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RESEARCH ARTICLE

The Impact of Mindfulness Intervention on Cognitive Intelligence in Adolescents with Attention Deficit/Hyperactivity Disorder (ADHD) Symptoms

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ABSTRACT

Attention Deficit/Hyperactivity Disorder (ADHD) is the most prevalent neurodevelopmental disorder among school-age children. Adolescents with ADHD symptoms often struggle to manage attention. Therefore, increasing their awareness to enhance cognitive and psychological well-being is essential. In this context, mindfulness intervention, as a preventive and improvement effort for cognitive intelligence, should be tested. This study aims to examine the effect of mindfulness intervention on improving cognitive intelligence in adolescents with ADHD symptoms. Methods: A true experimental study using a pre–post-test randomized control group design was performed with a sample of junior high school students in an inclusive school. Cognitive intelligence was measured using the Trail Making Test (TMT). The mindfulness intervention consisted of eight weekly sessions. Results: The intervention and control groups included 30 and 22 students, respectively, after informed consent signing, randomization, and accounting for dropout. The Mann-Whitney test results demonstrated significant cognitive improvement following the mindfulness intervention ($p < 0.05$). Conclusion: Mindfulness intervention effectively improves cognitive intelligence in adolescents with ADHD symptoms.

INTRODUCTION

Attention Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder commonly observed in school-age children, typically before the age of 12, and manifests in at least two different settings. The worldwide prevalence of ADHD is 13.5% in adults, 10.1% in adolescents, and 10.3% in children. Prevalence rates based on predominant clinical symptoms are 46.7% for the inattention subtype, 33.7% for the hyperactive/impulsive subtype, and 20.6% for the combined type (Al-Wardat et al., 2024; Alegre Bravo & Barahona, 2016). Adolescents with ADHD symptoms often face difficulties with attention and concentration, two key areas in the cognitive domain, leading to poor academic achievement. Mindfulness interventions, which focus on regulating attention, address these challenges, which are particularly disruptive in ADHD (Gatica et al., 2013; N.H & Setiawati, 2017; Setiawati et al., 2023).

ADHD is commonly treated pharmacologically with medication, but these interventions carry the risk of non-compliance due to the long treatment duration. Low adherence is associated with side effects and the stigma surrounding drug dependence. ADHD often occurs alongside other mental health conditions, including substance abuse, depression, obsessive-compulsive disorder, anxiety, and

gadget addiction. Adolescents with untreated symptoms may experience decreased academic achievement, lower self-esteem, increased clinical symptoms, aggresiveness, and engage in risky behaviors, such as suicide. They are also at increased risk for impaired interpersonal relationships that may persist into adulthood. Families often face stress related to guilt, depression, and social isolation, as well as marital and employment challenges. These difficulties affect many aspects of emotional, interpersonal, and psychological well-being (Ardiyani et al., 2021; Gray, 2021; Setiawati et al., 2020; Simanjuntak et al., 2024; Stibbe et al., 2020; Dianasari et al., 2024; Putriana et al., 2025).

Mindfulness interventions address various ADHD-related deficits and are also beneficial in managing conditions such as bipolar disorder, chronic pain, cancer, addictive behaviors, and ADHD symptoms in children and adolescents. Haydicky's (2015) research demonstrated that mindfulness interventions improved behavior and attention in children with ADHD. Bigelow's (2021) research further confirmed that mindfulness interventions improve executive function performance in adolescents with ADHD symptoms (Bigelow et al., 2021; Giarrizzo et al., 2003; Kaypaklı & Tamam, 2019; Laporta & Latorre, 2020; Lee et al., 2022). These findings support the notion that repeated refocusing of attention through formal and informal mindfulness practices can positively impact cognitive intelligence in adolescents with ADHD symptoms.

Despite a growing body of research, no studies have examined the effectiveness of mindfulness interventions in enhancing cognitive intelligence in adolescents with ADHD symptoms in Indonesia. This gap motivated the researchers to conduct this study using an Indonesian mindfulness module designed for adolescents with ADHD symptoms.

