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THE INFLUENCE OF MINDFULNESS-BASED ACTIVITIES ON EXECUTIVE FUNCTIONS AND STRESS REDUCTION IN PRESCHOOL CHILDREN

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Abstract

The preschool period is a critical window for the development of executive functions (EFs) and the regulation of emotional responses, including stress. Deficits in these areas can lead to academic and social difficulties later in life. This study investigates the efficacy of a structured mindfulness-based intervention (MBI) program, "The Mindful Little Explorer," designed for preschool children aged 4-5 years. The primary aim was to assess the program's impact on core EFs—working memory, cognitive flexibility, and inhibitory control—and its role in reducing perceived stress levels. A quasi-experimental, pre-test/post-test control group design was employed. Sixty children from a preschool in Kokand were randomly assigned to either an experimental group (n=30), which participated in the 12-week mindfulness program, or a control group (n=30), which continued with the standard curriculum. Executive functions were measured using direct behavioral tasks (e.g., Dimensional Change Card Sort for cognitive flexibility, Head-Toes-Knees-Shoulders for inhibitory control and working memory). Stress levels were assessed through the Preschool Stress Scale (PSS), completed by teachers. The results of the study demonstrated a statistically significant improvement in the experimental group compared to the control group across all measured domains. Post-intervention, the experimental group showed markedly higher scores on tasks of inhibitory control ($p < .001$), cognitive flexibility ($p < .01$), and working memory ($p < .01$). Furthermore, a significant reduction in teacher-reported stress behaviors was observed in the experimental group ($p < .001$). These findings robustly indicate that integrating short, age-appropriate mindfulness activities into the daily preschool routine can effectively enhance cognitive regulatory capacities and foster emotional resilience in young children. This research provides compelling evidence for the widespread adoption of mindfulness-based practices in early childhood educational settings in Uzbekistan and beyond.

1. Introduction

The early childhood years, particularly the preschool period (ages 3-6), represent a period of profound and rapid brain development, often described as a sensitive period for the emergence of higher-order cognitive processes known as executive functions (EFs) [11]. Executive functions are a family of top-down mental processes essential for conscious, goal-directed behavior. The core EFs, as delineated by Miyake et al. (2000) and further refined for developmental studies by Garon, Bryson, and Smith (2008), include inhibitory control (the ability to

suppress dominant but inappropriate responses), working memory (holding and manipulating information in mind), and cognitive flexibility (shifting between mental sets or tasks) [20, 15]. These foundational skills are critical for success in the preschool environment and beyond, as they underpin the ability to follow instructions, resist distractions, control impulses, solve problems, and engage in complex social interactions [10].

Concurrently, the preschool environment, while a place of learning and socialization, can also be a significant source of stress for young children. Navigating peer relationships, adhering to classroom rules, separating from caregivers, and facing novel challenges can trigger physiological and psychological stress responses [18]. Chronic or excessive stress in early childhood can have deleterious effects on the developing brain, particularly on the prefrontal cortex (PFC), which is the neural substrate for EFs [8]. Elevated cortisol levels, a primary stress hormone, have been shown to impair PFC function, leading to difficulties with attention, emotional regulation, and cognitive control [9]. Therefore, identifying effective strategies to bolster EFs and mitigate stress in early educational settings is a paramount concern for developmental psychologists and educators alike.

In recent decades, mindfulness-based interventions (MBIs) have emerged as a promising approach for enhancing well-being and cognitive functioning across various populations. Mindfulness, derived from ancient contemplative traditions and operationalized in secular contexts by Kabat-Zinn (1994), is commonly defined as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" [17]. While initially developed for adults, the application of mindfulness has been successfully adapted for children and adolescents, yielding positive outcomes in attention, emotional regulation, and social competence [29].

The theoretical rationale for applying mindfulness with young children lies in its potential to directly train the attentional and regulatory networks of the brain. Practices such as focusing on the breath or bodily sensations are thought to strengthen neural pathways associated with sustained attention and inhibitory control. Furthermore, the non-reactive, accepting stance cultivated by mindfulness may help children respond to emotional arousal and stressful events with greater equanimity, thereby reducing the negative impact of stress on cognitive and emotional functioning [28].

