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Working Memory Profiles in Children with ADHD: Differences Between ADHD-I, ADHD-C, and Typically Developing Children

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ABSTRACT

Attention-Deficit/Hyperactivity Disorder (ADHD) is characterized by significant working memory (WM) deficits. However, cognitive differences between the predominantly inattentive (ADHD-I) and combined (ADHD-C) presentations require further investigation based on Baddeley's multi-component model. This study compared WM profiles in children with ADHD-I, ADHD-C, and typically developing (TD) children to identify subtype-specific cognitive signatures and discuss clinical implications. Participants included 137 children (41 ADHD-I, 45 ADHD-C, 51 TD) aged 7–12 recruited from clinics in Tehran, Iran, using convenience sampling. Diagnosis was confirmed via DSM-5 criteria and the IVA-2 test. WM components were assessed using the Working Memory Test Battery for Children (WMTB-C). Data were analyzed using one-way ANOVA with post-hoc tests. Both ADHD groups showed significant impairments across all WM components compared to TD children. For the phonological loop and visuospatial sketchpad, no significant differences were found between ADHD-I and ADHD-C. However, for the central executive component, the ADHD-C group performed significantly worse than the ADHD-I group ($p < .01$). While WM impairments are widespread in ADHD, the central executive is more severely affected in the combined presentation. These findings suggest distinct cognitive profiles for ADHD subtypes, highlighting the need for tailored interventions targeting executive functions in ADHD-C. However, due to the cross-sectional design and clinic-based sample, causal inferences and generalizability are limited. Future longitudinal and neuroimaging studies are warranted to confirm these findings and inform clinical practice.

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Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most prevalent neurodevelopmental disorders, affecting approximately 5–7% of children and adolescents worldwide (Liu et al., 2025). It is characterized by persistent difficulties in sustaining attention, impulse control, and hyperactivity (Ayano et al., 2020). The disorder not only leads to academic, social, and emotional consequences (Coghill et al., 2023) but also underlies profound deficits in cognitive systems associated with attentional control and information processing (Rubia, 2018). According to the DSM-5 diagnostic framework (APA, 2013), ADHD manifests in three clinical presentations: the predominantly inattentive presentation (ADHD-I), the predominantly hyperactive-impulsive presentation (ADHD-H), and the combined presentation (ADHD-C). The predominantly inattentive presentation is the most common pattern in the general population across age groups, while the combined presentation is more frequently observed in clinic-referred samples and is associated with higher symptom severity and behavioral challenges (Lin et al., 2023). Children with ADHD-I primarily exhibit prominent difficulties in sustained attention, organization, and slower information processing, whereas those with ADHD-C demonstrate these issues along with hyperactive and impulsive behaviors (Nikolas & Nigg, 2013). Evidence suggests that the underlying cognitive and neuropsychological mechanisms of these presentations may not be identical and that each may possess a distinct cognitive profile (Saad et al., 2020; Wu et al., 2022). Therefore, investigating more fundamental cognitive structures, particularly systems crucial for attentional regulation and sequential information processing, can provide deeper insight into the differences between these two presentations and pave the way for developing more targeted interventions.

One of the most significant cognitive components impaired in ADHD is working memory (WM) (Kofler et al., 2020; Kofler et al., 2024; Wells et al., 2018). Deficits in this system not only affect the maintenance, processing, organization, and updating of information but are also critical for learning, problem-solving, and behavioral regulation (Kofler et al., 2020). WM is the ability to hold and manipulate information over a brief period without external guidance (Baddeley et al., 2021), enabling individuals to retain information in the presence of irrelevant stimuli and manipulate it to guide goal-directed behavior (Hasanzadeh & Ahmadi, 2015). Within Baddeley's multi-component model (Baddeley & Hitch, 1974), WM comprises three key subsystems: the phonological loop, responsible for the temporary storage and retrieval of verbal information; the visuospatial sketchpad, which maintains visual and spatial representations; and the central executive, which oversees attentional control, coordinates the subsystems, and actively manipulates information. Examining the performance of each of these components in ADHD can reveal the specific cognitive weaknesses of each clinical presentation and help delineate cognitive differences between ADHD-I and ADHD-C.

From a theoretical standpoint, Baddeley's multi-component model offers a framework for predicting differential WM impairments across ADHD subtypes (Kofler et al., 2020). The central executive, responsible for attentional control and information manipulation, is theoretically more aligned with the regulatory deficits characteristic of ADHD-C, such as impulse control and hyperactivity (Barkley, 1997). In contrast, the phonological loop and visuospatial sketchpad, as passive storage systems, may be more directly related to the primary attentional and organizational difficulties seen in ADHD-I (Martinussen & Tannock, 2006). Therefore, examining these components separately allows for a test of whether the cognitive architecture of ADHD subtypes diverges in a manner consistent with the model's predictions.

Previous research indicates that children and adolescents with ADHD have significant impairments in various WM components. A meta-analytic study found that effect sizes were generally larger for visuospatial storage and visuospatial central executive tasks (storage-plus-processing) compared to phonological storage and phonological central executive tasks

(Martinussen et al., 2005). The central executive component, in particular, appears to be distinctly affected (Kofler et al., 2020). Previous studies in this area have typically controlled for potential confounding variables such as age, gender, full-scale IQ, socioeconomic status, and the presence of comorbid psychiatric conditions (e.g., Martinussen et al., 2005; Nikolas & Nigg, 2013) to isolate the specific relationship between ADHD subtypes and working memory function. Consequently, WM deficit patterns in ADHD are multifaceted, varying in nature and severity depending on the task type (simple storage vs. storage-plus-processing) (Kofler et al., 2020; Martinussen et al., 2005).

However, research findings regarding differences in WM components between the inattentive and combined presentations are inconsistent. Some studies suggest that individuals with ADHD-C perform more poorly on verbal and visual recall tasks compared to those with ADHD-I (Nikolas & Nigg, 2013; Phillips et al., 2022). In contrast, other studies report no significant differences in WM between the two subtypes (Alloway et al., 2010). Conversely, some research indicates that differences are more closely related to the overall severity of the disorder rather than the specific subtype (Nikolas & Nigg, 2013; Wu et al., 2022). Distinguishing WM profiles between ADHD-I and ADHD-C is fundamentally important for several reasons. Theoretically, according to Baddeley's multi-component model, the phonological loop, visuospatial sketchpad, and central executive may be differentially impaired in ADHD subtypes (Marsh et al., 2025). Research suggests that WM deficits in ADHD-I and ADHD-C may reflect more fundamental differences in cognitive architecture and neural networks involved in attentional control and response inhibition. Specifically, the central executive and storage subcomponents are vulnerable in both subtypes, but the severity and pattern of these impairments may differ (Saydam et al., 2015). On a practical and clinical level, distinguishing between WM profiles can have significant implications.

A precise understanding of the weaknesses specific to each subtype allows professionals to design interventions that better align with the actual cognitive needs of children. Research shows that WM deficits, particularly in the central executive component, play a key role in the behavioral and academic problems of children with ADHD, and the severity of these deficits correlates with the severity of inattentive and hyperactive/impulsive symptoms (Kofler et al., 2020). Recent studies emphasize that cognitive interventions are most effective when tailored to the individual cognitive profile and ADHD subtype of each child. For example, children with severe WM deficits benefit more from targeted interventions in this domain, and improvements in WM performance can lead to a reduction in clinical symptoms and enhanced academic and daily functioning (Wexler et al., 2021).

Given the inconsistencies in previous research regarding WM differences between ADHD subtypes and the methodological limitations of prior studies (e.g., small samples, lack of comprehensive WM assessment), the present study aimed to compare WM profiles using a well-validated battery in a reasonably sized clinical sample. Accordingly, this research specifically evaluates the three main components of Baddeley's model: the phonological loop, the visuospatial sketchpad, and the central executive. Using standardized tasks designed to independently assess the performance of each WM subcomponent, this study seeks to determine whether each presentation possesses a distinct cognitive signature. The findings of this study can contribute to a more precise understanding of the heterogeneity within ADHD and facilitate the development of cognition-based assessments and interventions.

Method

Participants

The present study sample consisted of 137 children (41 with ADHD-I, 45 with ADHD-C, and 51 TD) aged 7 to 12 years (mean = 8.09, SD = 1.05) from Tehran, Iran, selected via convenience sampling from psychology clinics (see Table 1). All parents and children provided informed consent prior to participation. It is important to acknowledge that the use of convenience sampling from clinic-referred populations may limit the representativeness of the sample. Additionally, the sample lacks diversity in terms of socioeconomic status, geographic location, and cultural background, which may restrict the generalizability of the findings to broader populations.

Group Assignment

All children diagnosed with ADHD and their parents completed a comprehensive psychoeducational and diagnostic evaluation. This included a semi-structured clinical interview conducted by psychologists or psychiatrists in accordance with DSM-5 criteria (APA, 2013), along with the completion of the Child Behavior Checklist-Parent Version (CBCL-P). The precise subtyping of ADHD was further confirmed based on scores from the Integrated Visual and Auditory Continuous Performance Test version 2 (IVA-2), in which participants must respond to the target stimulus (the number "1") while inhibiting responses to the non-target stimulus (the number "2") (Sandford & Turner, 2000). To enhance the validity of the test results, stimulant medication was discontinued at least 24 hours prior to testing.

Participants in the typically developing (TD) group were recruited from the same clinic population, but specifically among children presenting for routine, non-clinical consultations (e.g., academic counseling, parenting guidance) rather than for psychiatric concerns. To ensure neurotypical status, TD participants were required to meet the following criteria: (1) no parent-reported history of psychiatric, neurological, or learning disorders; (2) school records indicating typical academic and behavioral functioning with no history of individualized educational support; and (3) normal-range scores on all syndrome scales of the Child Behavior Checklist-Parent version (CBCL-P; $T < 60$). Additionally, all TD children underwent the same IVA-2 assessment as the ADHD groups, and only those with scores within the normal range (standard score ≥ 85) were included in the final sample.

Inclusion criteria for all participants required an IQ of 85 or above, assessed using the Stanford-Binet Intelligence Test. Children with neurological disorders or other major psychiatric conditions were excluded from the study. Subsequently, all children were assessed individually using the Working Memory Test Battery for Children (WMTB-C) in a quiet, distraction-free room.

Materials

Working Memory Test Battery for Children (WMTB-C)

This test, based on the model by Baddeley and Hitch (1974), was designed to assess WM in children aged 4.7 to 15 years. The present study utilized the Persian version of the test, which was translated and validated by Arjmandnia (2017). The battery measures three components: the phonological loop, the visuospatial sketchpad, and the central executive, and includes nine subtests: Digit Recall, Word List Matching, Word Recall, Nonword Recall, Block Recall, Mazes Recall, Listening Recall, Counting Recall, and Backward Digit Recall. Test-retest reliability for children aged 4.7 to 15 years has been reported to range from .45 to .83 (Arjmandnia, 2017). Completing this battery takes approximately 45 minutes.

Integrated Visual and Auditory Continuous Performance Test (IVA-2)

The Integrated Visual and Auditory Continuous Performance Test (IVA-2) is a computerized assessment tool. It is used as a screening instrument alongside other diagnostic methods such as parent and teacher behavioral rating scales to evaluate attention, response inhibition, and to screen for Attention-Deficit/Hyperactivity Disorder (ADHD) in individuals aged 6 through adulthood. Administered in approximately 20 minutes, it consists of 500 trials, including practice and warm-up phases. During the test, respondents must respond to the target stimulus (e.g., the number "1") while inhibiting responses to non-targets (e.g., the number "2"). Scores are provided as raw and standardized values (mean = 100, SD = 15). Test-retest reliability coefficients for its subtests range from .75 to .97 (Sandford & Turner, 2000). The IVA-2 has demonstrated high sensitivity (92%) and predictive power (90%) compared to parent-report diagnostic scales (Sandford & Turner, 2000).

Results

The present study employed a cross-sectional design with three groups (ADHD-I, ADHD-C, and TD) to compare working memory profiles. An a priori power analysis using G*Power indicated that a minimum sample of 96 participants was required to detect medium-to-large effects (f = 0.35) with 80% power at $\alpha = 0.05$. The final sample of 137 children exceeded this requirement, ensuring adequate statistical power for group comparisons. Table 1 presents the demographic characteristics of the study participants. There were no statistically significant differences in age between the ADHD-I, ADHD-C and TD groups (see Table 1).

Table 1. Description of the Sample

	Groups			F	P
	ADHD-I	ADHD-C	TD		
N	41	45	51		
Male: female	(17:24)	(20:25)	(28:23)		
Age, mean (SD)	8.08 (1.04)	9.09 (1.06)	8.09 (1.05)	.37	.69

To investigate group differences, a one-way ANOVA was conducted on each subtest. All assumptions were met, including normality (assessed via Shapiro-Wilk tests, all $p > .05$) and homogeneity of variance (confirmed by Levene's test, all $p > .05$).

Table 2. ANOVA Results Comparing WM Subtest Scores

Variable	groups			ANOVA			Tukey results		
	ADHD-I	ADHD-C	TD						
	Means (SD)	Means (SD)	Means (SD)	F	p	η^2			
Digit Recall	84.71 (11.09)	81.22 (12.61)	95.96 (7.62)	25.92	<.01	.28	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
Word matching Recall	90.02 (11.43)	87.35 (14.27)	98.49 (7.65)	12.78	<.01	.16	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
Word Recall	96.58 (10.56)	91.75 (13.43)	107.02 (11.53)	20.61	<.01	.23	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
Nonword Recal	92.48 (10.02)	88.96 (9.61)	96.86 (6.63)	9.82	<.01	.13	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
Block Recall	90.05 (10.71)	82.53 (14.01)	101 (11.45)	28.12	<.01	.30	ADHD-I > ADHD-C	ADHD-I < TD	ADHD-C < TD
Maze Recall	95.90 (10.21)	91.58 (16.21)	107.23 (9.71)	20.70	<.01	.24	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
Listening Recall	91.93 (11.06)	83.82 (14.28)	100.82 (10.98)	23.45	<.01	.26	ADHD-I > ADHD-C	ADHD-I < TD	ADHD-C < TD
Counting Recall	92.59 (10.74)	86.58 (14.95)	106.86 (9.81)	34.85	<.01	.34	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
Backward digit Recall	86.04 (11.82)	78.69 (14.06)	101.98 (10.49)	23.75	<.01	.26	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD

Results of the one-way ANOVA (Table 2) indicated significant differences among the three groups across all WM subtests ($p < .01$).

Regarding the phonological component, post-hoc comparisons revealed that both ADHD-I and ADHD-C groups performed significantly worse than the TD group, with no significant difference between the two ADHD subtypes. Within the visuospatial component, in Block Recall, the ADHD-I group outperformed the ADHD-C group, though both ADHD groups scored significantly lower than the TD group. In Maze Recall, no significant difference was observed between the two ADHD groups, and both performed worse than the TD group. For the central executive-related subtests, post-hoc analysis showed that in Listening Recall, the ADHD-I group performed better than the ADHD-C group. However, in the other central executive subtests, there was no significant difference between the ADHD groups. Across all central executive subtests, both ADHD groups performed significantly worse than the TD group.

Table 3. ANOVA Results Comparing WM Components

Variable	groups			ANOVA			Tukey		
	ADHD-I	ADHD-C	TD						
	Means (SD)	Means (SD)	Means (SD)	F	p	η2			
PL	88.15 (11.32)	83.84 (14)	99.04 (7.62)	23.83	<.01	.26	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
VSSP	91.51 (10.28)	86.49 (13.74)	105.22 (10.17)	34.37	<.01	.34	ADHD-I = ADHD-C	ADHD-I < TD	ADHD-C < TD
CE	86.51 (11.82)	78.69 (14.06)	101.98 (10.49)	45.92	<.01	.41	ADHD-I > ADHD-C	ADHD-I < TD	ADHD-C < TD

Note. PL: Phonological Loop; VSSP: Visuospatial Sketchpad; CE: Central Executive

The results presented in Table 3 indicate significant differences among all three groups across the main components of WM. ($p < .01$). For the Phonological Loop, post-hoc tests using Tukey's method indicated that both ADHD groups performed significantly worse than the TD group, with no significant difference between ADHD-I and ADHD-C. The effect size for this component ($\eta^2 = .26$) is large according to Cohen's guidelines, indicating that 26% of the variance in phonological loop performance is explained by group membership.

In the Visuospatial Sketchpad, performance was also significantly lower in both ADHD groups compared to the TD group, and no significant difference emerged between the two ADHD subtypes. The effect size ($\eta^2 = .34$) is large, suggesting that 34% of the variance in visuospatial sketchpad performance is attributable to group differences.

Regarding the Central Executive, a significant and substantial difference was observed among the groups. Post-hoc comparisons revealed that the ADHD-I group performed better than the ADHD-C group, while both ADHD groups scored significantly lower than the TD group. The effect size for this comparison ($\eta^2 = .41$) is considered large, indicating that approximately 41% of the variance in central executive performance is accounted for by group membership. This represents a clinically meaningful distinction between the two ADHD subtypes.

It should be noted that the absence of significant differences between ADHD-I and ADHD-C on several subtests (e.g., Digit Recall, Word Recall, Counting Recall, and Backward Digit Recall) may reflect insufficient statistical power for pairwise subtype comparisons. Although the a priori power analysis confirmed that the total sample was adequately powered for the overall three-group comparisons, the subgroup sizes (41 and 45 participants for ADHD-I and ADHD-C, respectively) were not specifically powered to detect smaller effects between the two clinical groups. Therefore, these non-significant findings should not be interpreted as definitive evidence of equivalence, and replication with larger samples specifically designed for pairwise subtype comparisons is warranted.

Discussion and Conclusion

The findings demonstrate that children with ADHD, regardless of subtype, exhibit impaired performance across all three components of WM—phonological loop, visuospatial sketchpad, and central executive—compared to TD children. This aligns with prior meta-analytic reviews identifying WM as a core cognitive deficit in ADHD (Martinussen et al., 2005; Pievsky & McGrath, 2018).

According to Baddeley's multicomponent model, the phonological loop and visuospatial sketchpad primarily support temporary storage, while the central executive coordinates attention, integrates information across subsystems, and manipulates content (Baddeley, 2000). In ADHD, deficits in sustained attention and executive control may compromise these subsystems, particularly under increased cognitive load (Kofler et al., 2020). A notable finding concerns the distinction between subtypes: although both ADHD groups showed deficits in phonological and visuospatial storage, children with ADHD-C exhibited more pronounced impairment in the central executive relative to those with ADHD-I (Pasini et al., 2007). This pattern is consistent with theoretical frameworks that position the central executive as a supervisory system, with ADHD characterized by greater impairment in this domain compared to storage-related subsystems (Kofler et al., 2020).