METHODS

This was a true experimental study conducted on adolescents with ADHD symptoms attending an inclusive junior high school. The study utilized a pre–post-test randomized control group design and was carried out from March 2023 to September 2024. The population comprised junior high school students in grades 1–3 at SMPN 3 Krian, Sidoarjo, during the 2022/2023 academic year. The sample was selected using total sampling, and the subjects were separated into intervention and control groups. Inclusion criteria included adolescents aged 12–16 years, students in grades 1–3 at SMPN 3 Krian Sidoarjo, those with ADHD symptoms and an ACTRS score ≥ 12, those able to communicate in Indonesian, and those willing to participate with family/guardian consent. Exclusion criteria included subjects with psychiatric disorders (e.g., intellectual disability, autism), organic mental disorders (e.g., cerebral palsy, epilepsy), or severe physical disorders. Dropout criteria included subjects who missed more than two weeks of intervention, experienced injury or severe illness during the study, were unable to follow the mindfulness training, or refused to continue participation.

The Abbreviated Conners' Teacher Rating Scale (ACTRS) is widely used to assess ADHD symptoms in adolescents. The ACTRS instrument was developed by C. Keith Conners, a renowned psychologist in the field of ADHD. This scale is also sensitive to the effects of medication, enabling the detection of changes over time. The ACTRS can distinguish between adolescents with and without ADHD, with a sensitivity of 83% and a specificity of 85% (Staff et al., 2021).

The Trail Making Test (TMT) is a neuropsychological tool utilized to measure various cognitive abilities in adolescents, including attention, processing speed, executive function, and mental flexibility. TMT-A measures cognitive functions, specifically attention to selecting and maintaining focus on an object. The test consists of numbers 1–25 arranged randomly and connected sequentially by drawing a line within 78 seconds. Meanwhile, TMT-B measures adolescents' planning, organizing, and implementation abilities. This instrument, sensitive to brain damage, particularly visual and task-switching abilities, consists of numbers and letters arranged randomly and connected sequentially by drawing a line within 180 seconds. Test completion time is measured in seconds. Faster completion indicates better cognitive intelligence, while failure to complete within the allotted time indicates impaired cognitive function (Harvie et al., 2022).

The intervention began after screening by homeroom teachers who filled out the ACTRS questionnaire involving 1,067 students. Students aged 12–16 years who scored ≥ 12 on the ACTRS were selected as subjects. Subjects meeting the inclusion criteria provided consent, and randomization was conducted using lottery numbers. Even-numbered participants were allocated to

the control group, while odd-numbered ones were placed in the intervention group. Both groups completed a pre-intervention questionnaire; absentees or those who failed to complete the questionnaire were considered dropouts. The intervention group participated in eight module-based mindfulness sessions over eight weeks, while the control group continued their daily activities. The procedure followed the Training Module for Adolescents with ADHD, a modification of Debra Burdick's module on Mindfulness for Children with ADHD. This research obtained permission to use 15 of the 34 activities from the book for the mindfulness training module. The module was systematically arranged to ensure ease of application by health workers or laypersons interested in mindfulness. The intervention began with a preparation phase, introducing subjects to the analysis team. In the subsequent phase, weekly mindfulness sessions were held over eight weeks, with each session lasting 120 minutes and consisting of two activities. Sessions were delivered in groups to increase effectiveness, with each group comprising 10–15 students. After the last session, each subject completed post-intervention TMT questionnaires.

Data were collected and processed into distribution tables and diagrams based on respective distributions. To analyze differences in cognitive intelligence before and after the mindfulness intervention, an independent (two-sample) t-test was used for normally distributed data, and the Wilcoxon Signed Rank Test was used for non-normally distributed data. To determine differences in cognitive intelligence between adolescents with ADHD symptoms who received the mindfulness intervention and those who did not, an independent t-test was used for normally distributed data, while the Mann-Whitney test was applied for non-normally distributed data.

RESULTS

The total number of students at SMPN 3 Krian was 1,067. A total of 52 respondents met the inclusion criteria, with the distribution of numbers and characteristics displayed in Table 1.