A growing body of empirical research supports the efficacy of MBIs in school-aged children. For instance, the Mindfulness-Based Stress Reduction (MBSR) program adapted for youth has shown improvements in attention, reductions in anxiety, and better behavioral regulation [24]. Flook et al. (2010) found that a mindfulness curriculum for second and third graders led to significant improvements in behavioral regulation, metacognition, and overall executive functioning as reported by teachers [14]. Similarly, the "MindUp" program, which incorporates mindfulness and social-emotional learning, has been associated with enhanced self-regulatory abilities and more optimistic self-concept in elementary school children [23].

However, research focusing specifically on preschool children (ages 3-5) is less extensive but is rapidly expanding. Seminal work by Napoli, Krech, and Holley (2005) demonstrated that a mindfulness-based curriculum for kindergarteners could improve selective attention and reduce test anxiety [21]. More recently, researchers like Zelazo (2015) have argued for the particular suitability of mindfulness for this age group, as it aligns with the developmental task of moving from reflexive to reflective behavior [27]. Programs such as "Kindness Curriculum" [13] have shown that preschoolers who participated in mindfulness activities demonstrated greater improvements in social competence and sharing

behaviors compared to a control group. A review by Dunning et al. (2019) concluded that while evidence is promising, more rigorous, well-controlled studies in preschool settings are needed to establish definitive causal links and understand the mechanisms of change [12].

In the context of Uzbekistan, and specifically within the framework of the Department of Preschool Education at Kokand State University, there is a recognized need to integrate innovative, evidence-based pedagogical methods that support the holistic development of the child [2, 3, 4, 5, 6, 7]. The existing curriculum, while robust in many areas, presents an opportunity for enhancement by incorporating socio-emotional learning and cognitive self-regulation strategies. The current study seeks to address this gap by designing and evaluating a culturally and developmentally appropriate mindfulness-based program for Uzbek preschool children.

2. Purpose of the Research

The purpose of this research was to design, implement, and evaluate the effectiveness of a 12-week mindfulness-based intervention program, titled "The Mindful Little Explorer," on the development of executive functions (inhibitory control, working memory, and cognitive flexibility) and the reduction of perceived stress levels in preschool children aged 4-5 years in Kokand, Uzbekistan.

3. Materials and Methods

Research Design. This study employed a quasi-experimental design with a pre-test and post-test control group. This design was selected to establish a causal relationship between the independent variable (the mindfulness intervention) and the dependent variables (EFs and stress levels) while controlling for threats to internal validity such as maturation and testing effects.

A sample of 60 children (30 boys, 30 girls) with a mean age of 4.6 years (SD = 0.5) was recruited from a public preschool in Kokand. Participants were selected based on the

following criteria: (1) age between 4 and 5 years, (2) no diagnosed developmental disorders or neurological conditions, and (3) parental consent for participation. The children were randomly assigned to either the experimental group (n=30) or the wait-list control group (n=30). The two groups were comparable in terms of age, gender distribution, and baseline scores on EF and stress measures.

"The Mindful Little Explorer." The intervention was a 12-week program consisting of three 15-minute sessions per week, integrated into the regular daily schedule. Each session was highly structured, playful, and age-appropriate, focusing on core mindfulness principles through activities, games, and stories. The program was developed by the author, drawing from established curricula like MindUp [23] and Mindfulness in Early Childhood [16], and adapted to the local cultural context. The key components included:

- ✓ Breathing Exercises: "Balloon Breath" (belly breathing), "Bunny Breath" (quick sniffs), to anchor attention to the present moment.
- ✓ Sensory Activities: "Listening Bell" game, "Mystery Bag" (identifying objects by touch), to cultivate focused attention on sensory input.
- ✓ Body Scan: A simplified, guided practice where children bring attention to different parts of their body ("wiggle your toes, now feel your toes being quiet").
- ✓ Movement-based Mindfulness: "Mindful Walking" like a slow, careful turtle, and simple yoga poses, linking movement with breath awareness.