Recent meta-analyses further indicate that central executive demands increase with processing load and response inhibition requirements, effects that appear more marked in the combined subtype (Friedman & Robbins, 2022). However, it is important to emphasize that the present study did not include neuroimaging measures; therefore, any interpretations linking behavioral findings to specific neural mechanisms (e.g., Cai et al., 2021) remain speculative and should be viewed as hypotheses to be tested in future research. From a neural perspective, some studies have associated ADHD-C with altered connectivity—particularly increased coupling between executive, salience, and sensory networks—which may contribute to broader deficits in cognitive control and attention regulation (Qian et al., 2019). Structural and functional differences in frontostriatal and prefrontal regions have been suggested to be more prominent in ADHD-C than in ADHD-I (Saad et al., 2020). Nevertheless, because the current study did not collect neuroimaging data, these neurobiological interpretations are offered as hypotheses rather than conclusions drawn from the present findings.

These results are also consistent with the Dual Pathway Model of ADHD, which posits separable but overlapping contributions of WM/executive deficits and inhibitory dysregulation to ADHD symptomatology (Stevens et al., 2018). In ADHD-C, additive impairments across both pathways may exacerbate executive dysfunction, whereas in ADHD-I, deficits may relate more specifically to attentional maintenance. Neuroimaging studies further distinguish subgroups with predominant executive hypofunction in prefrontal-striatal circuits from those with altered reward processing, supporting heterogeneous neural profiles across presentations (Stevens et al., 2018).

The finding that children with ADHD-C exhibit more severe central executive deficits than those with ADHD-I has practical implications. The large effect size ($\eta^2 = .41$) indicates a clinically meaningful distinction, supporting the inclusion of central executive tasks (e.g., listening recall, backward digit span) in routine assessments. For children with ADHD-C, interventions targeting executive functions—such as computerized working memory training, self-regulation strategies, and classroom accommodations—may be particularly beneficial. For those with ADHD-I, interventions might focus on strengthening storage components through mnemonic strategies and external aids. Future research should examine whether matching interventions to cognitive profiles enhances outcomes.

Several limitations should be acknowledged. The cross-sectional design precludes causal inferences, and convenience sampling from clinic-referred populations limits generalizability. The absence of neuroimaging measures means neural interpretations remain speculative, and

some WMTB-C subtests demonstrated low reliability, affecting measurement precision. Although the total sample was adequately powered for three-group comparisons, subgroup sizes may have been insufficient to detect smaller effects between ADHD-I and ADHD-C. Finally, potential confounding variables (e.g., comorbidities, medication history) were not fully controlled, highlighting the need for future longitudinal studies with more diverse samples and rigorous methodologies.

This study confirms WM impairments across ADHD presentations, with more severe central executive deficits in the combined subtype. The results align with established cognitive models and neuropsychological evidence, supporting distinct cognitive profiles in ADHD-I and ADHD-C. Comprehensive assessment of executive functions and tailored interventions, particularly for the combined presentation, are warranted. However, given the aforementioned limitations, future longitudinal and neuroscientific studies are needed to further elucidate the mechanisms underlying these subtype differences and to inform evidence-based clinical practice**.**

Declarations

Author Contributions

All authors contributed actively to the conception, design, and execution of the research.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Ethical considerations

All procedures performed in studies involving human participants were in accordance with the ethical standards of University of Tehran research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this research.

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The Effectiveness of the "Aram" Computerized Cognitive Rehabilitation Program on Improving Visual–Spatial Perception and Working Memory in Students with Specific Learning Disorders

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ABSTRACT

Specific learning disorder is among the most common academic challenges in children and can significantly impair cognitive functioning and educational progress. The present study aimed to investigate the effectiveness of the computer-based cognitive rehabilitation program “Aram” on improving visual–spatial perception and working memory in students with specific learning disorder. This quasi-experimental study employed a pretest–posttest design with a control group. The statistical population included 9- to 10-year-old boys with specific learning disorder referred to the Derakhshesh Child and Adolescent Counseling Center in Najafabad during the second half of 2024. Thirty participants were selected through purposive sampling and randomly assigned to experimental and control groups. After sample attrition, data from 27 participants were analyzed. The research instruments included selected subtests of the Wechsler Intelligence Scale for Children–Fifth Edition (WISC-V), including Block Design and Visual Puzzles for assessing visual–spatial perception, and Digit Span and Picture Span for evaluating working memory. The experimental group received the Aram computer-based cognitive rehabilitation intervention in 12 sessions of 45 minutes each, while the control group received no intervention. Data were analyzed using multivariate and univariate analyses of covariance. The findings indicated that, after controlling for pretest scores, the intervention significantly improved visual–spatial perception and working memory in the experimental group compared with the control group ($p < 0.001$). The results suggest that the Aram program can effectively improve cognitive functioning in students with specific learning disorder.

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Introduction

Specific learning disorder (SLD) is one of the most common neurodevelopmental disorders in childhood and is characterized by persistent difficulties in learning academic skills such as reading, writing, and mathematics despite adequate educational opportunities and normal intellectual functioning (American Psychiatric Association, 2022). These difficulties often extend beyond academic performance and are associated with impairments in cognitive, emotional, and social functioning. Previous studies have shown that children with SLD frequently experience deficits in several cognitive domains that interfere with information processing and academic achievement (Huwaipathirana et al., 2021; McMahon & Hatten, 2021). Therefore, identifying and improving the underlying cognitive deficits associated with SLD has become an important focus of contemporary educational and clinical research.

One of the major cognitive domains associated with learning disorders is visuospatial perception. Visuospatial perception refers to the ability to perceive, organize, analyze, and mentally manipulate visual and spatial information. This ability plays a crucial role in reading, writing, mathematical reasoning, visual–motor coordination, and problem solving. Deficits in visuospatial processing may impair children's ability to recognize spatial relationships, discriminate shapes and patterns, and accurately process visual information in educational contexts (Newcombe & Frick, 2010; Mix & Cheng, 2012). Recent findings indicate that students with SLD perform significantly weaker than their peers on tasks related to visuospatial perception and visual processing abilities (Seyedsharbati et al., 2021; Javadi Bazargani, 2023). Furthermore, interventions targeting visuospatial skills have demonstrated positive effects on cognitive and academic performance in children with learning disabilities (Pourfarahmand & Taher, 2022).

Another important cognitive component involved in learning processes is working memory. Working memory is a limited-capacity cognitive system responsible for the temporary storage and manipulation of information necessary for learning, comprehension, reasoning, and goal-directed behavior (Baddeley, 2012; Cowan, 2017). Children with SLD commonly exhibit impairments in both verbal and visuospatial working memory, which negatively affect reading comprehension, mathematical performance, and attentional control (Swanson & Sache-Lee, 2001). Recent studies have emphasized the critical role of working memory in academic achievement and cognitive flexibility among students with learning difficulties (Reisian et al., 2025; Norouzi Homayoun et al., 2025). Accordingly, improving working memory capacity has become an important therapeutic target in educational rehabilitation programs.

In recent years, computer-based cognitive rehabilitation has attracted increasing attention as an effective intervention for improving cognitive deficits in children with neurodevelopmental disorders. Cognitive rehabilitation programs are designed to strengthen cognitive functions such as attention, working memory, executive functions, and visuospatial processing through structured and repetitive cognitive exercises (Maggio et al., 2019; Mendez et al., 2022). Evidence suggests that technology-based cognitive interventions can significantly improve cognitive performance and adaptive functioning in children with learning disabilities (Safari Vasal et al., 2022; Amini et al., 2022). In addition, recent studies have highlighted the importance of scientifically designed educational games and digital interventions in promoting cognitive and metacognitive skills among children (Sahraeian, 2025).

One example of these interventions is the computer-based cognitive rehabilitation program "Aram," which was developed based on attention and working memory models. This program includes structured cognitive exercises targeting working memory, sustained attention, selective attention, and cognitive flexibility through interactive computerized activities (Nejati, 2018).

Previous findings have demonstrated that the Aram program can significantly improve cognitive functioning, particularly working memory and visuospatial abilities, in children with learning difficulties (Saeidmanesh et al., 2025). However, despite growing evidence regarding the effectiveness of cognitive rehabilitation interventions, limited studies have simultaneously examined the effects of the Aram program on both visuospatial perception and working memory in students with specific learning disorder, particularly in Iranian educational settings. Therefore, the present study aimed to investigate the effectiveness of the Aram computer-based cognitive rehabilitation program on improving visuospatial perception and working memory in students with specific learning disorder.

Method

Research Design and Participants

The present study employed a quasi-experimental design with a pre-test–post-test control group arrangement. The statistical population consisted of all male students aged 9 to 10 years (third- and fourth-grade elementary school students) diagnosed with specific learning disorder (SLD) and referred to the Darakhshesh Child and Adolescent Counseling Center in Najafabad during the second half of 2024.

The sample size was determined based on established methodological criteria for experimental and quasi-experimental designs in behavioral sciences, which recommend a minimum baseline of 15 participants per group to achieve adequate statistical power and satisfy the assumptions required for analysis of covariance (ANCOVA) (Delavar, 2018). Accordingly, a total of 30 male students were selected from among 87 boys with SLD using purposive sampling and randomly assigned to two groups of 15 participants each: an experimental group and a control (waiting-list) group.

Selection was based on the following inclusion criteria: age range of 9 to 10 years (enrolled in third or fourth grade), male gender, informed consent from both the student and parents, diagnosis of learning disorder involving impairment in reading, writing, or mathematics based on a clinical interview in accordance with DSM-5, confirmed diagnosis of specific learning disorder and eligibility to receive special education services by the center's officials and psychologist through review of their registered records, absence of comorbidity with other neurodevelopmental disorders, cognitive ability above the borderline range (IQ $\geq$ 90) as determined by the Colored Progressive Matrices of Raven's Children (RPM), no receipt of other intervention or educational services during the previous 6 months, and no psychiatric treatment before or during the study. The exclusion criteria included unwillingness of the child or family to continue participation, absence from more than two consecutive training sessions, and receiving other educational services.

Among the initial sample, 14 participants were in third grade (7 assigned to the experimental group and 7 to the control group) and 16 participants were in fourth grade (8 assigned to the experimental group and 8 to the control group). During the implementation of the intervention, however, three participants were excluded due to attrition, including absence from more than two sessions and insufficient cooperation during the sessions. These included two participants from the fourth-grade experimental group and one participant from the fourth-grade control group. Accordingly, the final statistical analysis was conducted on data from 27 participants.

Measurement Tools

Wechsler Intelligence Scale for Children, Fifth Edition (WISC-V): The Wechsler Intelligence Scale for Children, Fifth Edition consists of 21 subtests. Thirteen subtests have been retained from the fourth edition of the Wechsler Intelligence Scale for Children. These subtests include Block Design, Similarities, Matrix Reasoning, Digit Span, Coding, Vocabulary, Symbol Search, Information, Picture Concepts, Letter-Number Sequencing, Cancellation, Comprehension, and Arithmetic. In addition, eight new subtests have been added to this test,

namely Figure Weights, Visual Puzzles, Picture Span, Naming Speed Literacy, Naming Speed Quantity, Immediate Symbol Translation, Delayed Symbol Translation, and Recognition Symbol Translation (Karami et al., 2020). A review of the available sources concerning the psychometric properties of the WISC-V indicates the desirable reliability and validity of this scale. Evidence related to the internal consistency reliability of the test, reported in the WISC-V Technical and Interpretive Manual, based on split-half reliability and test-retest reliability in the general sample, at the subtest level ranges from 0.81 to 0.94, and at the index level ranges from 0.88 to 0.96 (Wechsler, 2014). The Technical and Interpretive Manual of the WISC-V shows that the concurrent validity of this scale with other valid intelligence tests is at an acceptable level. In addition, the Persian version of the WISC-V has been standardized by Kamkari and Shakerzadeh and has desirable psychometric properties.

Block Design Subtest: The Block Design subtest in the Wechsler test is an instrument used to assess visuospatial abilities, organization, and problem-solving. Within a specified time limit, the examinee sees a pattern or picture on the screen or on the test booklet and reconstructs the design using two-colored blocks (Karami and Karami, 2018). This subtest measures sensorimotor coordination, fluid intelligence, visual perception and visual organization, simultaneous processing, spatial visualization, figure-ground differentiation and orientation, and the analysis and synthesis of visual stimuli.

Visual Puzzles Subtest: Visual Puzzles effectively measures spatial visualization abilities and visual perception. This subtest is designed to assess the cognitive dimensions associated with solving visual problems. Within a specified time limit, the examinee sees a completed puzzle on the screen or on the test booklet and selects three response options that, when combined, solve the puzzle (Karami and Karami, 2018). The Cronbach's alpha coefficient for the Visual Puzzles subtest is usually reported to be above 0.80, indicating good reliability for this subtest (Wechsler, 2014).

Digit Span Subtest: The Digit Span subtest in the Wechsler tests includes three types: Digit Span Forward, Digit Span Backward, and Digit Span Sequencing. This subtest measures sequencing, short-term memory, information transfer, auditory processing, attention and concentration, neural trace, information registration, simultaneous processing, mental operations and manipulation, and visuospatial imagery. The administration of this subtest is as follows: in the forward condition, the participant repeats the digits presented by the examiner in the same order; in the backward condition, the digits must be repeated in reverse order; and in the sequencing condition, numbers are presented with greater complexity and the individual must recall them in a specific sequence. Some studies have reported Cronbach's alpha values between 0.80 and 0.90 for these subtests (Wechsler, 2008; Karami and Karami, 2018).

Picture Span Subtest: Picture Span assesses visual memory, recognition, and attention and is logically related to intelligence and cognitive abilities. The reliability coefficient for the Picture Span subtest has been reported to be approximately 0.85 (Wechsler, 2014). The administration procedure is as follows: a child is presented with a page containing one or more images within a specified time, and then the examinee selects the image or images from the response page (Karami and Karami, 2018).

Raven's Colored Progressive Matrices for Children (RPM): Raven's Progressive Matrices were first standardized in England by Raven in 1938 (Raven, 2000). This test has two forms: one for children aged 5 to 9 years and another for individuals 9 years and older, including adults (Nodei et al., 2016). Raven's Progressive Matrices is a nonverbal intelligence test that is widely used across different cultural and socioeconomic groups worldwide (Westberg et al., 2017). The administration of the Raven intelligence test is such that it consists of a series of patterns and diagrams, part of which is incomplete, and the examinee is expected to choose the correct missing part from several options printed below the figure (Raven, 2000). Obtaining a score of 90 or above on this test was considered as the inclusion criterion for participants.

Procedure

In the pre-test phase, both the experimental and control groups completed the pre-test assessments. The Block Design and Visual Puzzles subtests of the WISC-V were used to assess visuospatial perception, while the Digit Span and Picture Span subtests were utilized to measure working memory.

Subsequently, the experimental group received the computer-based cognitive rehabilitation intervention (ARAM) in 12 individual sessions, each lasting 45 minutes, conducted three times per week. The control group received no intervention during this period and remained on a waiting list. The intervention was delivered using the ARAM Memory and Attention Rehabilitation Software, developed by Najati (2018) based on the Sohlberg and Mateer attentional model and Baddeley's working memory model. The ARAM program consists of a series of hierarchically organized tasks designed to enhance various dimensions of attention and working memory. The core functional features and principles of the program are detailed in Table 1.

Table 1. Principles and Structural Features of the ARAM Program

Feature	Description
Hierarchical Difficulty	Tasks were organized hierarchically, with difficulty increasing based on the user's performance.
Immediate Reinforcement	Correct task performance was followed by immediate reinforcement.
Multi-Dimensional Attention	Tasks were designed according to different dimensions of attention.
Engagement & Motivation	Tasks were engaging and enjoyable, thereby increasing the patient's motivation.
Repetition & Mastery	Tasks could be repeated until the patient reached the desired level of mastery.
Performance-Based Advancement & Therapist Oversight	Advancement within the program was determined based on the patient's performance, and therapist supervision was required to upgrade task difficulty.

Additionally, if a child was unable to achieve 80% accuracy at a given level, that level was repeated (Nemat et al., 2024). The tasks included in the ARAM program consisted of: Colored Houses Task, Faces Task, Similar Windows Task, Marked Tables Task, Fragmented Images Task, Acronym Formation Task, Last Colors Task, Animal Tracking Task, Repeated Images Task, Word–Letter Matching Task, and Delayed Color Matching Task. All tasks comprised ten levels of difficulty, which were adjusted according to the number of stimuli, presentation speed, stimulus complexity, and governing task rules.

The implementation procedure was as follows: the therapist first explained the task instructions to the patient, after which the patient performed the task. Feedback for correct responses was provided automatically and intelligently by the software. Evaluation of performance at the end of each task, as well as selection of the task type and difficulty level, was conducted by the therapist. Each student began at the simplest level of each task and was not permitted to progress to a higher level until achieving at least 80% correct responses. Depending on the student's performance, it was possible for two consecutive sessions to be completely identical in terms of training content. Overall, each participant had 45 minutes to complete eight games per session. If the participant did not demonstrate sufficient progress, the same level of the game was repeated in the subsequent session.

At the end of the training sessions, a post-test was administered to both groups in the final session. To respect participants' privacy, they were assured that all information would remain confidential and would be used solely for research purposes. In addition, to observe the principles of research fairness and prevent any deprivation of participants' rights, the control group was informed after the experimental intervention and post-test that, if they wished, they would also be offered the same educational intervention. Finally, the collected data were analyzed using SPSS version 27, employing multivariate analysis of covariance (MANCOVA) and univariate analysis of covariance (ANCOVA).

Table 2. Description of the Tasks Administered in the Aram Cognitive Rehabilitation Program (Najati, 2018)

Execution time	Task Title	Task Description	Cognitive Value
Week 1	Colored Houses	Participants were required to identify a target stimulus, namely a colored house, among visually similar distractors that differed only in color.	This task primarily engaged sustained attention, selective attention, and inhibitory control.
	Similar Windows	Participants selected windows behind which the same image was displayed.	This task was designed to strengthen visuospatial span and working memory.
	Faces	Participants categorized faces according to skin color, hair color, and facial expression.	This task required selective attention and inhibitory control.
Week 2	Marked Tables	A sequence of tables containing numbers or black dots in one of the cells was presented to participants, who were then required to memorize the locations of the marks. Subsequently, four response options were displayed, and the correct option had to be selected based on the location of each mark in the previously presented sequence.	This task engaged the visuospatial sketchpad and the phonological loop of working memory.
Week 3	Fragmented Images	Several images were divided into separate fragments, each of which was presented briefly to participants. They were required to retain the fragments in memory and then select the correct image from among four alternatives.	This task primarily engaged the visuospatial sketchpad.
	Repeated Images	A series of images was presented, and participants had to identify whether each image had been previously shown.	This task engaged the visuospatial sketchpad and the phonological loop.
Week 4	Animal Tracking	A grid containing an animal image in one of its cells was presented. Arrows then appeared in different directions, and participants were required to follow the indicated path and select, from four alternatives, the cell in which the animal would arrive at the end of the route.	This task engaged and strengthened the visuospatial sketchpad.
	Last Colors	A sequence of colors was presented and then interrupted at an unspecified point. Participants were required to identify the last two or more colors from the response options.	This task updated working memory and strengthened the central executive component of working memory.

Results

For data analysis, descriptive statistics including mean and standard deviation, as well as inferential statistics including multivariate and univariate analysis of covariance (MANCOVA and ANCOVA), were used. Data analysis was performed using SPSS version 27.