Table 1: Subject characteristics

Characteristic	Group	
	Intervention (n = 30)	**Control (n = 22)**
Baseline ACTRS score		
≥ 12	30 (100%)	22 (100%)
Mean ± SD	16.07 ± 4.417	15.55 ± 3.306
Median (min-max)	15 (12–28)	14.5 (12–23)
Grade		
7	14 (46.7%)	12 (54.5%)
8	16 (53.3%)	10 (45.5%)
Age (years)		
13	7 (23.3%)	5 (22.7%)
14	12 (40%)	11 (50%)
15	10 (33.3%)	6 (27.3%)
16	1 (3.3%)	0 (0%)
Mean ± SD	14.17 ± 0.834	14.05 ± 0.722
Sex		
Male	24 (80%)	19 (86.4%)
Female	6 (20%)	3 (13.6%)
Mothers' educational background		
Junior high school	8 (26.7%)	6 (27.3%)
Senior high school	20 (66.7%)	15 (68.2%)
Undergraduate	2 (6.7%)	1 (4.5%)

Both groups' baseline ACTRS scores indicated ADHD symptoms (≥12). The intervention and control groups were predominantly composed of students in grades 8 (53.3% and 54.5%, respectively) with an average age of 14 years. Male participants were dominant in both groups, comprising 24 (80%) in the intervention group and 19 (86.4%) in the control group. Mothers' educational backgrounds were mostly high school graduates in both groups, at 66.7% and 68.2%, respectively.

The initial overview of the cognitive intelligence of SMPN 3 Krian students who took part in the study is presented in Table 2.

Table 2: Overview of cognitive intelligence of adolescents with ADHD symptoms before mindfulness intervention

Before	Median (min-max)		P-value
	Intervention	Control	
TMT-A	39 (22–93)	35.5 (24–180)	0.926
TMT-B	92 (38–219)	76 (39–200)	0.644

Initially, the average cognitive intelligence in both groups indicated "no impairment of cognitive function," with the Mann-Whitney test results showing no significant differences ($p > 0.05$). The range of TMT-A scores was more varied in the control group, while TMT-B scores were relatively balanced. In TMT-A, two intervention students and four control students exhibited impaired cognitive function. In TMT-B, one intervention student and two controls were impaired, while three control students did not complete the test.

The results of the normal distribution test on the differences in cognitive intelligence scores are presented in Table 3.

Table 3: Results of the normal distribution test of data on the differences in cognitive intelligence scores

Score difference	Group	n	P-value
TMT-A	Intervention	30	< 0.001
	Control	22	0.659
TMT-B	Intervention	30	< 0.001
	Control	19	0.045

The results demonstrated that only the differences in TMT-A scores in the control group were normally distributed ($p > 0.05$). Differences in cognitive intelligence scores before and after the intervention were analyzed using a paired t-test for normally distributed data and the Wilcoxon test for non-normally distributed data.

Table 4: Differences in cognitive intelligence before and after intervention in the two groups

	Mean ± SD Median (min-max)		Score difference	P-value
	Pre-intervention	Post-intervention		
Intervention				
TMT-A	39 (22–93)	27 (18–56)	-9 (-38–(-1))	< 0.001 [a]
TMT-B	92 (38–219)	62.5 (29–145)	-25 (-145–(-4))	< 0.001 [a]
Control				
TMT-A	56.18 ± 48.310	49.09 ± 46.643	-7.09 ± 15.039	0.038 [b]
TMT-B	76 (39–200)	82 (38–200)	-1 (-19–49)	0.601 [a]

Notes: a = Wilcoxon test; b = paired t-test

In the intervention group, TMT-A and TMT-B scores significantly decreased after the intervention ($p < 0.05$). In the control group, TMT-A scores also decreased significantly ($p < 0.05$), while TMT-B scores did not show significant changes ($p > 0.05$). The cognitive differences in both groups are displayed in Table 5.