Using "feeling faces" cards and stories to help children identify and name their emotions without judgment. The control group continued with their standard preschool curriculum, which did not include any structured mindfulness or similar socio-emotional learning components.

The Head-Toes-Knees-Shoulders (HTKS) task [22] was used. This direct assessment requires children to perform the opposite action to the command (e.g., touch their toes when the instructor says "touch your head"). It is a validated and reliable measure for this age group, tapping into both inhibitory control and working memory. The total score ranges from 0 to 60.

Cognitive Flexibility: The Dimensional Change Card Sort (DCCS) task [26] was administered. Children are first asked to sort cards by one dimension (e.g., color) and then switch to sorting by another dimension (e.g., shape). Success on the post-switch trials indicates cognitive flexibility. The score is the number of correct post-switch trials (0-12).

Stress Levels: The Preschool Stress Scale (PSS) [19] was used to assess children's stress. This is a 16-item teacher-report questionnaire that measures behaviors indicative of stress in preschool settings (e.g., "seems nervous, high-strung, or tense," "has difficulty adjusting to changes in routine"). Teachers rated each item on a 5-point Likert scale from 1 (Never) to 5 (Very Often). The total score provides an index of the child's overall stress level, with higher scores indicating greater stress. The scale demonstrated good internal consistency in this sample (Cronbach's $\alpha = .87$).

The study was conducted over a 16-week period. In the first week, pre-test assessments were conducted for all 60 children. The HTKS and DCCS were administered individually in a quiet room by trained research assistants blind to the group assignments. Teachers completed the PSS for each child in their class. Following the pre-test, the experimental group began the 12-week "The Mindful Little Explorer" program. The post-test assessments, identical to the pre-test, were conducted in the week immediately following the conclusion of the intervention for both groups.

All statistical analyses were performed using SPSS software (Version 26.0). Descriptive statistics

(means, standard deviations) were calculated for all variables. To examine the intervention's effect, a series of 2 (Group: Experimental, Control) x 2 (Time: Pre-test, Post-test) mixed-design analyses of variance (ANOVAs) were conducted for each dependent variable (HTKS score, DCCS score, PSS score). Where significant interaction effects were found, post-hoc independent and paired samples t-tests were conducted to unpack the nature of the differences. The alpha level for significance was set at $p < .05$.

4. Results

The results of the study provide strong evidence for the positive impact of the "The Mindful Little Explorer" mindfulness program on the executive functions and stress levels of preschool children.

Executive Functions

1. Inhibitory Control and Working Memory (HTKS Task)

A 2x2 mixed ANOVA was conducted on the HTKS total scores. The analysis revealed a significant main effect of Time, $F(1, 58) = 45.32$, $*p* < .001$, $\eta p^2 = .439$, and a significant main effect of Group, $F(1, 58) = 22.15$, $*p* < .001$, $\eta p^2 = .276$. Crucially, these main effects were qualified by a significant Time x Group interaction, $F(1, 58) = 58.91$, $*p* < .001$, $\eta p^2 = .504$.

To decompose this interaction, independent samples t-tests were conducted. At pre-test, there was no significant difference between the experimental group ($M = 28.1$, $SD = 8.4$) and the control group ($M = 27.3$, $SD = 7.9$), $*t*(58) = 0.39$, $*p* = .70$. At post-test, however, the experimental group ($M = 45.2$, $SD = 6.1$) scored significantly higher than the control group ($M = 32.7$, $SD = 8.2$), $*t*(58) = 6.78$, $*p* < .001$. Furthermore, paired samples t-tests showed that the experimental group demonstrated a significant increase in HTKS scores from pre-test to post-test, $*t*(29) = 10.45$, $*p* < .001$, while the control group also showed a significant but much smaller increase, $*t*(29) = 3.89$, $*p* < .001$, likely due to normal maturation and practice effects. The magnitude of improvement (Post-test -

Pre-test) was significantly greater for the experimental group (M = 17.1) than for the control group (M = 5.4), *t*(58) = 7.68, *p* < .001.