Table 3. Demographic Characteristics of the Experimental and Control Groups

Variable	Category	Experimental Group (n = 13)	Control Group (n = 14)	Total Sample (N = 27)
Age (years)	Mean ± SD	8.99 ± 0.22	8.97 ± 0.33	–
	Min – Max	8.72 – 9.44	8.34 – 9.61	–
Grade level	3rd grade	7 (53.8%)	7 (50.0%)	14 (51.9%)
	4th grade	6 (46.2%)	7 (50.0%)	13 (48.1%)
Type of LD	Reading disorder	8 (61.5%)	6 (42.9%)	14 (51.9%)
	Writing disorder	2 (15.4%)	4 (28.6%)	6 (22.2%)
	Mathematics disorder	3 (23.1%)	4 (28.6%)	7 (25.9%)
Economic status	Good	2 (15.4%)	3 (21.4%)	5 (18.5%)
	Moderate	3 (23.1%)	9 (64.3%)	12 (44.4%)
	Poor	8 (61.5%)	2 (14.3%)	10 (37.0%)
Father's education	Master's degree	1 (7.7%)	1 (7.1%)	2 (7.4%)
	Bachelor's degree	3 (23.1%)	6 (42.9%)	9 (33.3%)
	Associate degree	4 (30.8%)	5 (35.7%)	9 (33.3%)
	High school diploma	5 (38.5%)	2 (14.3%)	7 (25.9%)
Mother's education	Master's degree	3 (23.1%)	2 (14.3%)	5 (18.5%)
	Bachelor's degree	5 (38.5%)	10 (71.4%)	15 (55.6%)
	Associate degree	4 (30.8%)	0 (0.0%)	4 (14.8%)
	High school diploma	1 (7.7%)	2 (14.3%)	3 (11.1%)

Table 4. Mean and Standard Deviation of the Main Scales in the Pretest and Posttest

Scale	Group	N	Pretest M	Pretest SD	Posttest M	Posttest SD
Visuospatial perception	Control	14	34.71	7.95	35.21	7.07
	Experimental	13	35.69	8.51	41.77	2.92
Working memory	Control	14	9.50	2.274	9.27	2.125
	Experimental	13	9.31	2.446	11.69	2.564

Before conducting the multivariate and univariate analyses, the necessary assumptions were examined. The Shapiro–Wilk test showed that the distribution of posttest scores for visuospatial perception and working memory was normal in both the experimental and control groups ($p > 0.01$). In addition, Box's M test for the homogeneity of covariance matrices indicated that the homogeneity assumption was satisfied (Box's M: $M = 0.548$, $F = 0.167$, $p = 0.919$). Levene's test was also non-significant for both variables, indicating equality of variances (visuospatial perception: $F = 0.076$, $p = 0.784$; working memory: $F = 4.597$, $p = 0.042$). Furthermore, the slope of the regression line for the pretests was examined and confirmed in the analysis of covariance, indicating a significant correlation between the pretests and posttests and the fulfillment of the assumption of linearity. Therefore, all necessary assumptions for parametric analyses, including ANCOVA and MANCOVA, were met, and the validity of the statistical analysis results is ensured.

Table 5. Results of Multivariate Tests (MANCOVA) for Visuospatial Perception and Working Memory

Statistic	Value	F	df	Hypothesis df	sig	Partial Eta Squared	Observed Power
Pillai's Trace	0.855	65.022	2	22	< 0.001	0.855	1.000
Wilks' Lambda	0.145	65.022	2	22	< 0.001	0.855	1.000
Hotelling's Trace	5.911	65.022	2	22	< 0.001	0.855	1.000
Roy's Largest Root	5.911	65.022	2	22	< 0.001	0.855	1.000

The results of the MANCOVA indicate that there was a statistically significant difference between the experimental and control groups in the linear combination of the two dependent variables, visuospatial perception and working memory (Wilks' Lambda: $F(2, 22)=65.022$, $p<0.001$, $\eta^2=0.855$). These findings suggest that the implemented intervention program was able to enhance participants' performance in both cognitive components simultaneously and effectively.

Table 6. Results of Univariate Covariance Analysis (ANCOVA) for the Subscales of Visuospatial Perception

Subscale	Source	SS	df	MS	Sig	Eta
Block Design	Pretest	671.362	1	671.362	< 0.001	0.849
	Group	70.179	1	70.179	< 0.001	0.371
Visual Puzzles	Pretest	213.408	1	213.408	< 0.001	0.922
	Group	29.754	1	29.754	< 0.001	0.621

The results of the analysis of covariance presented in Table 4 indicate that pretest scores in both subscales Block Design and Visual Puzzles played a significant role in predicting posttest performance ($p < 0.001$). After controlling for the effect of the pretest, a significant difference was observed between the experimental and control groups in both abilities. The obtained effect sizes indicate that the implemented intervention made a substantial contribution to enhancing participants' visuospatial skills ($\eta^2= 0.371$ for Block Design and $\eta^2= 0.621$ for Visual Puzzles).

Overall, these findings suggest that the intervention program was able to significantly and markedly improve the performance of the experimental group in both constructing spatial patterns (Block Design) and solving visual problems (Visual Puzzles).

Table 7. Results of Univariate Analysis of Covariance (ANCOVA) for Working Memory Subscales

Subscale	Source	SS	df	MS	F	Sig	Partial Eta Squared
Digit Span Forward	Group	39.715	1	39.715	111.735	0.000	0.842
	Error	-	-	-	-	-	-
Digit Span Backward	Group	36.372	1	36.372	62.220	0.000	0.748
	Error	-	-	-	-	-	-
Digit Span Sequencing	Group	40.022	1	40.022	74.278	0.000	0.780
	Error	-	-	-	-	-	-
Picture Span	Group	34.280	1	34.280	26.470	0.000	0.524
	Error	-	-	-	-	-	-

The results of the analysis of covariance presented in Table 5 indicate that there was a significant difference between the experimental and control groups in all working memory subscales, including Digit Span Forward, Digit Span Backward, Digit Span Sequencing, and Picture Span ($p < 0.001$). In addition, the high effect size values across all four variables, ranging from 0.524 to 0.842, indicate that the implemented intervention made a very substantial contribution to improving working memory performance. Overall, these findings confirm that the educational intervention used was able to significantly and meaningfully enhance participants' performance across all dimensions of working memory.

Discussion and Conclusion

The present study aimed to investigate the effectiveness of the computer-based cognitive rehabilitation program "Aram" on visuospatial perception and working memory in students with specific learning disorder. The findings indicated that the intervention had a significant positive effect on visuospatial perception. This finding is consistent with previous studies demonstrating the effectiveness of computer-based cognitive rehabilitation in improving visuospatial abilities and related cognitive functions among children with learning difficulties (Capurso et al., 2024; Kim et al., 2024; Maresca et al., 2024; Royatvand Ghiyathvand & Amiri Majd, 2018; Kakavand & Keshavarz, 2019; Haghighatpanah et al., 2019). These findings suggest that targeted cognitive exercises can improve the processing, organization, and interpretation of visual and spatial information in students with learning disorders.

The positive effect of the Aram program on visuospatial perception may be explained by the structure of the intervention itself. Cognitive rehabilitation interventions are designed to strengthen basic cognitive skills such as attention, working memory, information processing, and executive functions, all of which play an important role in visuospatial processing. Numerous studies have shown that regular and targeted cognitive training can lead to structural and functional changes in brain regions associated with visuospatial processing (Karbach & Verhaeghen, 2014; Klingberg, 2010). Furthermore, the use of computer technologies in cognitive rehabilitation allows individualized and adaptive exercises with immediate feedback, which may increase students' motivation, active participation, and intervention effectiveness. Compared with traditional interventions, these computerized approaches provide greater opportunities for repeated and consistent practice and may improve visuospatial memory, visual information processing speed, and visuomotor coordination in students with learning disorders.

The findings also showed that the Aram cognitive rehabilitation program had a significant positive effect on working memory in students with specific learning disorder. This finding is in line with previous studies indicating that computer-based cognitive rehabilitation interventions can improve working memory performance and executive functioning in children with learning difficulties (Trigueros et al., 2024; Chan et al., 2024; Shapiro, 2024; Rute Pérez et al., 2023; Alivand Vafa et al., 2024; Amini et al., 2022; Khanjani & Salehi Aghdam Afi, 2018; Faizi Pur et al., 2018). Since working memory is a fundamental cognitive component involved in learning, reasoning, comprehension, and academic performance, strengthening this ability may substantially improve students' educational functioning and cognitive flexibility.

One possible explanation for the improvement in working memory is that repeated and adaptive cognitive exercises activate and strengthen neural systems involved in verbal, visuospatial, and executive aspects of working memory. Through repeated stimulation of neural pathways, more efficient cognitive processing patterns may gradually develop. In addition, gradual progression of task difficulty based on individual performance, along with immediate reinforcement and therapist supervision, may increase persistence, cognitive engagement, and sustained attention during rehabilitation sessions. Previous studies have similarly suggested that structured and individualized cognitive rehabilitation programs can effectively improve working memory and related academic skills in students with learning disorders (Shaban et al., 2024). Therefore, computer-based cognitive rehabilitation programs such as Aram may serve as an effective complementary intervention for strengthening working memory and related cognitive functions in students with specific learning disorder.

Despite the important findings of the present study, several limitations should be acknowledged. First, the sample size was relatively small, which may limit the generalizability of the findings. Second, the study was conducted only on male students aged 9 to 10 years; therefore, caution should be exercised in generalizing the results to female students or other age groups. Third, the absence of a follow-up phase prevented the evaluation of the long-term stability of the intervention effects. In addition, some environmental and educational factors that may influence cognitive performance were beyond the researchers' control.

Based on these limitations, future studies are recommended to use larger and more diverse samples, include both genders and different educational levels, and conduct follow-up assessments to evaluate the long-term effectiveness of cognitive rehabilitation interventions. It is also suggested that future research compare different computer-based cognitive rehabilitation programs and examine their effects on other cognitive and academic variables such as attention, academic achievement, and executive functions. From a practical perspective, educational and counseling centers may benefit from integrating scientifically designed computer-based cognitive rehabilitation programs into intervention plans for students with learning disorders.

In conclusion, the findings of the present study demonstrated that the Aram computer-based cognitive rehabilitation program significantly improved visuospatial perception and working memory in students with specific learning disorder. These findings highlight the importance of technology-based cognitive interventions in strengthening cognitive functioning and supporting the educational development of students with learning difficulties. Therefore, structured computer-based cognitive rehabilitation programs may be considered effective complementary interventions in educational and clinical settings for children with specific learning disorder.

Declarations

Author Contributions

All authors contributed equally to the conceptualization, study design, data collection, data analysis, and writing of this research.

Data Availability Statement

The data and datasets generated and analyzed in this study are available from the corresponding author upon reasonable request.

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Ethical considerations

All stages of this study were conducted in accordance with the ethical principles stated in international research guidelines. Informed consent was obtained from the students and their parents, and the confidentiality of their information was maintained throughout the research process. This study was approved by the Research Ethics Committee of the Islamic Azad University, Najafabad Branch, under the ethics code IR.IAU.NAJAFABAD.REC.1404.013.

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Conflict of interest

The authors declare that there was no conflict of interest in conducting this research.

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The Effectiveness of a Mindfulness-Based Cognitive Therapy Training Program on Executive Functions and Sustained Attention in Children with Learning Disorders

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ABSTRACT

Executive function deficits are among the most common cognitive difficulties experienced by children with learning disorders and are associated with poor academic achievement, impaired emotional regulation, and difficulties in everyday functioning. Mindfulness-Based Cognitive Therapy (MBCT) has been proposed as a promising intervention for improving cognitive and emotional functioning in this population. Therefore, the present study investigated the effectiveness of an MBCT training program on executive functions and sustained attention in children with learning disorders. A quasi-experimental pretest–posttest design with a control group was employed. Thirty children aged 9–12 years diagnosed with learning disorders were selected from the Learning Disorders Clinic of the Faculty of Psychology and Educational Sciences, University of Tehran, and randomly assigned to an experimental group (n = 15) or a control group (n = 15). The experimental group participated in twelve weekly 90-minute MBCT sessions, whereas the control group received no intervention. Data were collected using the Executive Skills Questionnaire–Revised (ESQ-R) and the Integrated Visual and Auditory Continuous Performance Test (IVA) and analyzed using multivariate analysis of covariance (MANCOVA). The findings indicated that MBCT significantly improved planning, emotional regulation, and time management compared with the control group. However, no significant effects were found for organization, behavioral regulation, or sustained attention. These findings suggest that MBCT is an effective intervention for enhancing specific components of executive functioning in children with learning disorders. Incorporating mindfulness-based interventions into educational and clinical settings may strengthen self-regulatory and cognitive abilities, thereby improving academic performance and psychological functioning in this population.

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Introduction

Executive functions play a crucial role in the development and expansion of children's academic and social abilities and are of particular importance in their academic and social readiness for school entry (Bünger et al, 2021). Research findings have demonstrated that cognitive abilities associated with executive functions can predict and contribute to adaptive behaviors. Accordingly, executive functions play a significant role in information processing, everyday life skills, and effective self-maintenance (Bernardi et al, 2018). These functions are considered fundamental skills for individuals' mental and physical well-being, and impairments in these abilities may lead to behavioral and psychological problems as well as difficulties in performing daily activities (Dayan et al, 2007). In fact, executive functions encompass abilities such as decision-making, strategic planning, attention, self-initiation, impulse control, working memory, cognitive flexibility, response inhibition, and academic performance (Amani,2017).

Attention, as one of the most important components of executive functions, plays a vital role in information processing and in the selection of relevant data for analyzing and responding to the environment (Bünger et al, 2021). Sustained attention, which is a subtype of attention, refers to the ability to maintain focus over time and is considered the most fundamental level of attention. Since other forms of attention also depend on sustained attention, any impairment in this component may indicate deficiencies in other types of attentional functioning (Jalilvand, 2020).

Mindfulness-Based Cognitive Therapy (MBCT), originally introduced by Segal et al (2012) for the prevention of depressive relapse, is a combination of cognitive approaches and meditation techniques aimed at teaching individuals how to regulate attention in order to recognize mood changes and prevent the recurrence of symptoms (Sipe,& Eisendrath, 2012). MBCT, through the use of cognitive-behavioral and metacognitive strategies, emphasizes attentional focus and can prevent the development of negative mood states, maladaptive thoughts, and worry-related responses while facilitating the formation of new perspectives and the experience of positive emotions (Segal et al., 2012). This therapeutic approach teaches individuals to accept their emotions, live in the present moment, and enhance their resilience (Hayes et al, 2006). Furthermore, it enables individuals to relate differently to challenging physical and emotional states, utilize healthier coping strategies, identify the underlying causes of maladaptive behaviors, and disengage from previous dysfunctional patterns. In addition, this approach promotes the acquisition of practical skills for coping with everyday challenges (Bowen et al., 2021).

In the field of learning disorders, particular attention has been given to the role of executive functions, especially sustained attention. For example, Kiani et al (2021) investigated the effectiveness of a mindfulness-based cognitive empowerment program on improving executive functions in children with Attention-Deficit/Hyperactivity Disorder (ADHD). Their findings indicated that the program led to improvements in various components of executive functioning. Similarly, Huguet et al (2017) reported that mindfulness-based practices could enhance concentration and attention in children with internalizing behavioral disorders. In addition, Schoenberg & Speckens (2014) emphasized that the use of mindfulness techniques may improve executive functions by enhancing the functioning of the prefrontal cortex. Collectively, these studies highlight the positive effects of mindfulness-based programs on improving executive functions and sustained attention in children with learning disorders, suggesting that such interventions may serve as effective strategies for enhancing the cognitive capacities of these children.

Given the importance of executive functions in the learning process and academic achievement, the assessment and enhancement of these functions may have substantial effects on the cognitive, emotional, and social capacities of children. Disorders such as Attention-Deficit/Hyperactivity Disorder (ADHD) and learning disorders, which are highly prevalent

among children, can lead to difficulties in sustained attention, working memory, planning, organization, and emotional regulation. These difficulties, in turn, negatively affect academic performance (Kiani et al, 2021). In this regard, research has shown that mindfulness-based interventions and cognitive therapies can improve these functions and enhance the cognitive performance of children with learning disorders and ADHD. Numerous studies have emphasized that mindfulness, as a non-pharmacological intervention, can reduce problems such as inattention, anxiety, and poor impulse control by strengthening attention and emotional self-regulation. For example, Segal et al (2012) demonstrated that mindfulness techniques help children better identify and regulate their emotions, particularly in challenging situations requiring concentration and decision-making. Furthermore, combining this approach with other cognitive training programs may lead to improvements in sustained attention, working memory, and cognitive flexibility (Huguet et al, 2017). Findings from various studies have also indicated that mindfulness-based programs significantly improve emotional regulation and reduce anxiety in children with generalized anxiety disorder and ADHD (Hematian et al, 2020). Moreover, incorporating mindfulness techniques into educational programs can strengthen the cognitive abilities of children with specific learning disorders and contribute to improvements in executive functions such as planning, organization, and cognitive flexibility (Dehghani et al, 2021).

Accordingly, the primary aim of the present study was to investigate the effectiveness of a mindfulness-based educational program in improving executive functions and sustained attention among children with learning disorders. Conducting this study may contribute to the identification and enhancement of these children's cognitive and behavioral skills, and its findings may be utilized in developing effective educational and therapeutic strategies aimed at improving executive functioning and enhancing their academic abilities.

Method

Research Design and Participants

The present study employed a quasi-experimental pretest–posttest design with a control group. The statistical population consisted of all children with learning disorders who were referred to the clinic of the Faculty of Psychology and Educational Sciences at the University of Tehran during the 2024–2025 academic year and had received services for learning disorders at this center. From among these children, 30 participants were selected using purposive sampling and were randomly assigned to either the experimental group (n = 15) or the control group (n = 15). The inclusion criteria consisted of children aged 9 to 12 years diagnosed with learning disorders by the psychologists of the learning disorders clinic, with the diagnosis documented in their clinical records. The exclusion criteria included unwillingness to continue participation in the sessions and absence from more than two treatment sessions.

The research procedure was conducted as follows: after obtaining the necessary coordination with the clinic director, children and their parents were invited to participate in the study. An introductory session was held for the mothers in which the objectives and procedures of the intervention sessions were explained. After informing the participants about the aims of the study, parents were asked to allow their children to participate in the treatment program. Written informed consent was obtained from all parents prior to participation. In addition, educational guidance was also provided to the parents.

Before the initiation of the intervention, both groups were assessed at the pretest stage. Parents were asked to complete the Executive Functions Questionnaire regarding their children, and the IVA test was administered to the children as well. Subsequently, participants were randomly assigned to the two groups, and the experimental group received the mindfulness intervention. The intervention program consisted of twelve 90-minute sessions conducted in a group format once per week. Following completion of the intervention period, both the experimental and

control groups were reassessed during the posttest phase, and the collected data were then analyzed.

Measurement Tools

Integrated Visual and Auditory Continuous Performance Test (IVA)

The Integrated Visual and Auditory Continuous Performance Test (IVA) is a visual–auditory continuous performance test designed to assess two major components, namely attention and response inhibition. This instrument evaluates four primary domains, including attention, vigilance, focus, and processing speed, across different types of attention such as sustained, selective, divided, and persistent attention (response inhibition) (Moreno-García et al, 2015). Previous studies have indicated that the IVA test demonstrates adequate sensitivity (92%) and predictive accuracy (89%) for the accurate assessment of sustained attention in children and adolescents (Boojari et al., 2015). Furthermore, this instrument has shown appropriate sensitivity (92%) and predictive validity (90%) in assessing attention, concentration, and the diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD) (Moreno-García et al, 2015). In the present study, the sustained attention component of the IVA test was utilized.

Executive Skills Questionnaire–Revised (ESQ-R)

The original version of the Executive Skills Questionnaire–Revised (ESQ-R) was developed by Dawson and Guare (2018) as a self-report, paper-and-pencil instrument. The questionnaire initially consisted of 33 items. Following psychometric evaluations, Strait et al (2020) revised the instrument and reduced it to 25 items by removing several statements. The revised version assesses five executive skill domains, including planning, time management, emotional regulation, organization, and behavioral regulation. The questionnaire is scored using a Likert scale ranging from "Never" to "Always," with scores from 0 to 3 assigned respectively.The questionnaire has demonstrated satisfactory validity and reliability. For example, Strait et al (2020) reported a Cronbach's alpha coefficient of .91 for the total scale, and Nasir and Pheh (2021) confirmed the construct validity of the instrument. In addition, Abdolmohamadi and Alimohamadi (2025) reported the following internal consistency coefficients: .91 for the total executive skills score, .86 for planning, .62 for time management, .68 for emotional regulation, .72 for organization, and .79 for behavioral regulation. In the present study, the calculated internal consistency coefficients were .91 for the total executive skills score, .86 for planning, .62 for time management, .68 for emotional regulation, .72 for organization, and .79 for behavioral regulation.

Intervention Protocol

The content of the Mindfulness-Based Cognitive Therapy (MBCT) sessions was designed and implemented based on the adapted protocol of Semple and Lee (2011). A summary of the session structure and content is presented in Table 1.

Table 1. Content of Mindfulness-Based Cognitive Therapy (MBCT) Protocol Sessions

Sessions	Goal	Activity	Implementation Method
1	Establishing communication, creating a friendly atmosphere, and providing initial explanations about the intervention program	Establishing rapport and familiarity with the therapeutic environment, participants, and rules; introducing the concept of mindfulness	In this session, the therapist and participants become acquainted with each other, and participants' initial questions are answered.
2	Understanding attention distractors, the wandering mind, and awareness of bodily sensations	Discussing obstacles to mindfulness, emphasizing practice as the foundation of the work, moving slowly but mindfully, and mindful breathing training	In this session, the therapist attempts to familiarize participants with bodily sensations through exercises such as deep breathing and attention to breathing.
3	Growth and development of mindful thoughts	Mindful attention to thoughts and bodily sensations, mindful attention to the body, and three mindful breaths	In this session, the therapist attempts to develop mindful attention through exercises such as mindful sitting and practicing three mindful breaths.

Sessions	Goal	Activity	Implementation Method
4	Remaining in the present moment and mindful living	Reviewing exercises from previous sessions, performing mindful yoga movements, and practicing a three-minute mindful breathing exercise	In this session, the therapist introduces the three-minute mindful breathing exercise and maintaining attention.
5	Becoming familiar with thoughts, accepting them, and understanding their relationship with bodily sensations	Mindful listening, mindful attention to the body, practicing a three-minute mindful breathing exercise, and thought clouds exercise	In this session, the therapist encourages participants to observe thoughts without judgment and describe their bodily sensations.
6	Becoming aware of emotions and observing them without assigning meaning to them	Mindful attention to emotions and bodily symptoms created by emotions, and muscle relaxation	In this session, the therapist conducts three-minute mindful breathing exercises, mindful yoga movements, another three-minute breathing exercise, and emotion identification exercises.
7	Strengthening bodily mindfulness	Conducting a three-minute mindful breathing exercise and reviewing all exercises	In this session, the therapist strengthens mindfulness through mindful yoga movements, a three-minute mindful breathing exercise, and mindfulness-based body exercises.
8	Awareness of thoughts, bodily sensations, and emotions, and redirecting attention to stimuli	Clear visualization, mindful yoga movements, observing thoughts and mental events and allowing them to pass, and practicing a three-minute mindful breathing exercise	In this session, the therapist uses various activities to help participants become aware of their bodily sensations, emotions, and thoughts.
9	Learning body scanning and focusing on different parts of the body	Performing mindful movements and mindful walking, and focusing on one's body	In this session, the therapist conducts body scan activities, such as imagining light moving from the head down through the body.
10	Integration of bodily sensations, mood, and emotions	Conducting a three-minute mindful breathing exercise, mindful touch, mindful attention to the body, and another three-minute mindful breathing exercise	In this session, the therapist helps participants integrate emotions, bodily sensations, and mood through various activities.
11	Mindful living and attention management	Mindful smelling and mindful yoga movements	In this session, the therapist helps participants develop attention management and mindful living through various activities.
12	Review of sessions and continuation and maintenance of mindfulness	Generalizing the learned concepts to all life activities such as classroom activities, home environment, and shopping	In this session, the therapist reviews previous activities conducted throughout the treatment and attempts to help participants generalize mindfulness to all aspects of life.

Procedure

For data analysis, both descriptive and inferential statistics were used. At the descriptive level, frequency, percentage, mean, and standard deviation were employed, while at the inferential level, multivariate analysis of covariance (MANCOVA) was conducted using IBM SPSS Statistics version 25.

Results

In Table 2, the mean and standard deviation of the participants in the experimental and control groups are reported.

Table 2. Mean Scores and Standard Deviations of Executive Function and Sustained Attention Components

Variable	Stage	Group	Mean	Standard Deviation
Planning	Pretest	Experimental Group	23/85	2/60
		Control Group	24/88	3/14
	Posttest	Experimental Group	18/72	2/15
		Control Group	18/72	2/15
Emotion Regulation	Pretest	Experimental Group	7/00	1/65
		Control Group	7/33	1/18
	Posttest	Experimental Group	4/38	2/64
		Control Group	7/41	1/55
Time Management	Pretest	Experimental Group	9/14	1/70
		Control Group	9/26	1/49
	Posttest	Experimental Group	6/60	2/17
		Control Group	9/53	1/23
Organization	Pretest	Experimental Group	7/34	0/97
		Control Group	6/80	0/11
	Posttest	Experimental Group	5/33	1/11
		Control Group	5/61	1/92
Behavior Regulation	Pretest	Experimental Group	7/92	1/94
		Control Group	7/53	1/45
	Posttest	Experimental Group	7/13	1/91
		Control Group	6/80	0/87
Visual Sustained Attention	Pretest	Experimental Group	71/45	4/39
		Control Group	71/06	5/59
	Posttest	Experimental Group	72/54	6/04
		Control Group	73/87	5/28
Auditory Sustained Attention	Pretest	Experimental Group	67/45	8/29
		Control Group	72/80	8/60
	Posttest	Experimental Group	65/82	7/38
		Control Group	72/52	8/87

Given that the aim of the present study was to investigate the effect of Mindfulness-Based Cognitive Therapy (MBCT) on improving executive functions and sustained attention in children with learning disabilities, the assumptions of multivariate analysis of covariance (MANCOVA) were first examined before testing the hypothesis. To assess the equality of variances, Levene's test was conducted.

Table 3. Levene's Test for Examining the Homogeneity of Variances

Variable	F	df1	df2	Sig
Planning	0/169	1	28	0/68
Emotion Regulation	0/198	1	28	0/66
Time Management	3/11	1	28	0/08
Organization	2/59	1	28	0/11
Behavior Regulation	0/66	1	28	0/42
Visual Sustained Attention	2/51	1	28	0/12
Auditory Sustained Attention	1/61	1	28	0/31

According to the results presented in Table 3, Levene's test was not statistically significant, indicating that the assumption of homogeneity of variances was satisfied and that conducting the analysis of covariance was appropriate. In addition, examination of the homogeneity of covariance matrices using Box's test (Box's M = 18.74) indicated that this assumption was also met ($P > 0.05$). Furthermore, the interaction between the covariate (pretest scores) and the group was not significant, indicating that the assumption of homogeneity of regression slopes was satisfied. Therefore, conducting multivariate analysis of covariance was permissible. Since the assumptions of parametric testing were met, analysis of covariance was used for data analysis. The results of the covariance analysis demonstrated that the changes observed between the two groups at the post-intervention stage were statistically significant. In addition, to compare the two groups on each dependent variable separately, tests of between-subjects effects within the univariate analysis of covariance were conducted, the results of which are presented in Table 4.

Table 4. Multivariate Analysis of Covariance (MANCOVA) for Examining the Effectiveness of Mindfulness-Based Cognitive Therapy (MBCT)

Variable	SS	DF	F	Sig
Planning	237/85	1	44/75	0/0001
Emotion Regulation	18/21	1	9/07	0/006
Time Management	41/42	1	14/12	0/001
Organization	3/25	1	1/52	0/22
Behavior Regulation	0/036	1	0/16	0/89
Visual Sustained Attention	46/86	1	2/55	0/12
Auditory Sustained Attention	54/83	1	1/78	0/19

The results of the multivariate analysis of covariance presented in Table 4 showed that, after controlling for pretest scores, the effect of group on posttest scores was significant for the planning component ($F(1,29) = 44.75$, $P = 0.001$), the emotion regulation component ($F(1,29) = 9.07$, $P = 0.006$), and the time management component ($F(1,29) = 14.12$, $P = 0.001$). Specifically, following the MBCT intervention, scores on planning, emotion regulation, and time management significantly increased in the experimental group compared to the control group. In contrast, after controlling for pretest scores, the effect of group on posttest scores was not significant for the organization component ($F(1,29) = 1.52$, $P = 0.22$) or the behavior regulation component ($F(1,29) = 0.16$, $P = 0.89$). These findings indicate that the MBCT intervention did not lead to significant improvements in organization or behavior regulation compared with the control group. Furthermore, the findings showed that the Mindfulness-Based Cognitive Therapy intervention did not have a significant effect on sustained attention.

Discussion and Conclusion

The present study was conducted to investigate the effectiveness of Mindfulness-Based Cognitive Therapy (MBCT) training on improving executive functions in children with learning disorders. The findings indicated that these interventions significantly improved various components of executive functioning, including planning, emotional regulation, and time management, in the experimental group. These findings are consistent with previous studies (Sattari Shiraz and Sattari Shiraz, 2024; Dehghani et al, 2021). The results further confirm that mindfulness training can serve as a valid and reliable intervention for enhancing executive functions in children with learning disorders.

One of the important components examined in the present study was the effect of mindfulness training on emotional regulation. In particular, children with learning disorders often experience difficulties in regulating their emotions in challenging situations such as examinations or social interactions. However, in the current study, children in the experimental group demonstrated a greater ability to manage their emotions effectively in stressful situations after participating in mindfulness-based training sessions.

The findings may be explained by the fact that Mindfulness-Based Cognitive Therapy (MBCT), through strengthening present-moment awareness and nonjudgmental acceptance of thoughts and feelings, helps children not only overcome emotional difficulties but also enhance their cognitive abilities. More specifically, these interventions enable children to confront their experiences and emotions without negatively evaluating themselves or their circumstances, thereby improving their functioning across different life situations. These effects were particularly evident in enhanced emotional regulation and planning ability. In fact, mindfulness, by increasing self-awareness and emotional control, helps individuals regulate their plans more effectively and improve their decision-making abilities (Hematian et al., 2020).

These findings are consistent with the results reported by Mohammadzadeghan et al. (2022), who demonstrated that mindfulness can reduce anxiety and improve emotional regulation. Previous studies have also shown that self-awareness, particularly among children with learning disorders, can significantly improve executive functions such as time management, planning,

and reduced impulsivity. Similar findings have been confirmed in several other studies as well (Mohammadzadeghan et al., 2022). The findings of the present study are in line with these results. Therefore, it can be concluded that the self-awareness fostered through mindfulness plays a fundamental role in strengthening the cognitive capacities necessary for the academic functioning of children with learning disorders.

Another important effect of mindfulness training involves its impact on the prefrontal cortex, which is the primary brain region responsible for executive functions such as planning, attentional control, and emotional regulation. Through mindfulness practices that emphasize self-awareness and nonjudgmental control, this brain region becomes more active. This process helps children apply their cognitive abilities in a more organized and effective manner (Dehghani et al, 2021). Accordingly, mindfulness processes may enhance individuals' capacity to regulate behaviors and make decisions associated with executive functioning (Malekzadeh et al., 2023).

The findings of the present study also indicated that children in the experimental group demonstrated greater sustained attention and showed better performance in time management and task completion. This finding is consistent with the results reported by Sattari Shiraz and Sattari Shiraz (2024). These results emphasize that mindfulness plays a fundamental role not only in emotional regulation but also in improving attentional and task-oriented skills.

Overall, it can be concluded that Mindfulness-Based Cognitive Therapy (MBCT) training improves executive functioning in children with learning disorders. In order to successfully master academic tasks, students must acquire a range of essential skills that develop through experience, education, and learning. While most children perform these skills automatically, children with learning disorders often experience difficulties in applying such skills during learning processes and therefore require explicit instruction and support. These interventions, by strengthening abilities such as sustained attention, planning, emotional regulation, and working memory, can substantially improve the academic performance of these children.

Finally, it should be noted that the present study had several limitations, including the limited sample size, non-random participant selection, and the inability to control for participants' economic, social, and educational conditions, all of which may restrict the generalizability of the findings. Therefore, future studies are recommended to be conducted across different regions and with more diverse populations. In addition, considering the effectiveness of this intervention, examining its applicability in other groups, such as children with neurodevelopmental disorders, is also recommended. Despite these limitations, the findings of the present study highlight the importance of incorporating mindfulness-based approaches into educational and therapeutic settings and introduce mindfulness as an effective method for improving the cognitive and emotional functioning of children with learning disorders.

Declarations

Author Contributions

All authors equally contributed to the conception, design, data collection, analysis, and writing of this research.

Data Availability Statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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Ethical considerations

Informed consent to use written and verbal data for research purposes was obtained from all participants prior to the simulation. It was clearly stated that verbal data will be recorded and/or analyzed for academic research purposes, and participants were given the option to refuse their data to be recorded at any time prior, during or after the event.

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Conflict of interest

The authors declare that there were no conflicts of interest in conducting this research.

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The Efficacy of Cognitive Rehabilitation on Cognitive Distortion, Depression, and Life Expectancy of the Elderly with Mild Alzheimer's

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ABSTRACT

The present study aimed to evaluate the effectiveness of cognitive distortion, depression, and life expectancy of the elderly with mild Alzheimer's. The present study was a quasi-experimental interventional study with pre-test and post-test conducted on the elderly with mild Alzheimer's disease who were referred to day rehabilitation centers in Ardabil in 2025. Of these, 36 elderly individuals with mild Alzheimer's disease were selected via convenience sampling and randomly assigned to either the experimental group (n=18) or the control group (n=18). The experimental group received ten 60-minute sessions of a computer-based cognitive rehabilitation program. Data were collected using the Cognitive Distortions Questionnaire, Beck Depression Inventory, and Snyder's Hope Scale. The data were analyzed using multivariate analysis of covariance (SPSS-28). The findings revealed that cognitive rehabilitation significantly decreases unrealistic relationship expectations (F=34.31), interpersonal rejection (F=21.22), interpersonal misperception (F=30.49), and depression (F=32.28), and increases agency thinking (F=17.24), and pathways thinking (F=24.20) in the elderly with mild Alzheimer's disease (P<0.01). The findings of the present study collectively highlight the comprehensive efficacy of cognitive rehabilitation in elderly individuals with mild Alzheimer's disease. By targeting cognitive distortions, alleviating depressive symptoms, and fostering healthier lifestyle practices, the intervention demonstrates multidimensional benefits that extend beyond isolated cognitive improvements.

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Introduction

Healthy aging is typically marked by modest cognitive changes, such as slower processing speed, slight reductions in working memory capacity, and diminished mental flexibility, that, while noticeable, do not interfere with daily independence (Mukherjee et al., 2024). These age-related shifts become concerning when they begin to exceed normal expectations, signaling the transition toward mild Alzheimer's (Sritana & Phungpinij, 2024). At this early stage, older adults may still manage most routine tasks but increasingly struggle with recent-memory retention, multitasking, complex problem-solving, and adapting to unfamiliar environments (Wang et al., 2025). Their awareness of these inconsistencies can provoke anxiety, frustration, or a retreat from social engagement (Jemimah et al., 2023). Early recognition of these deviations, paired with structured routines, evidence-based cognitive stimulation, and supportive interpersonal environments, is critical to maintaining autonomy and slowing the trajectory of neurodegenerative decline (Mandal et al., 2022). Park et al. (2025) reported that among older adults living in publicly subsidized housing in the United States, the pooled prevalence of mild cognitive impairment was 25.5%, while the prevalence of Alzheimer's disease and related dementias was 13.5%, highlighting the need for improved cognitive screening in this population.

Cognitive distortions, systematic errors in interpreting information, can become more salient in older adults as natural age-related changes influence processing speed, cognitive flexibility, and emotional regulation (Schäfer et al., 2024). Although these changes are not inherently pathological, they may increase reliance on habitual mental shortcuts, making older individuals more vulnerable to biased thinking patterns such as catastrophizing, overgeneralization, or negative labeling (Rallabandi et al., 2023). These distorted appraisals can shape how aging adults interpret memory lapses, physical symptoms, and social interactions, often amplifying perceptions of threat or personal inadequacy (Nukhat et al., 2024). The presence of cognitive distortions in later life can meaningfully affect psychological resilience and adaptive functioning (Zhang et al., 2023). Older adults who adopt rigid or pessimistic interpretations of everyday events may experience elevated stress reactivity, reduced motivation to engage in social or cognitive activities, and increased withdrawal from challenging environments (Dominguez et al., 2024).

Depression in older adults arises from a complex interplay of biological, psychological, and social factors that accumulate across the lifespan (Wei et al., 2025). Age-related neurochemical changes, chronic health conditions, functional decline, and bereavement all contribute to elevated risk (Quintana-Hernández et al., 2023). Unlike younger populations, depressive symptoms in older adults often present in subtler forms, such as fatigue, slowed cognition, sleep disruption, or somatic complaints, leading to underdiagnosis and delayed treatment (Zandpour et al., 2024; Kim et al., 2021). This atypical presentation reflects both physiological changes in aging and a tendency to normalize emotional distress as an inevitable part of growing older (Cutuli et al., 2022). The impact of depression on older adults extends beyond mood disturbance, often affecting cognition, physical functioning, and long-term health outcomes (Sáiz-Vázquez et al., 2021). Depressed older adults may demonstrate reduced adherence to medical recommendations, diminished engagement in meaningful social activities, and lower participation in preventive health behaviors (Wei et al., 2025).

Life expectancy in older adults is determined by a multidimensional constellation of factors, including biological health, lifestyle behaviors, socioeconomic context, and psychological resilience (Xiaopeng et al., 2025). Advances in medical science and public health have extended longevity, yet disparities persist across demographic groups (Lee et al., 2024). Functional independence, effective chronic disease management, and sustained cognitive vitality play central roles in shaping both lifespan and health span (Mooldijk et al., 2022). Older adults who maintain active lifestyles, balanced nutrition, and regular health monitoring are more likely to experience prolonged and higher-quality longevity (Lanctot et al., 2024). Psychosocial factors also significantly impact life expectancy among older adults. A strong sense of purpose, sustained social connectedness, and emotional stability are associated with healthier physiological profiles, lower systemic inflammation, and reduced risk of morbidity (Mostert et al., 2025).

Cognitive rehabilitation has demonstrated considerable efficacy in supporting older adults by targeting specific cognitive domains that often decline with age, including memory, attention, executive functioning, and processing speed (He et al., 2022). Through structured tasks, guided practice, and individualized strategy training, cognitive rehabilitation promotes neurocognitive engagement that strengthens underlying neural pathways (Rajji et al., 2020). Evidence from neuropsychological and neuroimaging research shows that such interventions can enhance cognitive efficiency, improve compensatory mechanisms, and slow the trajectory of age-related cognitive weakening, making them particularly valuable for older adults experiencing early cognitive changes or mild neurodegenerative conditions (Manenti et al., 2020). Beyond measurable cognitive gains, cognitive rehabilitation makes a meaningful contribution to functional independence in older adults (Justo-Henriques et al., 2025). By teaching targeted strategies, such as external memory aids, problem-solving routines, and environmental modifications, rehabilitation programs translate cognitive improvements into real-world benefits (Tortora et al., 2024).

Older adults who participate consistently often demonstrate improved medication management, better adherence to daily routines, more effective decision-making, and heightened confidence in navigating complex tasks (Kudlicka et al., 2023). These functional enhancements reduce caregiver burden, support aging-in-place, and contribute to greater autonomy, which is a central goal in geriatric care (Irazoki et al., 2020). Cognitive rehabilitation also exerts significant psychological and psychosocial benefits, further amplifying its overall effectiveness in aging populations (Shabahang et al., 2020; Chang et al., 2022). Participation in structured cognitive programs fosters a sense of mastery, self-efficacy, and active engagement, which can counteract emotional vulnerabilities such as anxiety, frustration, or depressive symptoms associated with cognitive decline (Osawa et al., 2025). Moreover, group-based interventions promote social interaction and reduce feelings of isolation, creating an environment that reinforces cognitive resilience and emotional well-being (Nissim et al., 2023). By addressing both cognitive and psychosocial dimensions, cognitive rehabilitation emerges as a comprehensive, evidence-based approach that enhances quality of life and supports healthy, empowered aging (Perra et al., 2023).

In older adults with mild Alzheimer's disease, cognitive decline not only impairs memory and executive functioning but also contributes to cognitive distortions, depressive symptoms, and potentially influences life expectancy. Addressing these challenges early is essential to

preserving independence, enhancing psychological well-being, and improving overall health outcomes. Cognitive rehabilitation offers a structured, evidence-based approach to strengthen residual cognitive abilities, develop compensatory strategies, and foster adaptive coping mechanisms. The ultimate aim of this intervention is to evaluate and enhance the efficacy of cognitive rehabilitation on reducing cognitive distortions, alleviating depression, and positively impacting life expectancy in elderly individuals with mild Alzheimer's, thereby promoting autonomy, emotional resilience, and quality of life.

Method

The present study was a quasi-experimental interventional study with pre-test and post-test conducted on the elderly with mild Alzheimer's disease who were referred to day rehabilitation centers in Ardabil in 2025. After preparing a list of 36 patients (who had been diagnosed with mild Alzheimer's disease by a neurologist), the researchers selected 18 patients for the experimental and control groups by lottery. Sample size determination was guided by prior research and calculated using G*Power software, with parameters set as follows: effect size = 1.25, statistical power $(1 - \beta) = 0.97$, and significance level $(\alpha) = 0.05$ (Kovač et al., 2025; Kang, 2021). The inclusion criteria for the study included elderly people aged 60 years and older, elderly people with mild Alzheimer's with a test score of less than 23 who had been approved by a geriatrician through a brain MRI examination, completing a consent form, participating and cooperating to participate in classes, and residing in Ardabil city. Exclusion criteria from the study also included elderly patients with restlessness, lack of cooperation from clients, and non-attendance or absence from more than two sessions.

Research instruments

Cognitive Distortions Questionnaire (CDQ): Hamamci & Büyüköztürk designed the Interpersonal Cognitive Distortions Questionnaire for the first time in 2004. This questionnaire has 19 items and includes 3 dimensions of rejection in interpersonal relationships, unrealistic expectations in relationships, and misunderstanding in interpersonal relationships. The items are rated on a 5-point Likert scale from strongly disagree (score 1), disagree (score 2), no opinion (score 3), agree (score 4) to strongly agree (score 5). To obtain the total score of this questionnaire, the scores of all 3 dimensions must be added. The range of scores on this questionnaire is from 19 to 95. Scores close to 95 indicate high levels of interpersonal cognitive distortion, and scores close to 19 indicate low levels of interpersonal cognitive distortion. In the research of Hamamci & Büyüköztürk (2004), the reliability of this questionnaire was obtained through internal consistency and Cronbach's alpha coefficient and the test-retest method after 2 weeks for the entire scale (0.67 and 0.74), and for the dimensions of rejection in interpersonal relationships (0.73 and 0.70), unrealistic expectations in relationships (0.66 and 0.76), and misunderstanding in interpersonal relationships (0.43 and 0.73), respectively. In the present study, the Cronbach's alpha coefficient for the total score and the three subscales ranged from 0.80 to 0.87.

Beck Depression Inventory (BDI): is a widely used self-report questionnaire designed to measure the severity of depression symptoms in individuals aged 13 and older (Beck, Steer & Brown, 1996). The BDI consists of 21 multiple-choice items, each corresponding to a specific symptom of depression. The scoring method of the items ranges from 0 to 3, with scores ranging from 0 to 63. Beck et al (1996) reported the validity of this test as 96.0, with internal consistency ranging from 73.0 to 92.0 with a mean of 86.0, and Cronbach's alpha coefficient for patients

and non-patients as 0.86 and 0.81, respectively. In the current study, Cronbach's alpha coefficient of this scale was also obtained at 0.89.

Snyder's Hope Scale (SHS): The hope scale, prepared by Snyder et al (1991), has 12 items and aims to evaluate the hope in an individual regarding self-assessment. The items are scored on a 5-point Likert scale and measure agency thinking and pathways. There are 4 items to measure agency thinking, 4 items to measure pathways, and 4 deviant items. Scores between12-24 indicate a low level of hope. Scores between 24 and 36 indicate average hope, and scores higher than 36 indicate a high level of hope (Snyder et al., 1991). The Hope Scale has acceptable internal consistencies (alphas of .74 to .88 across several studies) (Snyder et al., 1991). The test-retest reliability of the total score, agency thinking, and pathways subscales was .85, .81, and .74 in a three-week interval, respectively (Snyder et al., 1991). The Hope Scale also has good convergent validity with the optimism scale (r= .50) and the desire for personal control (r= .54). In the present study, the Cronbach's alpha coefficient for the total score and the two subscales ranged from 0.84 to 0.93.

The Cognitive Rehabilitation: This program was implemented for 10 sessions of 60 minutes, two sessions per week. This program is a type of computer software that was developed based on the attention hierarchy system and the working memory model (Franco-Martín et al., 2020). This software consists of 10 exercises that are arranged in a progressive 10-stage manner from simple to difficult. After obtaining 80% of the correct answers, the individual can proceed to the exercises of the next stage, and this process continues until the individual can obtain the 80% score for that stage in each stage. Otherwise, the exercises of the same stage will be presented to him again so that he can finally achieve success. The final assignments and exercises of the cognitive rehabilitation software for maintaining attention and memory include 10 main exercises. Which is repeated during 10 intervention sessions, and only if successful in the first session (achieving a score of 80 or higher in each exercise) will the game level be moved to a more difficult stage (See Table 1). After collecting the research data, all responses were entered into SPSS software version 28. Multivariate Analysis of Covariance (MANCOVA) was employed to analyze the scores. The significance level for testing the assumptions was set at 0.05.

Table 1. Computer-based cognitive rehabilitation program

No	Target	Content
1	Strengthening sustained attention and selective attention	Showing a simple schematic house, with a different color than the roof, walls, and windows, as the target house; showing multiple houses at the end; clicking on a house similar to the target house more quickly; having distracting factors and a variety of houses each time the task is presented to make it progressively more difficult.
2	Strengthening sustained attention, attention shifting, and divided attention	Emoticons descending from the top of the screen to the bottom of the screen; the ability to control the speed of descent using the computer keyboard; the presence of different features, including skin color and emotional expressions in emoticons; placing emoticons on top of each other based on practice; changing the descent of emoticons and practice rules
3	Boosting memory capacity	A table appears with some similar images hidden in it; a hidden image is revealed by clicking on any cell of the table; connecting similar images in different cells of the table
4	Strengthening working memory visual and auditory	Display new images along with duplicate images; identify duplicate images by clicking on them.
5	Strengthening visual and spatial memory	Displaying parts of an image sequentially, presenting 4 complete images; selecting cut pieces to complete the desired image
6	Phonological reinforcement and inhibitory control	Displaying several words in sequence; displaying four words to an individual; selecting the relevant word based on the headwords of the words initially displayed.

No	Target	Content
7	Strengthening the ability to update	Presenting several colored cubes to the individual in sequence; providing the individual with four choices to choose the 2 colors of the last cubes they saw
8	Spatial and Visual Enhancement Update	Show a table with a picture of an animal inside each of its boxes; show arrows with different directions; ask the person to follow the direction of the arrows and find the animal's path and location.
9	Strengthening the ability to update	Present a row of new images along with repeated images; click on the image if you see repeated images
10	Strengthening Phonology and Inhibitory Control	Showing a sequence of words or sentences to a person, asking the person to indicate how similar the last letter of one word is to the first letter of the next word.

Results

The mean and standard deviation of the age of the experimental group patients were 68.75±5.39 years and for the control group patients were 69.11±5.87 years. The results of the chi-square test showed that there was no significant difference between the experimental and control groups in gender, education, job, marital status, and age grouping (P>0.05). The mean and standard deviation of pre-test-post-test scores of cognitive rehabilitations on cognitive distortion, depression, and life expectancy of the elderly with mild Alzheimer's in the experimental and control groups are presented in Table 2. Also in this table, the results of the Shapiro-Wilk test (S-W) are reported to check the normality of the distribution of variables in the two groups. According to this table, Shapiro-Wilk statistics is not significant for all variables. Therefore, it can be concluded that the distribution of variables is normal (Table 2).

Table 2. Descriptive Indices of Study's Variables in Control and Experimental Groups

Variables	Stage	Groups	Mean	SD	S-W	P*
Unrealistic relationship expectations	Pre-test	Experimental	29.56	1.65	0.106	0.071
		Control	29.05	1.43	0.101	0.082
	Post-test	Experimental	25.94	1.92	0.100	0.069
		Control	29.66	1.84	0.097	0.075
Interpersonal rejection	Pre-test	Experimental	31.33	1.14	0.115	0.081
		Control	30.72	1.56	0.101	0.062
	Post-test	Experimental	27.05	2.38	0.098	0.052
		Control	31.61	1.19	0.085	0.074
Interpersonal misperception	Pre-test	Experimental	10.11	0.75	0.096	0.053
		Control	9.72	1.17	0.119	0.074
	Post-test	Experimental	6.94	1.58	0.087	0.080
		Control	10.44	0.61	0.093	0.064
Depression	Pre-test	Experimental	28.72	0.95	0.088	0.061
		Control	30.05	1.39	0.092	0.057
	Post-test	Experimental	23.83	2.30	0.089	0.052
		Control	29.05	0.87	0.105	0.084
Agency thinking	Pre-test	Experimental	10.07	1.01	0.091	0.060
		Control	9.12	1.18	0.089	0.057
	Post-test	Experimental	13.55	1.58	0.095	0.071
		Control	10.11	0.90	0.114	0.084
Pathways thinking	Pre-test	Experimental	9.38	0.91	0.108	0.054
		Control	8.33	0.76	0.115	0.082
	Post-test	Experimental	12.44	1.24	0.095	0.063
		Control	9.23	0.73	0.099	0.070

**Note: Shapiro-Wilk test*

MANCOVA was used to evaluate the efficacy of cognitive rehabilitation on cognitive distortion, depression, and life expectancy of the elderly with mild Alzheimer's. The results of the Levin test to examine the homogeneity of variance of dependent variables in groups showed that the variance of cognitive distortion, depression, and life expectancy were equal in the groups (P>0.05). The results of the box test to evaluate the equality of the covariance matrix of dependent variables between the experimental and control groups also showed that the covariance matrix of the dependent variables is equal (Box M= 63.35, F=0.95, P=>0.306). The

significance of the box test is greater than 0.05, so this assumption is valid. Also, the results of the Chi-square-Bartlett test to examine the sphericity or significance of the relationship between cognitive distortion, depression, and life expectancy showed that the relationship between them is significant (χ^2=128.09, df=21, P<0.05). Another important assumption of multivariate analysis of covariance is the homogeneity of regression coefficients. It should be noted that the homogeneity test of regression coefficients was examined through the interaction of dependent variables and independent variables (intervention method) in the pre-test and post-test. The interaction of these pre-tests and post-tests with the independent variable was not significant and indicated the homogeneity of regression slope; therefore, this assumption also holds. Due to the establishment of multivariate analysis of covariance, the use of this test will be allowed. Then, to find out the differences between the groups, a multivariate analysis of covariance was performed (Table 3).

Table 3. The Results of Multivariate Analysis of Covariance on Mean Post-Test Scores

Test	Value	F	df	Error df	P	Effect Value
Pillai's Trace	0.583	5.36	6	23	<0.001	0.58
Wilks Lambda	0.417	5.36	6	23	<0.001	0.58
Hoteling Trace	1.398	5.36	6	23	<0.001	0.58
Roy's Largest Root	1.398	5.36	6	23	<0.001	0.58

According to Table 3, the results showed the effect of the independent variable on the dependent variables; In other words, experimental and control groups have a significant difference in at least one of the variables of cognitive distortion, depression, and life expectancy, which according to the calculated effect size, 58% of the total variance of experimental and control groups is due to the effect of the independent variable. Also, the statistical power of the test is equal to 1, which indicates the adequacy of the sample size. However, to determine in which areas the difference is significant, a univariate analysis of the covariance test was used in the MANCOVA, the results of which are reported in Table 4.

Table 4. Results of Univariate Analysis of Covariance on the Mean of Post-Test Scores of Dependent Variables in Experimental and Control Groups

Variables	SS	SS Error	df	MS	MS Error	F	P	Effect Value
Unrealistic relationship expectations	65.14	53.16	1	65.14	1.89	34.31	<0.001	0.55
Interpersonal rejection	76.05	100.36	1	76.05	3.58	21.22	<0.001	0.43
Interpersonal misperception	49.79	45.72	1	49.79	1.63	30.49	<0.001	0.52
Depression	103.82	90.03	1	103.82	3.21	32.28	<0.001	0.53
Agency thinking	29.91	48.56	1	29.91	1.73	17.24	<0.001	0.38
Pathways thinking	23.45	27.12	1	23.45	0.96	24.20	<0.001	0.46

According to the contents of Table 4, F-statistic is significant for unrealistic relationship expectations (F=34.31), interpersonal rejection (F=21.22), interpersonal misperception (F=30.49), depression (F=32.28), agency thinking (F=17.24), and pathways thinking (F=24.20) at the level of 0.001. These findings indicate that there is a significant difference between the groups in these variables. Also, according to the calculated effect size, 55% of unrealistic relationship expectations, 43% of interpersonal rejection, 52% of interpersonal misperception, 53% of depression, 38% of agency thinking, and 46% of pathways thinking were independent of the effect of the variable; As a result, it can be stated that cognitive rehabilitation significantly decrease cognitive distortion (unrealistic relationship expectations, interpersonal rejection,

interpersonal misperception) and depression, and increases of life expectancy (agency thinking, pathways thinking) in elderly with mild Alzheimer's disease.

Discussion and Conclusion

The present study was conducted to evaluate the efficacy of cognitive rehabilitation on cognitive distortion, depression, and life expectancy in elderly individuals with mild Alzheimer's disease. Given the progressive cognitive and emotional challenges associated with this condition, interventions that target both cognitive functioning and psychosocial well-being are essential (Nissim et al., 2023). Cognitive rehabilitation, through structured exercises, strategy training, and engagement in meaningful activities, provides a comprehensive approach to supporting residual cognitive abilities while promoting adaptive emotional and behavioral outcomes (Irazoki et al., 2020).

The results of the present study indicate that cognitive rehabilitation significantly reduced cognitive distortions in elderly participants with mild Alzheimer's (Tortora et al., 2024). By engaging participants in structured cognitive exercises and guided problem-solving tasks, the intervention facilitated more accurate interpretations of daily experiences and memory lapses, reducing tendencies toward catastrophizing or overgeneralization (Rajji et al., 2020). These findings are consistent with prior research suggesting that targeted cognitive training can recalibrate maladaptive thought patterns by promoting reflective thinking and enhancing executive control. Older adults who develop alternative cognitive strategies are better able to appraise situations realistically, decreasing the influence of distorted thinking on emotional responses and decision-making. Reducing cognitive distortions has important downstream effects on overall functioning (He et al., 2022). Participants demonstrated improved confidence in managing daily routines and navigating novel situations, highlighting that cognitive rehabilitation not only addresses cognitive deficits but also fosters adaptive coping mechanisms that support psychological resilience in mild Alzheimer's populations (Perra et al., 2023).

Cognitive rehabilitation was also associated with a marked reduction in depressive symptoms among elderly participants. By improving cognitive self-efficacy and providing structured mental engagement, the intervention helped alleviate feelings of helplessness and frustration that often accompany mild cognitive impairment (Chang et al., 2022). The reduction in depression can be understood through both cognitive and psychosocial mechanisms. Enhanced cognitive control and problem-solving skills empower older adults to manage challenges more effectively, while the social interaction inherent in rehabilitation programs provides emotional support and decreases feelings of isolation (Osawa et al., 2025). This decrease in depressive symptoms has broad implications for quality of life and functional independence. Older adults who experience improved mood are more likely to engage in daily activities, adhere to treatment regimens, and maintain social connections, all of which contribute to healthier aging trajectories and reinforce the overall benefits of cognitive rehabilitation (Justo-Henriques et al., 2025).

The study further suggests that cognitive rehabilitation positively influenced aspects of a healthy lifestyle and potentially life expectancy among participants. By enhancing cognitive function, promoting adaptive problem-solving, and encouraging structured daily routines, the intervention indirectly supports behaviors associated with longevity, such as physical activity, medication adherence, and social participation. Engagement in cognitive rehabilitation also

fosters emotional resilience, which is closely linked to physiological health outcomes. Reduced stress, improved mood, and enhanced coping abilities can mitigate the negative effects of chronic inflammation and neurodegeneration, factors that are known to influence life expectancy in older adults. Overall, these findings underscore the holistic benefits of cognitive rehabilitation for elderly individuals with mild Alzheimer's disease. Beyond cognitive and emotional improvements, the intervention contributes to healthier lifestyle behaviors, greater functional independence, and potentially enhanced longevity, highlighting its value as a comprehensive approach to supporting aging populations (Kudlicka et al., 2023).

The findings of the present study collectively highlight the comprehensive efficacy of cognitive rehabilitation in elderly individuals with mild Alzheimer's disease. By targeting cognitive distortions, alleviating depressive symptoms, and fostering healthier lifestyle practices, the intervention demonstrates multidimensional benefits that extend beyond isolated cognitive improvements. These results suggest that structured cognitive engagement not only strengthens residual cognitive capacities but also promotes emotional resilience, adaptive coping, and functional autonomy, which are critical for maintaining quality of life in the context of progressive neurodegenerative decline. In a broader sense, this study underscores the importance of early, evidence-based interventions that integrate cognitive, emotional, and behavioral dimensions in aging populations. The holistic impact of cognitive rehabilitation reflects the interconnected nature of cognition, mood, and lifestyle in determining overall well-being and potentially life expectancy. Ultimately, such interventions offer a promising avenue for supporting aging with dignity, preserving independence, and mitigating the multifaceted challenges associated with mild Alzheimer's disease.

Declarations

Author Contributions

S.A.F: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing; N.H.B: Data Curation, Software, Validation, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing; L.T: Supervision, Methodology, Investigation, Writing – Review & Editing; S.J.A: Conceptualization, Methodology, Investigation, Resources, Writing – Review & Editing; V. S. N: Validation, Formal analysis, Writing – Review & Editing, Project administration.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Ethical considerations

Ethical principles in manuscript writing have been adhered to by the guidelines of the National Ethics Committee and the COPE regulations.

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Conflict of interest

The authors declare no conflict of interest in this study.

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The Effectiveness of Acceptance and Commitment Therapy on Cognitive Flexibility, Rumination and Negative Automatic Thoughts in Students with Self-Harming Behaviors

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ABSTRACT

This study aimed to examine the effectiveness of Acceptance and Commitment Therapy (ACT) on cognitive flexibility, rumination, and negative automatic thoughts in adolescent girls engaging in deliberate self-harm in Kermanshah. The present research employed a quasi-experimental design with a pretest-posttest and control group. The statistical population included all adolescent girls aged 16 to 18 years in Kermanshah in 2025-2026. 40 participants scoring average or above on the Deliberate Self-Harm Inventory (Gratz, 2001) were randomly selected and assigned to either the experimental (20) or control group (20) following parental consent. The experimental group received 10 weekly 90-minute sessions of ACT, including exercises in acceptance, cognitive defusion, mindfulness, values clarification, self-compassion, and committed action (Turrell, Bell & Wilson, 2016). Research instruments included the Deliberate Self-Harm Inventory (DSI), the Cognitive Flexibility Inventory (CFI), the Ruminative Responses Scale (RRS), and the Negative Automatic Thoughts Questionnaire (NATQ). Data were analyzed using multivariate analysis of covariance (MANCOVA) in SPSS version 26. ACT significantly reduced self-harming behaviors, negative automatic thoughts, and rumination, while increasing cognitive flexibility compared to the control group. The findings indicate that ACT is an effective intervention for improving cognitive flexibility, reducing rumination, and decreasing negative automatic thoughts in adolescent girls engaging in deliberate self-harm, highlighting its potential utility in school and clinical settings.

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Introduction

Self-harm, defined as the deliberate, non-suicidal act of causing physical harm to oneself, is a significant mental health concern among high school students (Nawaz et al., 2024). It is often associated with emotional dysregulation, psychological distress, and maladaptive coping mechanisms (Noroozi Homayoon et al., 2023). Global studies suggest that the prevalence of self-harm among adolescents ranges from 10 to 20%, with higher rates in high-stress environments such as schools. In Iran, research indicates a prevalence of % 24.4 among high school students, with cultural and social factors contributing to its occurrence (Abbasi-Ghahramanloo, et al., 2024). Self-harm is frequently linked to cognitive inflexibility, rumination, and negative automatic thoughts, which exacerbate emotional distress and impair psychological functioning (Richardson et al., 2024). The lack of timely interventions increases the risk of chronic self-harm, suicidal ideation, and long-term mental health issues (Radunz et al., 2025).

Variable that appears to be strongly associated with self-harm is cognitive flexibility . Cognitive flexibility, defined as the ability to adaptively shift perspectives and generate alternative solutions to problems, is often impaired among students who engage in self-harm (Chung et al., 2024). According to cognitive theories, such as Hayes' Relational Frame Theory (2004), cognitive inflexibility stems from rigid thinking patterns and an overreliance on maladaptive cognitive frameworks, which hinder adaptive problem-solving (Patil et al., 2025). In students, this rigidity may manifest as difficulty adjusting to academic or social challenges, ultimately contributing to heightened emotional distress and self-harming behaviors (Westhoff et al., 2024). In Iran, cultural pressures such as high academic expectations and strong social conformity further intensify cognitive inflexibility, making the development of targeted interventions crucial. Moreover, research indicates that strengthening cognitive flexibility skills can significantly reduce rumination, improve emotional adjustment, and decrease tendencies toward high-risk behaviors (Azar et al., 2025).

Another variable that appears to be strongly associated with self-harm is Rumination . Rumination, defined as the repetitive and passive focus on negative emotions and experiences, is a major risk factor for self-harming behaviors and Suicidal tendencies (Le et al., 2025). According to Nolen-Hoeksema's Response Styles Theory (1991), rumination intensifies negative affect and undermines emotional regulation, functioning as a maladaptive coping mechanism (Sadri et al., 2025). Among students, it often emerges in response to academic failures, peer conflicts, or family stressors, which can heighten psychological distress and increase vulnerability to self-harm (Sun et al., 2025). Persistent rumination not only impairs problem-solving but also prolongs emotional suffering, creating a cycle of negative thinking and maladaptive behaviors. Therefore, interventions that directly target rumination are essential for reducing self-harm and promoting positive mental health outcomes in adolescents (Kpeno et al., 2024).

Another variable that appears to be strongly associated with self-harm is Negative automatic thoughts. Negative automatic thoughts, involving self-critical and self-deprecating internal dialogue, is highly prevalent among students who engage in self-harm (Wu et al., 2025). According to Beck's (1976) cognitive model, negative automatic thoughts originates from cognitive distortions such as overgeneralization and catastrophizing, which intensify feelings of worthlessness and hopelessness (Rogers et al., 2025). Among students, these maladaptive inner dialogues can result in social withdrawal, diminished academic motivation, and a heightened risk of self-harming behaviors. Furthermore, cultural factors, including strong academic pressures and the stigma surrounding mental health difficulties, may exacerbate these patterns of negative thinking (Ji hoon, 2024). Over time, persistent negative automatic thoughts not only deepens emotional distress but also perpetuates cycles of maladaptive behavior. Thus, interventions aimed at modifying cognitive distortions and reducing negative automatic

thoughts are essential for fostering resilience and promoting psychological well-being in adolescents. (Murali & Avudaiappan, 2024).

Various interventions, such as Cognitive Behavioral Therapy (CBT), have been used to address self-harm, this study focuses on Acceptance and Commitment Therapy (ACT). Developed by Hayes (2004), ACT emphasizes acceptance of difficult emotions, cognitive defusion, mindfulness, values clarification, and committed action to promote psychological flexibility (Barraca et al., 2025). ACT is particularly suitable for individuals with self-harm behaviors due to its focus on reducing experiential avoidance and fostering adaptive coping strategies (Bektaş-Aydın & Yüksel-Şahin, 2025). Research findings indicate the effectiveness of ACT on cognitive flexibility (Rad et al., 2025; Zou et al., 2024; Rahman Nia et al., 2024), rumination (Wang et al., 2025; Naghashzadeh, S. and Amani, 2025; Kolahkaj & Bakhshi Sooreshjani, 2024) and negative automatic thoughts (Anusuya & Gayatridevi, 2025; Thompson et al., 2022; Sevilla-Liu, 2022). In the Iranian context, particularly in Kermanshah, ACT's structured and group-based approach makes it feasible for school settings with limited resources. This study addresses a gap in the literature by examining the effectiveness of ACT on cognitive flexibility, rumination, and negative automatic thoughts in high school students engaging in self-harm, aiming to provide culturally relevant interventions to improve mental health outcomes.

Method

Setting and Participants

This study employed a quasi-experimental pretest–posttest design with a control group to examine the effectiveness of Acceptance and Commitment Therapy (ACT) on cognitive flexibility, rumination and negative automatic thoughts among adolescents with self-harming behaviors. The target population consisted of all female adolescents aged 16 to 18 years in Kermanshah, Iran, during 2025. Participants were initially screened using the Deliberate Self-Harm Inventory (DSHI), and those who scored above the predetermined cutoff point (>10) were considered eligible for participation. A total of 44 eligible adolescents were selected through purposive sampling. After obtaining written informed consent from both the participants and their parents, they were randomly assigned to either the ACT intervention group (n = 22) or the control group (n = 22). Inclusion criteria were: (a) obtaining a score above 10 on the DSHI, (b) being between 16 and 18 years of age, (c) willingness to participate in the study, (d) enrollment in secondary school, and (e) not receiving concurrent psychological or pharmacological treatment. Exclusion criteria included severe psychiatric disorders requiring immediate clinical intervention, substance use, absence from more than two treatment sessions, failure to complete the study measures, or withdrawal from the study.

Instruments

Deliberate Self-Harm Inventory

This 17-item inventory was developed by Gratz (2001) to measure the frequency, intensity, duration, and type of non-suicidal self-injury over the past year. Participants respond to each item with "Yes" (1) or "No" (0). Scores range from 0 to 17, with higher scores indicating more frequent non-suicidal self-injury. Internal consistency and test-retest reliability over 2–4 weeks were reported as 0.83 and 0.68, respectively. The inventory demonstrates acceptable convergent and discriminant construct validity (Gratz, 2001). In Shahani & Mansouri (2023), internal consistency was 0.73. In the present study, Cronbach's alpha was 0.79.

Ruminative Response Scale

This 10-item scale was developed by Treynor, Gonzalez & Nolen-Hoeksema (2003) to measure the tendency to engage in rumination. It uses a 4-point Likert scale ranging from 1 (almost never) to 4 (almost always) and has a two-factor structure (brooding and reflective pondering). Cronbach's alpha for the total scale and subscales in the original study were 0.85, 0.80, and 0.76, respectively. For the Persian version, alphas were 0.80, 0.66, and 0.72 (Mansouri, Mansouri & Mansouri, 2015). In this study, Cronbach's alpha for the total scale and subscales were 0.76, 0.69, and 0.74.

Cognitive Flexibility Inventory

This 20-item self-report scale was developed by Dennis & Vander-Wal (2010) to assess multiple aspects of cognitive flexibility, including the perception of difficult situations as controllable, recognizing multiple alternatives, and generating alternative solutions. It uses a 5-point Likert scale. Concurrent validity with the Beck Depression Inventory was reported as –0.39. Internal consistency for the total scale, control, and alternative options subscales were 0.91, 0.91, and 0.84. In Iran, test-retest reliability over two weeks was 0.90 for the total scale and 0.87, 0.89, and 0.75 for the subscales (Lakani & Akbari, 2021). In this study, Cronbach's alpha was 0.86 for the total scale and 0.83, 0.88, and 0.76 for the subscales.

Automatic Thoughts Questionnaire

This 30-item scale was developed by Hollon & Kendall (1980) to assess negative self-referential cognitions in depression. Scores above 70 indicate highly negative automatic thoughts. Items are scored on a 5-point Likert scale (1–5). Wishire reported construct validity via correlation with the Rumination Questionnaire ($r = 0.41$, $p < 0.001$) and internal consistency ($\alpha = 0.81$). Test-retest correlations over 2 weeks ranged from 0.57 to 0.76 (Tabatabei, 2011). In the present study, Cronbach's alpha was 0.82.

Intervention Protocol

The intervention was implemented according to the Acceptance and Commitment Therapy protocol for adolescents developed by Turrell, Bell, and Wilson (2016). The program consisted of 10 weekly group sessions, each lasting approximately 90 minutes. The protocol is a structured, manualized intervention specifically designed for adolescents and systematically targets the six core ACT processes, including acceptance, cognitive defusion, present-moment awareness, self-as-context, values clarification, and committed action. Throughout the sessions, participants engaged in experiential exercises, mindfulness practices, metaphors and group discussions aimed at enhancing psychological flexibility while reducing maladaptive cognitive and emotional processes associated with self-harming behaviors. The intervention was delivered in a standardized manner to ensure treatment fidelity and consistency across all sessions.

Table 1. ACT Group Intervention Sessions (Turrell, Bell & Wilson, 2016)

Session	Content
1	Assessment and orientation: Introduction of participants and therapist, establishment of group rules, screening and baseline assessment, introduction to the principles of Acceptance and Commitment Therapy (ACT), clarification of treatment goals and expectations, and preparation for group participation.
2	Creative hopelessness and psychological flexibility: Smarties exercise, object-based mindfulness practice, introduction to the DOTS model and the ACT Matrix, exploration of experiential avoidance, and metaphors illustrating the illusion of control and the costs of avoidance.
3	Values clarification: Mindfulness practice, identification of personally meaningful life values, distinguishing values from externally imposed rules and goals, and increasing awareness of value-consistent living.
4	Committed action and goal setting: Mindful eating exercise, formulation of value-based behavioral goals, development of action plans consistent with personal values, and the "Devils in the Boat" exercise to promote persistence despite internal obstacles.

Session	Content
5	Acceptance and willingness: Experiential mindfulness exercises (e.g., chair-jumping and wrinkled sock activities), practicing openness toward difficult emotions and thoughts, the "Mosquitoes" exercise, and formulation of three-month value-based goals.
6	Cognitive defusion: Bubble mindfulness exercise, metaphors illustrating the nature of thoughts, learning to observe thoughts without attachment or judgment, and practicing multiple cognitive defusion techniques.
7	Defusion from self-stories: Mindful walking practice, integration of previously learned ACT processes, word-chain and group storytelling exercises to challenge rigid self-narratives and promote psychological flexibility.
8	Self-as-context: Informal mindfulness practices, introduction to the observing self (self-as-context), experiential exercises designed to strengthen perspective-taking and reduce identification with internal experiences.
9	Self-compassion: Development of self-kindness through compassionate imagery and exercises involving the "younger self" and "older self," open-eye mindfulness, and fostering a compassionate relationship with oneself.
10	Integration and relapse prevention: Review and integration of all ACT processes, five-senses mindfulness practice, the "Passengers on the Bus" metaphor, development of individualized maintenance strategies, expression of gratitude, group feedback, and therapeutic termination.

Procedure

Following approval from the university ethics committee and authorization from the Kermanshah Department of Education, the researchers coordinated with administrators of public girls' secondary schools to recruit participants. Eligible students were invited to complete the Deliberate Self-Harm Inventory (DSHI) as a screening measure. Students whose scores exceeded the established cutoff point were identified as eligible, and their parents were contacted to provide detailed information regarding the study. After obtaining written informed consent from both parents and adolescents, 44 participants were enrolled and randomly assigned to either the ACT group or the control group. At baseline, all participants completed the Cognitive Flexibility Inventory (CFI), the Ruminative Response Scale (RRS), and the Automatic Thoughts Questionnaire (ATQ). Participants in the experimental group subsequently received 10 weekly group sessions of Acceptance and Commitment Therapy, each lasting approximately 90 minutes, following the adolescent ACT protocol developed by Turrell, Bell, and Wilson (2016). The intervention included psychoeducation about ACT, creative hopelessness, values clarification, values-based goal setting, acceptance of internal experiences, cognitive defusion, mindfulness exercises, self-as-context, self-compassion, and committed action. Participants in the control group received no psychological intervention during the study period and were placed on a waitlist. Upon completion of the intervention, both groups completed the posttest assessments using the same instruments administered at baseline. Data were analyzed using IBM SPSS Statistics version 27, and multivariate analysis of covariance (MANCOVA) was employed to evaluate the intervention effects while controlling for baseline scores. Statistical significance was set at $p < .05$. Ethical principles were strictly observed throughout the study, including voluntary participation, confidentiality of participants' information, the right to withdraw from the study at any time without penalty, and the provision of the ACT program to the waitlist control group after completion of the study upon request.

Results

Participants ranged in age from 16 to 18 years. Of the total sample, 22% were 16 years old, 58% were 17 years old, and 20% were 18 years old, indicating that the majority of participants were in middle to late adolescence. Regarding educational level, 25% of the participants were enrolled in the 10th grade, 55% in the 11th grade, and 20% in the 12th grade. Most 10th-grade students were 16 years old, most 11th-grade students were 17 years old, and the majority of 12th-grade students were 18 years old. Descriptive statistics for the study variables by group and assessment phase are presented in Table 2.

Table 2. Descriptive Statistics of Study Variables Across Phases

Group	Variable	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
ACT	Self-harm	14.50	1.34	7.00	0.84
	Negative automatic thoughts	112.30	4.71	72.80	3.20
	Rumination	23.20	2.42	16.86	1.68
	Cognitive flexibility	88.20	15.72	101.26	13.68
Control	Self-harm	15.00	1.31	14.50	1.50
	Negative automatic thoughts	115.20	4.96	110.80	4.21
	Rumination	20.73	1.49	20.53	1.99
	Cognitive flexibility	86.60	14.00	86.66	13.80

To examine the study hypotheses, a multivariate analysis of covariance (MANCOVA) was conducted. Prior to the analysis, the assumptions of normality, homogeneity of variances, and homogeneity of variance–covariance matrices were evaluated. The results of the Shapiro–Wilk test indicated that the distributions of self-harm, negative automatic thoughts, rumination, and cognitive flexibility did not significantly deviate from normality, with significance values of .914, .544, .744, and .159, respectively ($P > .05$). Levene's test also confirmed the assumption of homogeneity of variances, yielding significance values of .876, .541, .139, and .596 for self-harm, negative automatic thoughts, rumination, and cognitive flexibility, respectively ($P > .05$). Furthermore, the assumption of equality of variance–covariance matrices was assessed using Box's M test. As the test was non-significant ($P > .05$), this assumption was considered satisfied. Accordingly, because all assumptions for MANCOVA were met, the analysis was performed to compare the posttest scores of self-harm, negative automatic thoughts, rumination and cognitive flexibility between the ACT and control groups while controlling for pretest scores.
To examine the overall effect of the independent variable on the linear combination of dependent variables, multivariate tests in MANCOVA were conducted. The results are presented in Table 3.