Table 5: Differences in cognitive intelligence scores after intervention and between the intervention and control groups

	Mean ± SD Median (min-max)		P-value
	Intervention	Control	
Post-intervention			
TMT-A	27 (18–56)	35,5 (13–200)	0.207 [a]
TMT-B	65.0 ± 26.281	98.05 ± 49.780	0.013 [b]
Score difference			

TMT-A	-9 (-38–(-1))	-6,5 (-33–20)	0.128 [a]
TMT-B	-25 (-145–(-4))	-1 (-19–49)	< 0.001 [a]

Notes: a = Mann-Whitney test; b = independent t-test

The results of the Mann-Whitney test demonstrated no significant difference in TMT-A cognitive intelligence scores between the intervention and control groups or their differences ($p > 0.05$). However, both the Mann-Whitney test and the independent t-test revealed a significant difference in TMT-B cognitive intelligence scores between the groups and their differences ($p < 0.05$).

DISCUSSION

The majority of participants in both the intervention and control groups were male. This indicates that ADHD is more common in males than females, with a ratio of 3:1. Clinically, male adolescents are more likely to receive an ADHD diagnosis than females. This discrepancy can be associated with the DSM-5 diagnostic criteria, which are more aligned with male presentations of ADHD and only partially applicable to females. These differences contribute to the perception that ADHD is less symptomatic in female adolescents. Parents and teachers may also interpret the same behavior differently due to gender-related behavioral expectations (Waltereit et al., 2023).

The subjects were between 13 and 15 years old, with the majority being 14. The average age was comparable between the intervention and control groups. A 2023 study estimated that ADHD affects 7.6% of children aged 3–12 years and 5.6% of those aged 12–18 years worldwide (Al-Wardat et al., 2024).

Mothers' educational backgrounds in the intervention and control groups were similar. Most mothers were high school graduates, followed by junior high school graduates. Two mothers in the intervention group and one in the control group had an Associate/Bachelor's degree. Children of low-educated parents have a two to three times higher probability of experiencing ADHD than those with highly-educated parents. Additionally, low parental education is associated with child psychopathology and academic difficulties linked to mental health issues. Psychoeducation targeting parents with lower education levels can serve as an intervention to reduce ADHD symptoms and related academic challenges in children (Torvik et al., 2020).

The mindfulness intervention activities incorporated various modifications to maintain respondent engagement. These included sensory-based movement exercises and empirical learning behaviors, short concentration-based activities (e.g., mindful eating, attentive listening, yoga), repetitive breathing meditations (e.g., focusing on the sensation of breathing), highly organized sessions (e.g., detailed agendas, mindful homework), and enhanced parental participation through psychoeducation and training, as well as involvement in necessary activities at home.

In this study, the intervention group exhibited a substantial improvement in their cognitive intelligence ($p < 0.05$). TMT-A and TMT-B scores decreased after the intervention, indicating that subjects completed the tests in less time. The intervention group completed both TMT-A and TMT-B faster after receiving the mindfulness intervention. In the control group, TMT-A exhibited a substantial improvement ($p < 0.05$), but TMT-B did not exhibit a significant change ($p > 0.05$). The control group completed TMT-A faster, but the completion time for TMT-B remained nearly the same.

The TMT-A instrument measures cognitive functions related to attention, specifically selecting and maintaining focus on an object. In the post-test, subjects in both groups completed the test faster due to familiarity with the pre-test. In contrast, TMT-B completion times in the control group remained consistent between pre-test and post-test. TMT-B is sensitive to brain damage, particularly visual and task-switching abilities. It measures more complex cognitive abilities, such as planning, organizing, and executing, which are closely related to executive function. It is also sensitive to brain damage, particularly visual and task-switching abilities. Adolescents with ADHD often experience impairments in various cognitive functions, ranging from basic reaction time to more complex executive and social cognitive domains. Adolescents with ADHD have poorer

working memory than their healthy peers. This working memory deficit may contribute to their academic difficulties (Cadenas et al., 2020; Kofler et al., 2024).

The results for TMT-A and TMT-B in adolescents varied based on time-related scores. The older group of adolescents performed TMT-A and TMT-B more rapidly than their younger counterparts, although both groups performed similarly in terms of errors and corrections. Previous research reported 11–12 years as the critical age for completing line-sliding tasks like TMT-B. TMT-A measurements indicate that motor speed and sustained attention are largely developed in childhood and early adolescence, with no significant differences observed among subjects (Gündüz et al., 2021).