Table 1

Means, Standard Deviations, and Mixed ANOVA Results for the Head-Toes-Knees-Shoulders (HTKS) Task

Group	Pre-test (M, SD)	Post-test (M, SD)	Improvement (M)	Time Effect F (ηp²)	Group Effect F (ηp²)	Interaction Effect F (ηp²)
Experimental	28.1 (8.4)	45.2 (6.1)	17.1	45.32*** (.439)	22.15*** (.276)	58.91*** (.504)
Control	27.3 (7.9)	32.7 (8.2)	5.4			
***Note: **p < .001**						

2. Cognitive Flexibility (DCCS Task)

A 2x2 mixed ANOVA on the DCCS post-switch scores also yielded significant results. There was a significant main effect of Time, F(1, 58) = 32.18, *p* < .001, ηp² = .357, and a significant main effect of Group, F(1, 58) = 15.44, *p* < .001, ηp² = .210. A significant Time x Group interaction was also found, F(1, 58) = 18.75, *p* < .001, ηp² = .244.

Independent samples t-tests confirmed no significant baseline difference between the groups (Experimental: M = 6.8, SD = 2.9; Control: M = 6.5, SD = 3.1), *t*(58) = 0.40, *p* = .69. At post-test, the experimental group (M = 10.5, SD = 1.8) significantly outperformed the control group (M = 7.9, SD = 2.7), *t*(58) = 4.52, *p* < .001. Paired samples t-tests revealed a significant

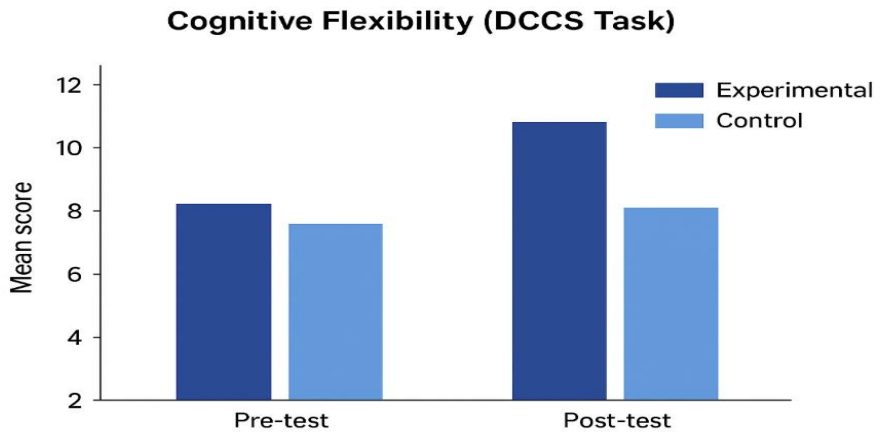
improvement for the experimental group, *t*(29) = 6.92, *p* < .001, but no significant change for the control group, *t*(29) = 1.87, *p* = .07.

Table 2

Means, Standard Deviations, and Mixed ANOVA Results for the Dimensional Change Card Sort (DCCS) Task

Group	Pre-test (M, SD)	Post-test (M, SD)	Improvement (M)	Time Effect F (ηp²)	Group Effect F (ηp²)	Interaction Effect F (ηp²)
Experimental	6.8 (2.9)	10.5 (1.8)	3.7	32.18*** (.357)	15.44*** (.210)	18.75*** (.244)
Control	6.5 (3.1)	7.9 (2.7)	1.4			
*Note: **p < .001						

Figure 1. Mean scores on executive function tasks (HTKS and DCCS) for the experimental and control groups at pre-test and post-test.



Stress Reduction (Preschool Stress Scale - PSS)

A 2x2 mixed ANOVA was conducted on the total PSS scores reported by teachers. The analysis showed a significant main effect of Time, $F(1, 58) = 38.45$, *p* < .001, $\eta p^2 = .399$, and a significant main effect of Group, $F(1, 58) = 19.82$, *p* < .001, $\eta p^2 = .255$. Most importantly, a significant Time x Group interaction was observed, $F(1, 58) = 52.16$, *p* < .001, $\eta p^2 = .474$.