Table 3. Multivariate Tests of Significance for MANCOVA

Test Type	Value	Hypothesis df	Error df	F	Sig.
Pillai's Trace	0.774	4.000	82.000	12.953	0.001
Wilks' Lambda	0.236	4.000	80.000	21.181	0.001
Hotelling's Trace	3.196	4.000	78.000	31.163	0.001
Roy's Largest Root	3.183	2.000	41.000	65.243	0.001

Based on Table 3, the results of multivariate tests in MANCOVA indicated a significant overall difference between the groups in terms of the linear combination of dependent variables. The Pillai's Trace value was 0.774 with a significance level of 0.001, indicating a significant effect of the intervention on the dependent variables collectively. Furthermore, other multivariate tests including Wilks' Lambda (0.236), Hotelling's Trace (3.196), and Roy's Largest Root (3.183) were all significant at $p < 0.001$, confirming this finding. In other words, there is a significant difference between the experimental and control groups in at least one of the dependent variables, and the intervention has successfully exerted its effect on the dependent variables. Therefore, with 99% confidence, it can be concluded that the overall difference between the groups on the dependent variables, after controlling for pretest scores, is statistically significant.

Following the confirmation of overall significant group differences in multivariate tests, univariate between-subjects effects were examined to determine the specific impact of the intervention on each dependent variable separately. The results of these tests within the MANCOVA framework are presented in Table 4.

Table 4. MANCOVA Results for Posttest Scores

Variable	Source	SS	DF	MS	F	p	η^2
Self-harm	Pretest	358.500	1	358.500	218.812	.001	0.842
	Group	203.199	1	101.600	57.668	.001	0.738
Negative automatic thoughts	Pretest	1801.820	1	1801.820	769.155	.001	0.949
	Group	390.748	1	195.374	83.400	.001	0.803
Rumination	Pretest	120.789	1	120.789	128.933	.001	0.759
	Group	197.031	1	98.515	105.157	.001	0.837
Cognitive flexibility	Pretest	6658.796	1	6658.796	1276.521	.001	0.969
	Group	2586.612	1	1293.306	247.933	.001	0.924

As presented in Table 4, the results indicate that ACT was significantly effective across all measured variables. Specifically, Acceptance and Commitment Therapy (ACT) led to a significant reduction in self-harming behaviors, negative automatic thoughts, and rumination, while significantly increasing cognitive flexibility compared to the control group ($P < .001$). The multivariate effect was also statistically significant, indicating a strong overall impact of the intervention on the combined dependent variables ($P < .001$). These findings suggest that ACT produced meaningful improvements in cognitive and emotional functioning, supporting its effectiveness for adolescents with self-harming behaviors when controlling for baseline differences.

Discussion and Conclusion

The aim of the present study was to examine the effectiveness of Acceptance and Commitment Therapy (ACT) on cognitive flexibility, rumination, and negative automatic thoughts in students engaging in self-harming behaviors. The first hypothesis demonstrated that Acceptance and Commitment Therapy had a significant positive effect on improving cognitive flexibility in students engaging in self-harm. The results of the first hypothesis were consistent with previous findings on cognitive flexibility (Rad et al., 2025; Zou et al., 2024; Rahman Nia et al., 2024). ACT, by teaching cognitive defusion and mindfulness, enabled students to detach from rigid thought patterns and adopt more adaptive perspectives. From a neuroscientific perspective, ACT likely enhanced the activity of the dorsolateral prefrontal cortex (dlPFC), which is involved in cognitive flexibility and problem-solving. Neuroimaging studies suggest that individuals with self-harm behaviors exhibit reduced dlPFC activity, contributing to cognitive rigidity. ACT's mindfulness exercises, such as observing thoughts without judgment, likely increased functional connectivity between the dlPFC and the anterior cingulate cortex (ACC), facilitating adaptive cognitive processing. From a psychological perspective, cognitive defusion techniques helped students distance themselves from maladaptive thoughts, reducing their impact on behavior. The values clarification component encouraged students to align their actions with personal goals, fostering flexible thinking in response to academic and social challenges. The group-based ACT setting, which promoted acceptance and non-judgment, enhanced students' confidence in adapting to stressors, aligning with Hayes' Relational Frame Theory (2004). Improved cognitive flexibility led to better problem-solving, reduced emotional distress, and decreased reliance on self-harm as a coping mechanism. Compared to CBT, ACT's emphasis on acceptance and values-driven action produced stronger effects on cognitive flexibility. Students reported improved ability to handle academic pressures and peer conflicts, indicating enhanced psychological resilience.

The second hypothesis showed that ACT had a significant positive effect on reducing rumination in students engaging in self-harm. The results of the second hypothesis were consistent with previous findings, including Wang (2025), Naghashzadeh & Amani (2025), and Kolahkaj & Bakhshi Sooreshjani (2024). ACT's focus on acceptance and mindfulness helped students interrupt repetitive negative thought patterns and reduce emotional fixation on distressing experiences. From a neuroscientific perspective, ACT likely reduced hyperactivity

in the default mode network (DMN), particularly the medial prefrontal cortex (mPFC), which is associated with rumination. Neuroimaging studies indicate that excessive DMN activity contributes to repetitive negative thinking in self-harming individuals. ACT's mindfulness practices, such as present-moment awareness, likely decreased DMN hyperactivity while enhancing insula activity, improving emotional awareness and regulation. From a psychological perspective, acceptance techniques enabled students to acknowledge negative emotions without becoming entangled in ruminative cycles, aligning with Nolen-Hoeksema's Response Styles Theory (1991). Cognitive defusion helped students view ruminative thoughts as transient mental events rather than absolute truths, reducing their emotional impact. The group-based setting fostered a sense of shared experience, reducing feelings of isolation that fuel rumination. Compared to CBT, ACT's focus on experiential acceptance produced faster reductions in rumination. Students reported decreased preoccupation with negative thoughts and improved emotional regulation, which contributed to reduced self-harm behaviors.

The third hypothesis demonstrated that ACT had a significant positive effect on reducing negative automatic thoughts in students engaging in self-harm. The results of the third hypothesis were consistent with previous findings on negative automatic thoughts (Anusuya & Gayatridevi, 2025; Thompson et al., 2022; Sevilla-Liu, 2022). ACT's cognitive defusion and values clarification techniques helped students reframe negative self-evaluations and reduce self-deprecating thoughts. From a neuroscientific perspective, ACT likely enhanced the activity of the ventrolateral prefrontal cortex (vlPFC), which is involved in cognitive reappraisal and emotional regulation. Neuroimaging studies suggest that individuals with self-harm behaviors exhibit reduced vlPFC activity, contributing to persistent negative automatic thoughts. ACT's mindfulness exercises increased functional connectivity between the vlPFC and the insula, enabling students to process negative emotions without engaging in self-critical thoughts. From a psychological perspective, cognitive defusion allowed students to observe negative automatic thoughts as passing thoughts rather than facts, aligning with Beck's (1976) cognitive model. Values clarification helped students focus on meaningful goals, reducing the salience of self-critical thoughts. The group-based ACT setting, which emphasized non-judgmental acceptance, fostered a positive self-concept and reduced feelings of shame. Compared to CBT, ACT's integration of acceptance and mindfulness produced deeper reductions in negative automatic thoughts. Students reported increased self-compassion and reduced self-blame, which contributed to decreased self-harm behaviors and improved social relationships.

In conclusion, Acceptance and Commitment Therapy had a significant positive effect on improving cognitive flexibility, reducing rumination, and decreasing negative automatic thoughts in students engaging in self-harm. By teaching acceptance, cognitive defusion, mindfulness, values clarification, and committed action, ACT enabled students to adopt adaptive cognitive and emotional strategies, interrupt ruminative cycles, and reframe negative self-evaluations. From a neuroscientific perspective, ACT enhanced the activity of brain regions such as the dlPFC, vlPFC, and insula, improving cognitive and emotional processing. From a psychological perspective, the group-based setting and emphasis on acceptance and values-driven action reduced emotional distress, increased psychological flexibility, and improved social functioning. These findings highlight ACT's potential as an effective intervention for students engaging in self-harm in educational settings, particularly in resource-limited areas like Kermanshah, where its structured and group-based approach is highly feasible.

This study had several limitations that restrict the generalizability of its findings. First, the population was limited to high school students in Kermanshah, which may tie the results to specific local conditions due to limited psychological resources. Second, the small sample size (40 participants) may have reduced the statistical power of the findings. Third, the lack of long-term follow-up (beyond three months) prevented the evaluation of the intervention's sustained

effects. Fourth, the failure to control for confounding variables such as family dynamics, academic stress, social support, or prior trauma may have influenced the results. Fifth, the lack of gender-specific analysis limited insights into gender differences in response to ACT. Sixth, the focus on high school students limited the generalizability to other age groups. Future research should include larger and more diverse populations across different cities to enhance generalizability. Examining ACT's effectiveness in other age groups and genders could broaden its applicability. Employing mixed-methods designs to explore students' experiences and factors influencing ACT's effectiveness is recommended. Long-term follow-up (beyond six months) is essential to assess the sustainability of effects. Investigating mediating variables such as self-esteem, resilience, and social support could clarify the mechanisms of ACT's effects. Analyzing cultural factors, such as stigma in small cities like Kermanshah, and gender differences could provide valuable insights. Using neuroimaging to examine neural changes resulting from ACT is also recommended.

Practically, ACT programs should be implemented as regular workshops in Kermanshah schools to provide students engaging in self-harm with access to psychological interventions. Establishing school-based counseling centers for early identification and intervention is essential. Training teachers and counselors to recognize self-harm and provide support can enhance intervention effectiveness. Awareness programs for parents and communities to reduce mental health stigma are recommended. Collaboration with local health centers and non-profits to train ACT specialists in Kermanshah could improve access. Developing online ACT programs for resource-limited areas could facilitate intervention delivery. Incorporating psychological education into school curricula could prevent self-harm and promote mental health.

Declarations

Author Contributions

Contributions all authors contributed actively to the conception, design, and execution of the research.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all participants prior to their involvement in the study.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this research.

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The Role of Empathy in Learning and Psychological Well-Being from a Social Cognition Perspective: A Systematic Review

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ABSTRACT

Empathy improves social relationships and also plays a role in students' academic achievement and mental health. However, no previous systematic review has synthesized evidence on empathy's role in classroom group dynamics, learning outcomes, and psychological well-being simultaneously. This systematic review followed PRISMA 2020 guidelines. Eight databases (PubMed, Scopus, ScienceDirect, Google Scholar, Magiran, SID, Noormags, and Civilica) were searched for papers published between January 2015 and December 2025. Two independent reviewers screened records, and quality was assessed. The initial search yielded 196 records. After screening, 17 studies met the inclusion criteria. Based on the findings, empathy is directly or indirectly related to increased learning ability, academic achievement, responsibility, positive interactions with peers at school, and psychological well-being on the one hand, and a decrease in undesirable social behaviors such as bullying and aggression on the other. However, considerable heterogeneity in study designs (cross-sectional, quasi-experimental, longitudinal, and qualitative) and outcome measures precluded meta-analysis. Considering such results, the necessity of designing psychoeducational packages focused on empathy in schools becomes evident. Strengthening empathy in educational settings may simultaneously improve academic achievement and psychological well-being while reducing bullying and maladjustment. Future research should employ longitudinal designs, standardized empathy measures, and active control groups to establish causality.

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Introduction

Empathy is a multidimensional construct that, although it has been primarily examined within psychology, has also stimulated extensive research in sociology and neuroscience (Schurz et al., 2021). This concept is sometimes mistakenly conflated with related notions such as sympathy or compassion; however, it has a fundamentally distinct nature. In experiences of sympathy or compassion, individuals attempt to understand the other person's feelings or pain while remaining in their own role. In contrast, empathy requires role reversal. Role reversal, which is considered a core technique in psychodrama, involves individuals exchanging their own role with that of another person in order to both understand the other more deeply and gain greater insight into themselves (Giacomucci, 2021).

Numerous models and theories of empathy have been proposed. Simulation theory is one such framework, which conceptualizes empathy as a neurobiological mechanism whereby the activation of neural structures associated with one's own experiences enables the modeling of others' mental states and the formation of intersubjective understanding (Preston & Hofelich, 2012). According to this view, when an individual observes another person experiencing an emotion, the observer's brain activates similar neural patterns, effectively "simulating" the other's experience. This simulation process is believed to occur automatically and below the level of conscious awareness, providing a biological basis for empathic understanding.

Another important theory relevant to the present study is the theory of vicarious emotional appraisal. This theory views empathy as integrated with emotion and conceptualizes it in terms of vicarious emotions arising from the appraisal of others' situations. Although this theory shares similarities with simulation theory, unlike that framework, which focuses solely on congruent responses, it also emphasizes empathic responses that may be incongruent with others' situations (Wondra & Ellsworth, 2015). For example, an observer might feel anger on behalf of a friend who has been treated unfairly, even if the friend does not feel angry. This incongruent empathic response is difficult to explain through pure simulation but is well accounted for by vicarious appraisal theory.

Empathy encompasses biological, cognitive, emotional, and behavioral dimensions. Cognitive and emotional empathy give rise to empathic and prosocial behaviors and, through this process, enhance students' psychological well-being (Han & Yoo, 2024; Schurz et al., 2021; Van Ryzin & Roseth, 2019). In addition, empirical studies have shown that empathy training in schools leads to increased group activities and social responsibility and, while reducing behavioral problems and anxiety, improves academic performance (Bezzina, 2022; Silke et al., 2024; Xiang et al., 2022). These findings suggest that empathy is not merely a social-emotional skill but also a potentially powerful lever for academic improvement.

It seems impossible to separate empathy from social relationships and group interactions, as empathy is fundamentally regarded as a social and interpersonal construct. Social relationships not only play a crucial role in the emotional experiences of children and adolescents but also influence their functioning at school. For this reason, students' social relationships in school settings have been the focus of numerous recent research studies (Schlesier et al., 2025).

Group work multiplies opportunities for the generation of new knowledge and enhances motivation for learning. It represents a dynamic and multidimensional process that involves individual willingness and collaboration with others in carrying out activities to achieve shared goals, engaging in tasks that require information exchange, assuming responsibilities, resolving conflicts, and contributing to collective improvement and development. In the context of classroom group learning, the following outcomes emerge:

- Positive interdependence: Occurs when each group member understands that his or her success is measured by the success of other group members and, subsequently, the group itself.

- Individual and group responsibility: Occurs when all group members accept responsibility for performing the task assigned to them while at the same time being aware of the duties of others and being responsive and supportive when needed.
- Promotive interaction: This interaction takes place face-to-face between group members so that they support each other in the learning process by sharing resources, knowledge, and past experiences.
- Social and group work skills: These are skills that students learn as a result of the need to interact. These skills include negotiation skills, decision-making, conflict resolution, building social networks, presenting creative ideas, and constructive criticism and accepting criticism.
- Group reflection: Through this process, the performance and dynamics of the group are evaluated, as well as the extent to which the results match the proposed goals. This allows for changes and optimal suggestions for future work to be identified and ensures that all members receive feedback on the positive aspects and areas for improvement in their performance (Guevara et al., 2023).

None of the above is possible without empathy. Despite the substantial body of research on empathy in educational settings, significant gaps remain. First, most previous reviews have focused either on social relationships alone or on academic outcomes without considering group processes. Second, the mechanisms through which empathy influences group-based learning remain underspecified. Third, no systematic review to date has specifically examined the role of empathy in the intersection of classroom group dynamics, learning outcomes, and psychological well-being simultaneously.

Therefore, the most important goal of the present study is to review the results of recent research studies on the role of empathy in students' learning and psychological well-being, with an emphasis on group activities, in order to emphasize the importance of this issue. Specifically, this systematic review aimed to answer the following research questions:

- What is the association between empathy and students' learning outcomes (academic achievement, learning ability, responsibility) in group-based classroom settings?
- What is the association between empathy and psychological well-being (mental health, subjective happiness, adjustment) among school students?

Method

Study Design and Registration

The present study, which is classified as a literature-based study, is a systematic review. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021).

Search Strategy

This study is the result of a careful search of reputable national and international electronic scientific databases and resources (such as Magiran, Scientific Information Database [SID], Noormags, Civilica, Scopus, PubMed, ScienceDirect, and Google Scholar). The search was conducted in January 2026 and covered papers published between January 2015 and December 2025 (the last ten years). Considering that the subject under study was very broad and the materials reviewed were numerous and varied, the researchers encountered many concepts related to empathy, group dynamics, group learning, collaborative learning, and cooperative learning throughout the study. However, given the research objective, the main criteria for selecting articles were the direct relevance of the articles' topics to the subject of the present study, publication within the last ten years, and the credibility of the article and the journal. The specific search string used in scientific databases and resources was constructed using Boolean operators as follows in Table 1.

Table 1. List of keywords and Boolean combinations used in the search

OR		OR		OR		OR
empathy empathic concern cognitive empathy emotional empathy affective empathy	And	group learning collaborative learning cooperative learning group dynamics teamwork peer learning	And	academic achievement learning outcome academic performance educational outcome	And	psychological well-being mental health subjective happiness student well-being adjustment

Eligibility Criteria

To ensure transparency and reproducibility, the eligibility criteria were specified using the framework as shown in Table 2.

Table 2. Inclusion and exclusion criteria for studies in the present systematic review

Inclusion Criteria	Exclusion Criteria
Publication date: January 1, 2015 – December 31, 2025	Publication date: Before January 1, 2015 or After December 31, 2025
Language: Persian or English	Language: Other than Persian or English
Study design: Empirical studies (quantitative, qualitative, or mixed-methods)	Study design: Non-Empirical studies
Population: School students (elementary, middle, high school; ages approximately 6-18 years)	Population: University students, adults, clinical populations, preschool children
Outcomes: (a) Learning outcomes: academic achievement, learning ability, responsibility, academic performance; OR (b) Psychological well-being: mental health, subjective happiness, school belonging, adjustment, reduced burnout/anxiety	Studies reporting only personality traits, parent empathy, or empathy in teachers (without student outcomes)

Screening Process

The screening process was conducted in three stages following PRISMA guidelines:

Stage 1: Removal of duplicates. All identified records were exported to reference management software (EndNote). Duplicate records were identified and removed.

Stage 2: Title and abstract screening. Two independent reviewers (the authors) screened the titles and abstracts of all remaining records against the eligibility criteria. Each record was categorized as "include," "exclude," or "uncertain." Records categorized as "uncertain" proceeded to full-text review. Given the agreement between the reviewers, there was no need to resolve the disagreements.

Stage 3: Full-text screening. The full texts of all records classified as "include" or "uncertain" were retrieved and assessed. Reasons for exclusion at this stage were documented and are reported in the PRISMA flow diagram.

Study Selection

In the initial search phase, 196 articles were found, of which only 17 fully met the selection criteria for the present study. The PRISMA 2020 flow diagram is presented in Figure 1.

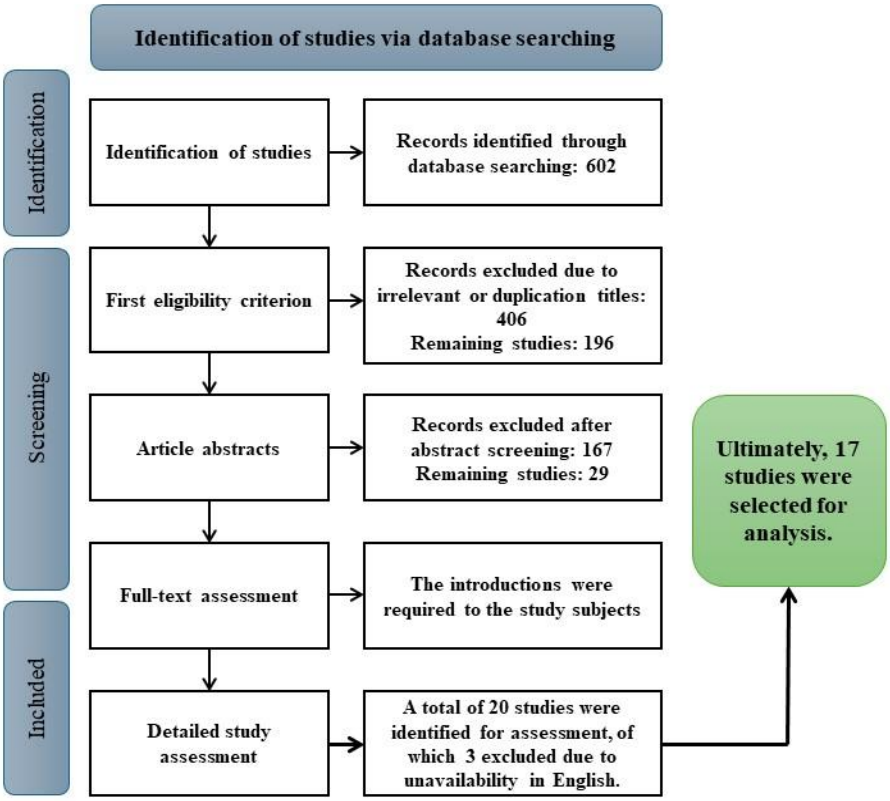

Figure 1: PRISMA flow diagram of the study selection process in the present research

Results

The selected articles' characteristics, methodological quality and summary of results are listed in Table 3.

Table 3. Summary of selected articles' results

Author(s) & Year	Title	Journal	Country	Sample size	Study design	Summary of results	Quality
Usán Supervía et al.Rorimpandey et al (2025)	Empathy, Confidence, and Collaboration: Exploring STAD's Impact on Students' Social-Emotional Development	Journal of English Language Studies	Indonesia	9	mixed-methods	Empathy enhances learning and psychological well-being by fostering mutual respect and support among students during group work.	Moderate
	The Mediating Role of Academic Goal Orientations in the Relationship Between Empathy and Subjective Happiness in Adolescent Students	SAGE Open	Spain	1664	Cross-sectional	Empathy is positively correlated with subjective happiness and task orientation in students and promotes adaptive behaviors.	Moderate
Makal & Çepni (2024)	Increasing Students' Empathy Levels in Science Education: A Thematic Review	Journal of Baltic Science Education	Turkey	N/A	Thematic review (Qualitative)	Empathy promotes ethics and character development in educational environments, leading to increased mental health in students. Collaborative learning environments, known for improving empathy skills, positively impact students' emotional and cognitive skills and improve group dynamics and overall learning experiences.	Moderate

Author(s) & Year	Title	Journal	Country	Sample size	Study design	Summary of results	Quality
Soto-García et al. (2024)	The TEI Program for Peer Tutoring and the Prevention of Bullying: Its Influence on Social Skills and Empathy among Secondary School Students	Social Sciences	Spain	738	comparative, expost facto study	Peer tutoring programs increase empathy, social skills, and conflict resolution among students and create a supportive group environment. This also contributes to the mental health of students.	High
Schipor et al. (2024)	Exploring the Relationship between Empathy, Friendliness, and Group Inclusion in Primary School Social Dynamics	Revista Romaneasca pentru Educatie Multidimensionala	Romania	78	Cross-sectional	On the one hand, empathy promotes harmonious development, and on the other hand, it increases group participation and friendly interactions among students. This is positively correlated with cognitive empathy and peace of mind, contributing to psychological well-being and effective collaboration in group work, ultimately improving classroom dynamics and relationships.	Moderate
Han & Yoo (2024)	Effect of Adolescents' Cognitive and Emotional Empathy and Altruistic Behavior on Psychological Well-Being	Korean Journal of Child Studies	Korea	282	Cross-sectional	Cognitive and emotional empathy in adolescents significantly affects their mental health through altruistic behavior. Enhancing empathy can enhance group dynamics and learning experiences, and ultimately help improve psychological adjustment and happiness among school students.	High
Roerig et al. (2023)	How, When and Why Abilities Go Social: Researching Children's Empathy and Prosocial Behaviors in Context	Frontiers in psychology	Netherlands	77	mixed methods	Empathy influences social behavior and group dynamics in classrooms, thereby improving students' mental health and learning.	Moderate
Bezzina (2022)	"I feel what you are feeling": Neural Processes for Empathy and its Impact on Academic and Holistic Achievement	Malta Journal of Education	Malta	N/A	Theoretical review (Qualitative)	Empathy enhances emotional health and creates a positive classroom climate. This contributes to students' academic and overall progress, and facilitates emotional literacy and supportive interactions that are important for psychological well-being in educational settings.	Moderate
Van Ryzin &.Roseth (2022)	The Longitudinal Relationship Between Peer Relations and Empathy and Their Joint Contribution to Reducing Bullying in Middle School: Findings from a Randomized Trial of Cooperative Learning	Journal of Prevention and Health Promotion	USA	1890	Randomized controlled trial	Emotional empathy, developed through collaborative learning, strengthens peer relationships and helps reduce bullying, thus promoting mental health among students. Teamwork enhances emotional understanding, which is crucial for positive social interactions and overall student development.	High
Xiang et al. (2022)	The Influence of Student-Teacher Relationship on School-Age Children's Empathy: The Mediating Role of Emotional Intelligence	Psychology research and behavior management	China	468	Cross-sectional	Empathy contributes to interpersonal relationships, academic achievement, and psychosocial adjustment of students. Enhancing empathy can enhance teamwork dynamics and overall mental health among students, particularly through positive student-teacher relationships.	Moderate

Author(s) & Year	Title	Journal	Country	Sample size	Study design	Summary of results	Quality
Miklikowska et al. (۲۰۲۲)	With a Little Help from My Empathic Friends: The Role of Peers in the Development of Empathy in Adolescence	Developmental Psychology	Sweden	318	Longitudinal	Friendships with empathetic peers enhance the development of empathy in adolescents. Empathetic social connections can have a positive impact on learning and psychological well-being, especially in teamwork environments where cooperation and mutual understanding are essential.	High
You et al. (2020)	The Effects of Middle School Art Class with an Empathy-Based Learning Model	Current Psychology	Korea	37	Quasi-experimental	Empathy-based learning has a positive impact on students' empathy and classroom participation, and it has been shown that enhancing empathy in teamwork can increase mental health and collaborative skills among middle school students, although it does not have a significant effect on self-esteem.	Moderate
Carina et al. (2020	High School Student Burnout: Is Empathy a Protective or Risk Factor?	Frontiers in psychology	Italy	998	Cross-sectional	Empathy skills have a positive impact on satisfaction with school relationships, which can reduce academic burnout and thus enhance mental health.	Moderate
Safara & Rafiee (2020)	The Effectiveness of Empathy Training on Social Adjustment and School Belonging in Elementary Sixth-Grade Students	Iranian Evolutionary Educational Psychology Journal	Iran	30	Quasi-experimental	Teaching empathy increases students' social adjustment and attachment to school, and fosters better interpersonal relationships and emotional awareness. This promotes mental health and effective teamwork because empathetic students are more caring, patient, and able to understand the needs of others in collaborative learning environments.	Moderate
Md Hashim et al. (2019)	Promoting Empathy Using Design Thinking in Project-Based Learning and as a Classroom Culture	Asian Journal of University Education	Malaysia	N/A	Qualitative	Empathy enhances students' mental health by fostering positive relationships and connections during teamwork. This encourages cooperation, reduces aggression, and fosters mutual understanding, ultimately leading to improved interaction and a supportive classroom culture that is beneficial for both learning and emotional health.	Moderate
Van Ryzin &.Roseth (2019)	Effects of Cooperative Learning on Peer Relations, Empathy, and Bullying in Middle School	Aggressive behavior	USA	1890	Randomized controlled trial	Cooperative learning increases emotional empathy, which significantly reduces bullying. Improved cognitive and emotional empathy is associated with increased peer relationships, suggesting that empathy plays an important role in students' mental health during teamwork.	High
Muniroh (2017)	Leading Empathic Engagement Through Teamwork Interaction in Classroom	oumal Pendidikan Humaniora	Indonesia	N/R (all students in a class)	single-subject experimental design	Empathy enhances learning and psychological well-being by fostering respect, compassion, and friendship between students during group work.	Moderate

Synthesis of Findings

Of the 17 included studies, 16 (94.1%) reported a positive association between empathy and either learning outcomes or psychological well-being. No study reported a negative association; one qualitative study reported mixed findings depending on contextual factors.

Discussion and Conclusion

The present study was conducted with the aim of emphasizing the important role of empathy in students' learning and psychological well-being. In the initial phase of the research, 196 national and international scientific articles were reviewed. Ultimately, 17 articles that fully met the article selection criteria were included.

Empathy and learning outcomes. Eight studies explicitly reported associations between empathy and academic achievement or learning ability. Empathy was associated with increased learning ability and academic achievement (Bezzina, 2022; Makal & Çepni, 2024; Md Hashim et al., 2019; Roerig et al., 2023; Rorimpandey et al., 2025; Xiang et al., 2022; You et al., 2020), responsibility (Van Ryzin & Roseth, 2019, 2022), and positive interactions with peers at school (Miklikowska et al., 2022; Schipor et al., 2024). Several studies emphasized that empathy enhances learning by fostering mutual respect and support among students during group work (Muniroh, 2017; Rorimpandey et al., 2025).

Empathy and psychological well-being. 13 studies reported associations between empathy and psychological well-being or mental health outcomes. Empathy was associated with subjective happiness (Usán Supervía et al., 2025), psychological well-being (Han & Yoo, 2024; Md Hashim et al., 2019; Miklikowska et al., 2022; Muniroh, 2017; Roerig et al., 2023; Schipor et al., 2024; Xiang et al., 2022; You et al., 2020), school belonging and social adjustment (Safara & Rafiee, 2020), and reduced bullying and aggression (Soto-García et al., 2024; Van Ryzin & Roseth, 2019, 2022). Additionally, empathy was associated with reduced academic burnout (Farina et al., 2020).

Cognitive vs. emotional empathy. Studies that distinguished between cognitive and emotional empathy found that both dimensions contributed positively but through different mechanisms. Cognitive empathy was more strongly associated with perspective-taking and conflict resolution, while emotional empathy was more strongly associated with prosocial behavior and reduced aggression (Han & Yoo, 2024; Van Ryzin & Roseth, 2019, 2022).

Role of group dynamics. 10 studies specifically examined empathy within the context of cooperative or group-based learning. These studies consistently found that cooperative learning structures enhance empathy development, which in turn improves group dynamics and learning outcomes (Han & Yoo, 2024; Makal & Çepni, 2024; Miklikowska et al., 2022; Muniroh, 2017; Roerig et al., 2023; Rorimpandey et al., 2025; Safara & Rafiee, 2020; Schipor et al., 2024; Soto-García et al., 2024; Van Ryzin & Roseth, 2019, 2022; You et al., 2020).

Based on the findings of the reviewed studies, empathy, by strengthening mutual support; morality and character development; emotional and cognitive skills; positive interpersonal relationships; compassion and prosociality; group dynamics; collaborative learning; social skills; social adjustment; subjective well-being; and school belonging, contributes, on the one hand, to increased learning and academic achievement, and on the other hand, to the promotion of students' mental health or psychological well-being. At the same time, empathy and its development are associated with reductions in aggression, bullying, academic burnout, and maladjustment. Research evidence indicates that empathy, whether expressed by peers or teachers, yields similarly positive effects. These findings are consistent with the findings of a few relatively similar review studies (Bezzina, 2022; Makal & Çepni, 2024).

Our findings extend previous theoretical frameworks in several important ways. First, consistent with simulation theory (Preston & Hofelich, 2012), the reviewed studies suggest that cognitive empathy enables students to understand their peers' perspectives, which facilitates

cooperation and conflict resolution. Second, in line with vicarious emotional appraisal theory (Wondra & Ellsworth, 2015), emotional empathy appears to drive prosocial behavior and reduce aggression, even when emotional responses are not perfectly congruent with the other's experience.

However, our review makes a unique contribution by specifically examining empathy in the context of group-based learning. Previous reviews have typically examined empathy in general social relationships or in individual academic outcomes. Our finding that empathy facilitates each of the five components of effective group work (positive interdependence, individual and group responsibility, promotive interaction, social and group work skills, and group reflection) provides a mechanism-based explanation for why empathy enhances learning.

An important point emphasized in the present study was the role of empathy in improving students' learning within group contexts. Empathy is often assumed to be associated solely with the enhancement of social relationships. While this assumption is accurate, it is not comprehensive. A review of the findings from several selected studies in the present research indicated that empathy is also associated with increased learning and academic achievement.

Based on these findings, it can be concluded that many academic difficulties do not stem from learning disorders per se, but rather arise from anxieties related to the highly competitive climate of some schools or from disrupted interpersonal relationships among students or between students and teachers or school staff. Therefore, identifying the roots of such problems by considering specific psychosocial factors, including empathy, is likely to lead to greater success in educational and therapeutic interventions.

The five components of effective group work described earlier (Guevara et al., 2023) each depend on empathic capacity. Positive interdependence requires students to recognize and value their peers' contributions- a fundamentally empathic process. Individual and group responsibility requires sensitivity to whether others are struggling or need support. Promotive interaction requires the ability to provide help in a way that is received positively, which depends on empathic accuracy. Social and group work skills -negotiation, conflict resolution, giving and receiving criticism- are impossible without perspective-taking. Group reflection requires the ability to evaluate one's own and others' performance without defensiveness or blame, again depending on empathy.

Although the present study did not directly examine the role of empathy in school settings through a field-based design, it sought, by conducting a comprehensive systematic review of studies in this area, to emphasize the salient role of empathy in the school environment. Highlighting and reiterating the role of empathy may, on the one hand, encourage future researchers to undertake more extensive empirical studies and, on the other hand, draw the attention of school counselors and child and adolescent psychologists to techniques such as role reversal that possess an empathic nature. The expansion of empathy in schools can reduce unhealthy forms of competition and replace anxiety with creativity.

Specific practical recommendations arising from this review include:

- *Integrate empathy training into existing curricula.* Rather than treating empathy as an add-on, schools should embed empathy-promoting activities into regular academic instruction, particularly in group work and project-based learning.
- *Train teachers in empathy facilitation.* Teachers need professional development to model empathic behavior, structure cooperative learning activities, and respond to conflicts in ways that build rather than erode empathy.
- *Use structured cooperative learning methods.* The RCTs included in this review (Van Ryzin & Roseth, 2019, 2022) provide strong evidence that structured cooperative learning (e.g., Student Teams-Achievement Divisions, STAD) effectively increases both empathy and academic outcomes.

- *Address competitive school climates.* Schools with excessively competitive climates may inadvertently suppress empathy. Interventions should target school-wide norms and policies that prioritize collaboration over competition.
- *Monitor both cognitive and emotional empathy.* Interventions should aim to develop both dimensions of empathy, as they contribute through different mechanisms to learning and well-being.

Nonetheless, several limitations must be acknowledged. First, the protocol was not prospectively registered, which increases the risk of reporting bias. Second, considerable heterogeneity in study designs, outcome measures, and analytic approaches precluded meta-analysis. Third, the inclusion of two review papers (Makal & Çepni, 2024; Bezzina, 2022) alongside primary empirical studies is methodologically problematic; these papers should ideally have been excluded or treated separately. Fourth, several included studies had small sample sizes (e.g., n=30, n=45) or did not report sample sizes at all, limiting statistical power and generalizability. Fifth, the majority of studies used cross-sectional designs, which cannot establish causality or temporal ordering. Sixth, publication bias is possible, as studies with null findings are less likely to be published. Seventh, the search was limited to English and Persian languages, potentially missing relevant studies in other languages. Eighth, grey literature (e.g., dissertations, conference proceedings, preprints) was not searched, increasing the risk of publication bias.

Based on the limitations identified in this review, the following recommendations for future research are offered:

- *Longitudinal studies.* Cross-sectional designs dominate the literature, but causality cannot be inferred from such studies. Future research should employ longitudinal designs with at least three time points to examine bidirectional effects between empathy, learning, and well-being.
- *Standardized measurement.* The field would benefit from consensus on core empathy measures.
- *Active control groups.* Intervention studies should include active control groups (e.g., alternative social-emotional learning programs) rather than no-treatment or waitlist controls to rule out nonspecific effects.
- *Diverse samples.* Most studies were conducted in Western or East Asian contexts. Research in other regions is needed to examine cultural variations in empathy-development links.
- *Implementation science.* Future research should examine not only whether empathy interventions work but also how they work, for whom, and under what conditions. Moderator analyses (e.g., by age, gender, socioeconomic status, school climate) would be valuable.
- *Cost-effectiveness studies.* Schools have limited resources; evidence on the cost-effectiveness of empathy interventions compared to other approaches (e.g., anti-bullying programs, mental health first aid) would inform policy decisions.
- *Meta-analysis.* As the evidence base grows, a meta-analysis pooling effect sizes across sufficiently homogeneous studies would provide more precise estimates of the empathy-learning and empathy_well-being associations.

The present study systematically reviewed 17 studies examining the role of empathy in students' learning and psychological well-being within group-based classroom contexts. The evidence consistently indicates that empathy is associated with better academic outcomes and greater psychological well-being, as well as reduced bullying and maladjustment. These associations appear to operate through both individual-level mechanisms (e.g., subjective happiness, reduced burnout) and group-level mechanisms (e.g., positive interdependence, promotive interaction). The necessity of designing psychoeducational packages focused on empathy in schools becomes more and more evident.

While the existing evidence is promising, significant methodological limitations - particularly the predominance of cross-sectional designs, heterogeneity in measurement, and lack of prospective registration- temper confidence in causal claims. Future research should prioritize rigorous longitudinal and experimental designs, standardized measures, and diverse samples. For now, educators and school psychologists can reasonably conclude that fostering empathy in schools is likely to benefit both academic and mental health outcomes, and that structured cooperative learning methods offer an evidence-based approach to achieving these dual goals.

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Author Contributions

The authors declare that they have no conflict of interest.

Data Availability Statement

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The authors confirm that all data generated or analyzed during this study are included in this article.

Ethical considerations

This article is a review study based exclusively on previously published literature and does not involve any human participants, animals, or identifiable personal data. Therefore, ethical approval and informed consent were not required. The authors adhered to the principles of academic integrity, transparency, and responsible reporting throughout the review process.

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