Subjects who received the intervention completed both TMT-A and TMT-B more accurately and in less time than the controls. Several studies have highlighted the mechanisms through which mindfulness interventions manage emotions, foster decentralization, and enhance focused attention. Participants in mindfulness interventions are trained to continuously redirect their attention or awareness to the present moment, acknowledging thoughts and emotions as transient states before returning to mindfulness practice. Mindfulness interventions stimulate changes or re-perceptions of experiences. The mindfulness identification process enables cognitive and behavioral changes that positively impact well-being (Tan, 2016).

Cognition involves an understanding of intelligence and emotions that evolve over time. This process is dynamic and represents a complex interaction of experiential, cultural, emotional, cognitive, and biological factors. The appropriate interaction, timing, rhythm, and moments for mediation, along with the use of specific cognitive strategies, are crucial for supporting and sustaining complex thought processes. This is particularly significant in organizing and fostering motivation and positive emotions in adolescents with ADHD symptoms (Cadenas et al., 2020).

In this study, the TMT-A cognitive intelligence scores did not differ significantly between the intervention and control groups, both after the intervention and in their score changes ($p > 0.05$). Both groups exhibited decreases in scores, indicating that subjects completed the test in less time. The TMT-A instrument measures cognitive functions related to attention, specifically the ability to select and maintain focus on an object.

Several studies have highlighted the mechanisms through which mindfulness interventions manage emotions, foster decentralization, and enhance focused attention. Additionally, several studies have shown that mindfulness interventions enable participants to consistently return their attention or awareness to the present moment, observing thoughts or emotions as passing states. Mindfulness interventions stimulate changes or re-perceptions of experiences. In this context, the process of cultivating awareness allows for cognitive and behavioral changes that positively impact well-being. Subjects were better able to maintain their attention, completing the test more accurately and efficiently.

In this study, the post-measurement was conducted after school exams, reducing stressors that might impair concentration. Additionally, both groups had taken the test previously, improving their familiarity with its flow and enabling faster completion. Mindfulness interventions facilitate changes or re-perceptions of experiences. The mindfulness identification process enables cognitive and behavioral changes that positively impact well-being (Tan, 2016).

Various aspects of memory develop during adolescence. Adolescents with ADHD symptoms exhibit memory abilities comparable to their peers. A study by Skalaban (2022) reported that adolescents with ADHD have stronger memory storage abilities than processing abilities, while their verbal and visuo-spatial abilities develop at a similar rate to those of their peers without ADHD (Skalaban et al., 2022).

In this study, the TMT-B cognitive intelligence scores differed significantly between the intervention and control groups, both after the intervention and in their score changes ($p > 0.05$). The intervention group completed TMT-B in less time than the control group. The TMT-B instrument measures more complex cognitive functions, including planning, organizing, and execution, which are linked to executive function. Adolescents with ADHD often experience impairments in various cognitive

functions, ranging from basic reaction time to more complex executive and social cognitive domains (Cadenas et al., 2020; Kofler et al., 2024).

Adolescents with untreated ADHD tend to have poorer working memory than those who receive treatment. The ability to regulate emotions, behavior, and executive function gradually improves during adolescence. Adolescents with ADHD may also exhibit variations in executive function deficits across different developmental stages (Cadenas et al., 2020; Kofler et al., 2024).

Limitations of this study include the absence of blinding, as the researchers were directly involved. Confounding factors such as parenting, parental employment, and respondents' quality of life were not analyzed. Additionally, the final measurement was conducted during the post-exam holidays, resulting in a higher rate of student absences.

CONCLUSION

In conclusion, this study demonstrated that mindfulness intervention increased the cognitive intelligence of the intervention group, whereas the control group exhibited either a decrease or no change. Mindfulness intervention has been demonstrated to improve cognitive intelligence in adolescents with ADHD symptoms, suggesting that it can serve as a non-pharmacological approach to address this problem. It is recommended that mindfulness training be conducted in small groups, with shorter sessions and a longer duration of participant engagement, to enhance its effectiveness.

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