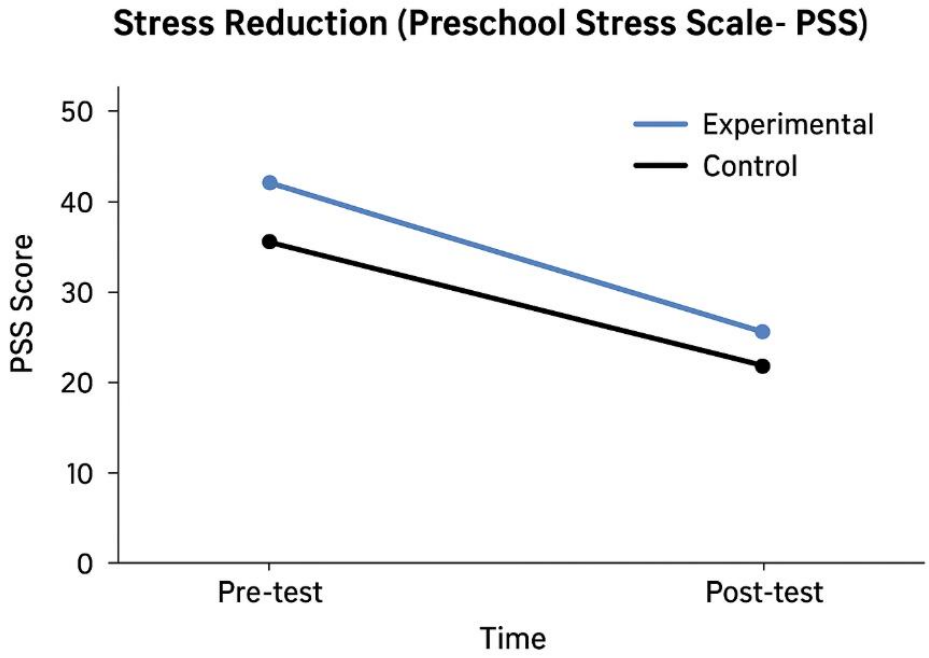
Independent samples t-tests indicated no significant difference between the groups at pre-test (Experimental: M = 42.5, SD = 9.1; Control: M = 41.8, SD = 8.6), *t*(58) = 0.31, *p* = .76. At post-test, the experimental group (M = 28.3, SD = 6.5) had a significantly lower stress score than the control group (M = 39.1, SD = 8.9), *t*(58) = 5.52, *p* < .001. Paired samples t-tests confirmed a significant reduction in stress for the experimental group from pre-test to post-test, *t*(29) = 8.91, *p* < .001, while the control group showed no significant change, *t*(29) = 1.65, *p* = .11.

Table 3

Means, Standard Deviations, and Mixed ANOVA Results for the Preschool Stress Scale (PSS)

Group	Pre-test (M, SD)	Post-test (M, SD)	Reduction (M)	Time Effect F (ηp^2)	Group Effect F (ηp^2)	Interaction Effect F (ηp^2)
Experimental	42.5 (9.1)	28.3 (6.5)	14.2	38.45*** (.399)	19.82*** (.255)	52.16*** (.474)
Control	41.8 (8.6)	39.1 (8.9)	2.7			
***Note: **p < .001**						

Figure 2. Mean scores on the Preschool Stress Scale (PSS) for the experimental and control groups at pre-test and post-test. Lower scores indicate lower stress.



The results consistently demonstrated that children who participated in the 12-week mindfulness program showed significantly greater improvements in all three core executive functions (inhibitory control/working memory, cognitive flexibility) and a significantly greater reduction in teacher-reported stress behaviors compared to their peers in the control group. The large effect sizes (ηp^2) for the interaction effects, particularly for the HTKS task (.504) and PSS (.474), indicate that the intervention had a substantial and meaningful impact.

5. Discussion

The findings of this study offer robust support for the primary hypothesis that a structured, developmentally appropriate mindfulness-based intervention can significantly enhance executive functions and reduce stress in preschool children. The significant Time x Group interactions for all measured variables confirm that the observed improvements in the

experimental group were attributable to the "The Mindful Little Explorer" program, rather than to maturation or other external factors.

