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Evaluating the effectiveness of dialectical behavior and motor perception training on the symptoms of attention deficit, cognitive avoidance and working memory of female students with attention deficit/hyperactivity disorder

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A B S T R A C T

Objective: Attention Deficit/Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders that is observed in early childhood. The aim of this study was to investigate the effectiveness of dialectical behavior and cognitive motor training on attention deficit, cognitive avoidance and working memory in female students with attention deficit/hyperactivity disorder.
Materials and Methods: The present study was quasi-experimental with pretest-posttest design. The statistical population consisted of 257 elementary school girls with attention deficit hyperactivity disorder and resident in district 2 of Tehran. Each meeting was given to participants. Data were collected using Cognitive Avoidance Questionnaire, Attention Deficit Disorder Scale and Wechsler Working Memory Test. Dialectical behavioral therapy sessions were held in 10 sessions and 12 sessions of cognitive and motor training were held in 12 one-hour sessions each week. For dialectical behavior therapy sessions, protocol therapy (Linehan, 1993) and McGinn Cognition and Motor Training (1970) were used. Data were analyzed using multivariate analysis of covariance and SPSS 27 software.
Findings: The results showed that there was no significant difference between the experimental and control groups of cognitive avoidance, attention deficit and working memory including cognitive avoidance (P=0.672, F=0.40), attention deficit (F=0.04, P=0.442), working memory (P=0.477, F=0.75).
Conclusion: It can be concluded that there is no significant difference between dialectical behavior therapy and cognitive and motor training on cognitive avoidance, attention deficit and working memory.
Keywords: *dialectical behavior therapy, perceptual and motor training, cognitive avoidance, attention deficit, working memory.*

1. Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders observed in early childhood (Zare & Aghaziarati, 2018). The global prevalence of ADHD is 7.2%, with an increasing trend in recent years across the world (MacLeod, 2018). In addition to common symptoms of this disorder

such as inattention, hyperactivity, and impulsivity, it has been found that children with ADHD often suffer from other comorbid disorders. The rates of ADHD comorbid with oppositional defiant disorder, conduct disorder, depression, anxiety, and Tourette syndrome are relatively high (Brassell et al., 2017). Since it is difficult to change behavioral and emotional patterns in adulthood, it is crucial to identify and treat the symptoms of this disorder in childhood before adolescence and adulthood (Friedrich et al., 2017).

A characteristic of this disorder is the inability to pay attention to details and a lack of focus during activities that require precision, attention, and concentration. Children with this disorder seem inattentive and not listening when spoken to directly and often fail to follow through on tasks or forget to do their chores. They frequently lose things as they do not remember where they put them (MacLeod, 2018).

One of the brain's executive functions involved in ADHD is working memory. Working memory is a structured system that connects short-term and long-term memory functions with other central brain areas and can be divided into four parts: 1- central executive, 2- visuospatial sketchpad, 3- phonological loop, 4- episodic buffer (Evans & Stanovich, 2013). Working memory includes both visual-spatial and verbal skills. Children use verbal memory to remember instructions, expand their language, and perform comprehension-related tasks. Visual-spatial working memory plays a role in remembering visual sequences in events, patterns, images, and mathematical skills (Abbasi Fashami, Akbari, & Hosseinkhanzadeh, 2020). It should be noted that the capacity of working memory in children aged 4 to 11 years gradually grows and increases (Mahnegar & Ahmaadi, 2020). Children with ADHD have deficits in working memory and experience problems in coordinating storage and processing of information simultaneously. They also face challenges in controlling treatment stimuli (Unsworth & Engle, 2007).

Another issue that children with ADHD may struggle with is cognitive avoidance. Cognitive avoidance, recognized by numerous theories, occurs when an individual does not want to be involved with certain personal experiences (thoughts, bodily sensations, emotions, memories) and makes efforts to change the form, frequency, and texture of these events for themselves (Hayes et al., 2004). Studies have shown that students with ADHD or specific learning disabilities use cognitive avoidance strategies to escape from worrying thoughts about social events. These students scored higher in cognitive, emotional, and cognitive avoidance deficits compared to their peers (Bögels & Mansell, 2004).

Various treatments, including medication, cognitive-behavioral therapy, and schema therapy, are proposed for treating ADHD, but none are considered definitive cures. One of the effective treatments that can reduce many symptoms is dialectical behavior therapy (Ciesinski et al., 2022; McCredie, Quinn, & Covington, 2017). Interventions of this therapeutic approach can be categorized into four main areas: mindfulness, emotional regulation, interpersonal effectiveness, and distress tolerance (Ciesinski et al., 2022; McCredie, Quinn, & Covington, 2017). Teaching mindfulness skills can be considered the most important component of dialectical behavior therapy, helping individuals change their emotions, thoughts, maladaptive behavior patterns, and interpersonal relationships (Rahmani & Omidi, 2019). The effectiveness of this method has been proven in various studies. