present-moment awareness. This decline, however, may have inadvertently amplified the observed relative benefit of the intervention in our analyses. Second, the fact that perceived stress and internalizing problem scores were maintained at follow-up while mindfulness and self-compassion scores dipped is interesting. It suggests there might be a "lag" or "sleeper" effect, where the skills learned continue to buffer stress and symptoms even as the conscious practice or self-reported facility with them slightly diminishes. Alternatively, other unmeasured factors, like improved peer support within the group or changes in cognitive patterns, might sustain the primary outcomes.

Implications

The findings offer concrete guidance for practitioners and educators in rural Chinese schools: (1) The study demonstrates that a structured, manualized mindfulness program can be feasibly integrated into the junior middle school schedule. The 45-minute weekly session plus brief daily practice is a manageable model that does not overly disrupt academic curriculum. (2) For RLBC, the program's value may lie not just in general stress reduction but in specifically fostering self-compassion. Facilitators should be trained to emphasize and gently guide this component, helping students apply

kindness inward, especially when discussing themes of family, separation, and personal challenge. (3) The follow-up trend suggests the need for planning sustainability. Schools could consider (a) training a core group of teachers or counselors to deliver the initial program, (b) incorporating shorter, regular "mindful moments" into the daily routine after the intensive program ends, and (c) offering optional refresher workshops to combat skill decay. (4) Delivering the program as a universal, classroom-based "life skills" or "well-being" course, as done here, successfully avoids labeling and stigmatizing the already vulnerable RLBC. This is a critical lesson for designing inclusive mental health support in collective-oriented cultures.

Strengths and Limitations

This study contributes to the international conversation by testing an MBI in a unique cultural and demographic context. It suggests that the core principles of mindfulness may be beneficial across diverse settings, but also underscores the imperative of careful adaptation and rigorous, context-sensitive evaluation. The mixed global evidence means we must move beyond asking "Does it work?" to the more nuanced questions: "How does it work, for whom, under what conditions, and implemented in what way?" In conclusion, while this study does not provide definitive answers, it successfully advances the field by demonstrating promise, proposing a testable mechanistic model, and clearly charting a path for the more sophisticated research required to translate this promise into robust, scalable support for the mental well-being of millions of Chinese RLBC.

Several limitations constrain the conclusions. First, the exclusive reliance on self-report measures introduces the potential for common method bias and shared variance. The low internal consistency of the PSS in our sample is a particular concern, urging caution in interpreting results involving perceived

stress. Second, the use of a passive wait-list control means we cannot rule out the influence of non-specific factors like facilitator attention, group dynamics, or expectancy effects. Future trials should employ active control conditions. Third, the per-protocol analysis, though supplemented by ITT, may overestimate efficacy. Fourth, the homogeneous sample (children of farmer migrants from one school) limits generalizability. Fifth, and critically, the cross-sectional nature of the mediation analysis at T2 precludes causal inferences about the proposed mechanism. The temporal sequence implied by the chain model requires testing with measurements at multiple time-points. Finally, the gradual decline in mindfulness and self-compassion scores at follow-up suggests booster sessions may be necessary to sustain gains.

Conclusion

In summary, this randomized trial offers encouraging initial evidence that school-based mindfulness training can be a valuable tool for promoting the mental well-being of Chinese RLBC. It points to the potential roles of enhanced self-compassion and reduced stress appraisals as underlying processes. However, the field must reconcile mixed evidence on MBIs. Further research with methodologically rigorous designs, diverse samples, longer follow-ups, and integrated qualitative components is needed to solidify these findings, establish clinical significance, and understand for whom and under what conditions such programs are most effective.

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Table 1 Demographic information of the participants

Variable	Experimental group（n=102)	Wait-list group（n=109)	Difference test
Gender			
Male	54	59	χ^2=0.030
Female	48	50	p>0.05
Age（M±SD）	12.86±0.56	12.73±0.54	t=1.698
			p>0.05
Grade (Grade 1 of Junior High School)	102	109	
Rural left-behind student	102	109	
Currently, parents have been away from home for more than six months.			
Father	53	51	χ^2=1.124
Mother	15	14	p>0.05
Father and mother	34	44	
Only one-child or not			
Yes	12	19	χ^2=1.350
No	90	90	p>0.05
Physical health status			
Good	56	68	χ^2=1.218
Common	46	41	p>0.05
Academic performance			
Excellent	23	25	χ^2=1.025
Average	61	59	p>0.05
Poor	18	25	

Table 2 Assessment outcomes of trait mindfulness, internalizing problems, self-compassion, and perceived stress in the experimental group and wait-list group (M±SD)

Variable	Experimental group（n=102)			Wait-list group（n=109)		
	Pre-test	Post-test	Tracking-test	Pre-test	Post-test	Tracking-test
Trait mindfulness	56.25±6.81	68.85±5.61	60.99±6.60	55.29±5.31	52.91±6.24	53.20±5.87
internalizing problems	14.70±6.09	8.82±5.56	10.08±7.60	15.32±10.41	16.33±10.84	17.22±11.31
Self-compassion	35.54±7.13	47.82±4.69	42.98±6.86	35.57±9.46	35.84±9.44	35.28±8.74
Perceived stress	27.49±7.28	22.77±8.02	23.66±8.39	27.38±8.66	27.35±7.80	27.22±7.68

Table 3 Analysis of variance for repeated measures of trait mindfulness, internalizing problems, self-compassion, and perceived stress

	Group				Test time				Group * Test time			
	Mean square	*F*	*p*	η^2p	Mean square	*F*	*p*	η^2p	Mean square	*F*	*p*	η^2p
Trait mindfulness	10710.72	289.063	<0.001	0.316	1480.47	39.955	<0.001	0.113	2965.109	80.023	<0.001	0.203
Internalizing problems	4097.33	45.069	<0.001	0.067	313.02	3.443	0.033	0.011	790.020	8.690	<0.001	0.027
Self-compassion	6785.34	107.297	<0.001	0.146	2091.163	33.068	<0.001	0.095	1952.363	30.873	<0.001	0.090
Perceived stress	1130.68	17.728	<0.001	0.027	342.33	5.367	0.005	0.017	320.750	5.029	0.007	0.016

Table 4 Simple effect analysis of trait mindfulness, internalizing problems, self-compassion, and perceived stress (D-value)

	Experimental Group			Wait-list Group			Experimental Group *vs.* Wait-list Group		
	Pre-test *vs.* Post test	Pre-test *vs.* Tracking-test	Post-test *vs.* Tracking-test	Pre-test *vs.* Post test	Pre-test *vs.* Tracking-test	Post-test *vs.* Tracking-test	Pre-test	Post-test	Tracking-test
	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)	D-value (cohen's *d*)
Trait mindfulness	-12.598*** (2.020)	-4.735*** (0.707)	7.862*** (1.284)	2.385** (0.411)	2.092** (0.374)	-0.294 (0.048)	0.961 (0.157)	15.945*** (2,686)	7.788*** (1.248)
Internalizing problems	5.873*** (0.735)	4.618*** (0.526)	-1.255 (0.188)	-1.009 (0.095)	-1.899 (0.174)	-0.890 (0.080)	-0.625 (0.062)	-7.507*** (0.871)	-7.142*** (0.740)
Self-compassion	-12.284*** (2.035)	-7.744*** (1.063)	4.843*** (0.824)	-0.275 (0.029)	0.294 (0.032)	0.569 (0.063)	-0.030 (0.004)	11.979*** (1.607)	7.705*** (0.981)
Perceived stress	4.716*** (0.616)	3.833*** (0.488)	-0.882 (0.108)	0.028 (0.003)	0.156 (0.019)	0.128 (0.017)	0.114 (0.014)	-4.574*** (0.578)	-3.563*** (0.443)

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

Table 5 Pearson correlation analysis between trait mindfulness, internalizing problems, self-compassion, and perceived stress

	M±SD（Minimum - Maximum）	Trait mindfulness	Internalizing problems	Self-compassion	Perceived stress
Trait mindfulness	57.78±8.21（29-84）	1			
Internalizing problems	13.83±10.00（0-52）	-0.46**	1		
Self-compassion	38.73±9.27（14-60）	0.52**	-0.48**	1	
Perceived stress	26.02±8.19（4-49）	-0.41**	0.49**	-0.56**	1

Note: ** $p<0.01$

Table 6 Analysis result of the trait mindfulness--self-compassion-perceived stress-internalizing problems model

	internalizing problems		internalizing problems		self-compassion		Perceived stress	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Trait mindfulness	-0.24	-6.187**	-0.46	-12.930**	0.52	2.090*	-0.17	-4.478**
Self-compassion	-0.19	-4.608**					-0.47	-12.182**
Perceived stress	0.28	7.187**						
R^2	0.34		0.21		0.27		0.33	
F	108.589**		167.174**		236.356**		154.917**	

Note: ** $p<0.01$, * $p<0.05$

Table 7 Decomposition of mediating, direct, and total effects in the trait mindfulness--self-compassion-perceived stress-internalizing problems model

	β	Boot SE	Boot LLCI	Boot ULCI	Effect proportion
Total mediating effect	-0.22	0.03	-0.27	-0.17	47.83%
trait mindfulness → self-compassion → internalizing problems	-0.10	0.03	-0.15	-0.05	21.74%
trait mindfulness → perceived stress → internalizing problems	-0.05	0.01	-0.08	-0.02	10.87%
trait mindfulness → self-compassion → perceived stress → internalizing problems	-0.07	0.01	-0.09	-0.05	15.22%
Direct effect	-0.24	0.03	-0.29	-0.18	52.17%
Total effect	-0.46	0.03	-0.56	-0.39	

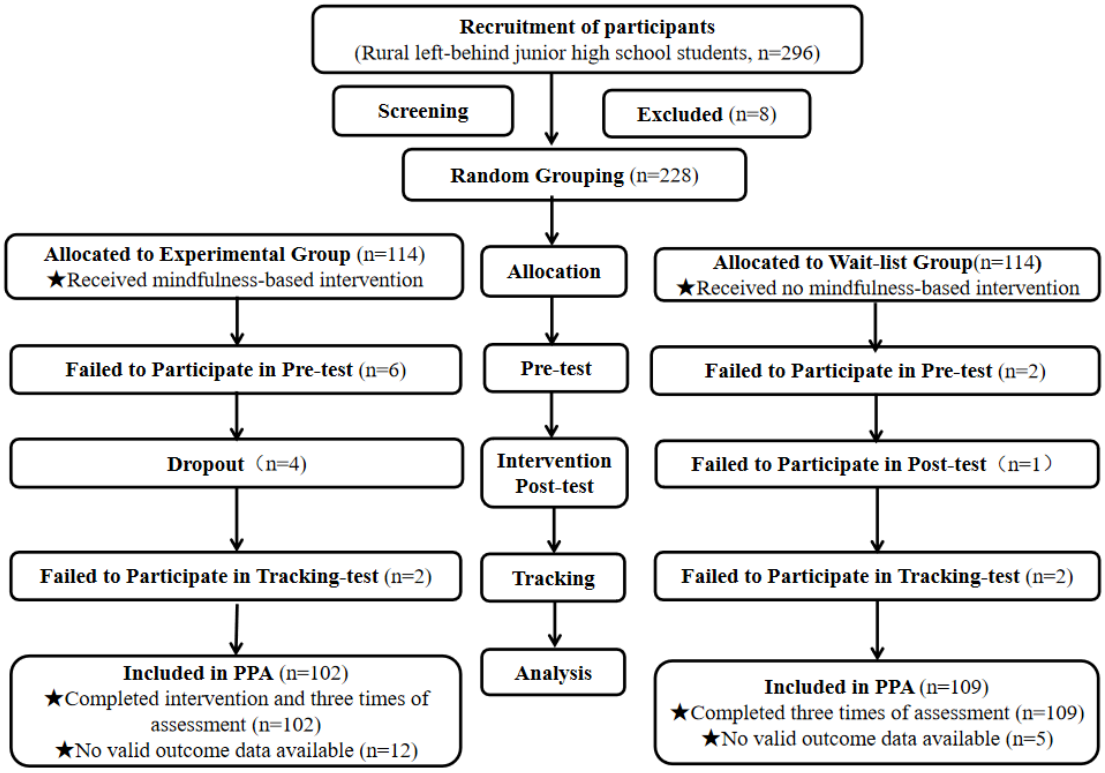


Fig. 1 Participants flow through the trial.

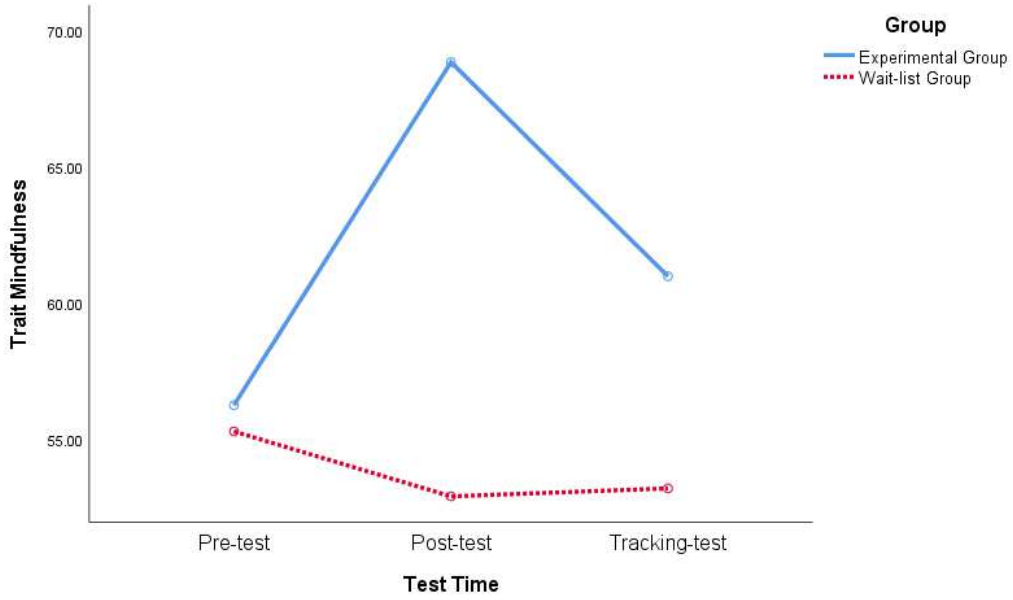


Fig. 2 Outcomes of trait mindfulness

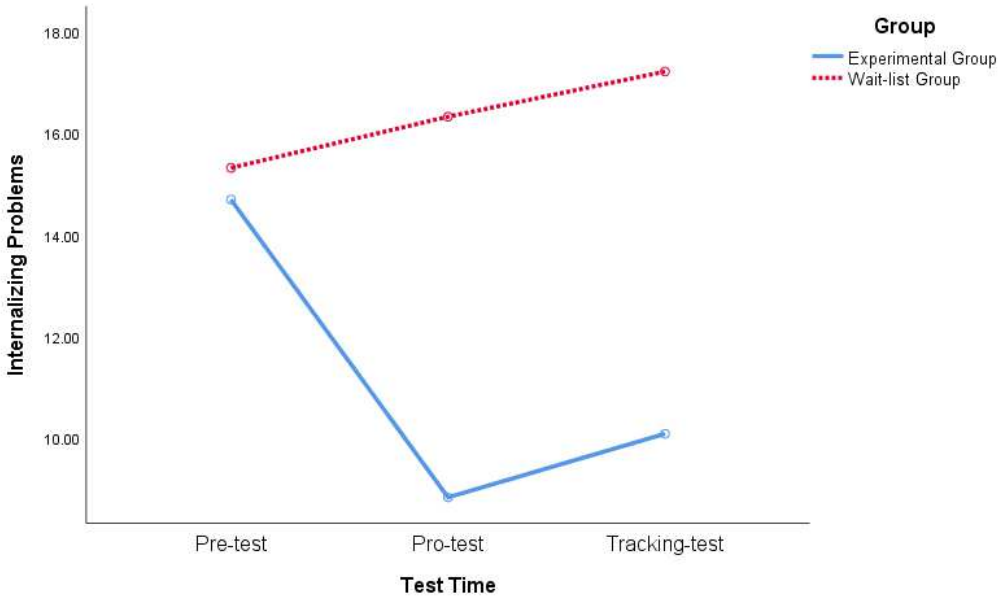


Fig. 3 Outcomes of internalizing problems

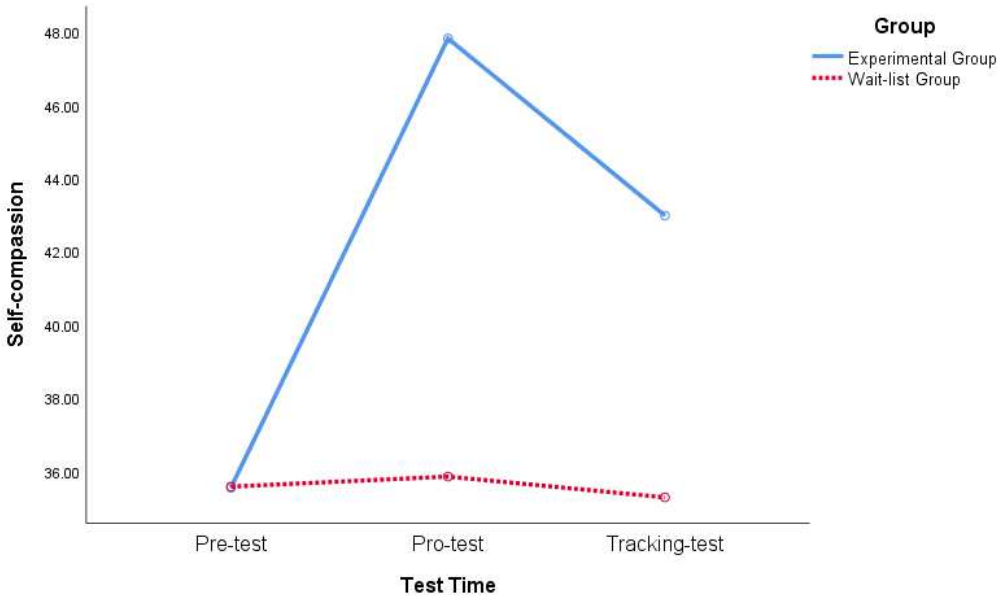


Fig. 4 Outcomes of self-compassion