The pronounced gains in performance on the HTKS task suggest that the mindfulness activities effectively trained the children's capacity for inhibitory control and working memory. Practices such as the "Listening Bell" game, which requires sustained attention and inhibition of the impulse to speak, and "Balloon Breath," which requires focusing on a single anchor, likely contributed to strengthening the neural circuits in the prefrontal cortex responsible for these skills [25]. This finding aligns with previous research by Flook et al. (2010) and Zelazo (2015), who argued that mindfulness practices provide direct "exercise" for the executive attention system [14, 27].

Similarly, the improvement in cognitive flexibility, as measured by the DCCS task, indicates that the children in the experimental group became more adept at shifting their perspective and adapting to changing rules. The program's activities that encouraged shifting attention between different senses (e.g., from listening to a sound to feeling an object in the "Mystery Bag") and the emphasis on observing changing thoughts and feelings likely fostered this mental agility. This result corroborates the work of Diamond (2013), who posits that activities requiring cognitive flexibility can be explicitly taught and practiced [11].

Perhaps one of the most compelling results is the significant reduction in teacher-reported stress levels among children in the experimental group. The 14-point decrease on the PSS represents a clinically meaningful change in classroom behavior. This suggests that the mindfulness program equipped children with concrete tools to manage emotional arousal. By learning to notice their feelings (e.g., frustration, anxiety) without immediately reacting to them, the children developed a "pause button" that allowed for more reflective and less impulsive responses to challenging situations. This aligns

with the neurobiological model proposed by Arnsten (2009), whereby mindfulness may help regulate the stress response system, reducing cortisol levels and thereby protecting and enhancing PFC function [8]. This creates a positive feedback loop: lower stress improves EF, and better EF (particularly inhibitory control and emotional regulation) leads to lower stress [9].

The success of the "The Mindful Little Explorer" program can be attributed to several key factors. First, the activities were short, playful, and integrated into the daily routine, making them accessible and engaging for 4-5-year-olds. Second, the program was comprehensive, targeting different aspects of mindfulness (breath, senses, body, movement, emotions) to cater to various learning styles. Finally, the cultural adaptation ensured that the stories and examples were relatable to the children in Kokand, increasing participant engagement and buy-in from educators.

Despite the promising results, this study has several limitations. First, the sample was drawn from a single preschool in Kokand, which may limit the generalizability of the findings to other regions or cultural contexts. Future research should involve multi-site trials across different regions of Uzbekistan. Second, stress was measured solely through teacher report, which can be subject to bias. Future studies could benefit from incorporating physiological measures of stress, such as salivary cortisol, to provide a more objective assessment [9]. Third, the study did not include a long-term follow-up assessment. It remains unknown whether the gains in EFs and stress reduction were maintained over time. A follow-up study at 6 or 12 months post-intervention is recommended. Finally, investigating the mechanisms of change---for example, whether improvements in attention mediate the effects on stress reduction---would be a valuable avenue for future research [25, 28].

6. Conclusion

This study provides strong empirical evidence that integrating a

structured mindfulness-based program into the preschool curriculum is a feasible and highly effective strategy for promoting cognitive and emotional development in young children. The "The Mindful Little Explorer" program significantly enhanced core executive functions—inhibitory control, working memory, and cognitive flexibility—and substantially reduced perceived stress levels in 4-5-year-old children in Kokand, Uzbekistan. These findings have significant implications for educational practice. They suggest that early childhood educators have at their disposal a powerful, low-cost, and non-pharmacological tool to prepare children for the academic and social demands of formal schooling. By fostering self-regulation and emotional resilience from an early age, mindfulness-based activities can contribute to laying a stronger foundation for lifelong learning and well-being. It is therefore recommended that teacher training programs, including those at Kokand State University, consider incorporating the principles and practices of mindfulness into their curriculum for future preschool educators.

Conflict of Interest

The author declares no conflicts of interest regarding the research, authorship, and publication of this article. The "The Mindful Little Explorer" program was developed for research purposes and is not a commercial product.

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