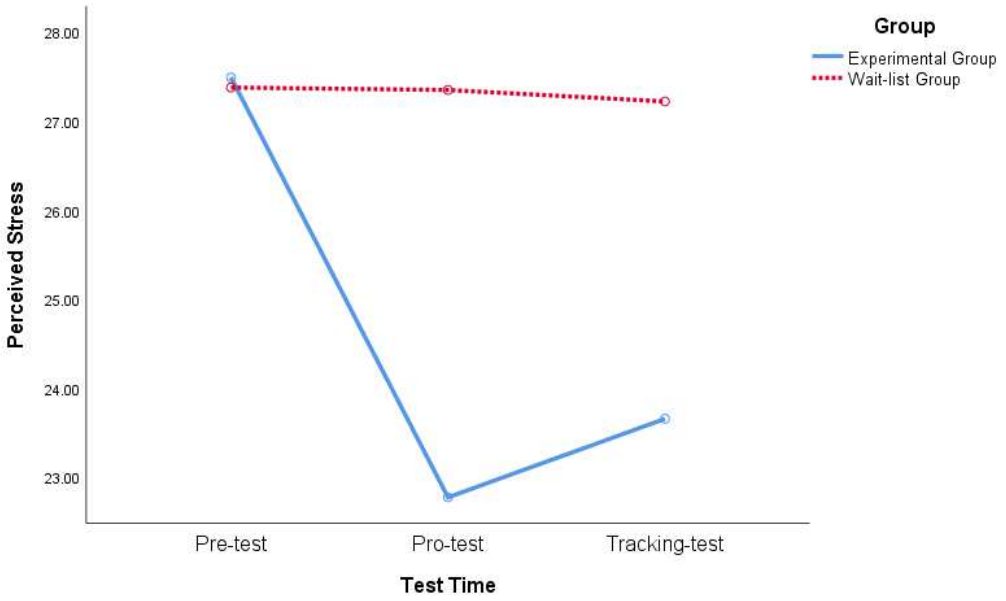


Fig. 5 Outcomes of perceived stress

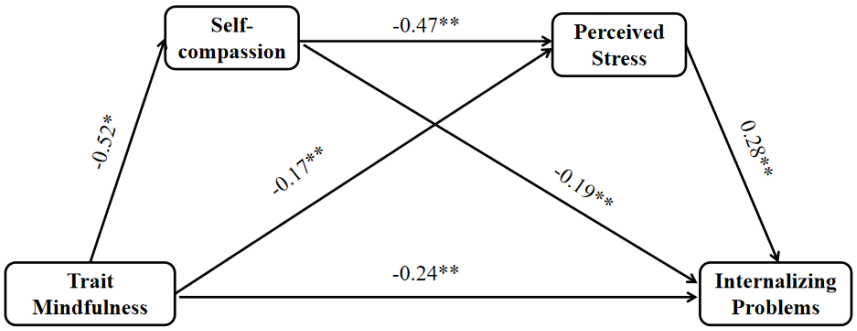


Fig. 6 Analysis result of the pathway model of impact of trait mindfulness on internalizing problems.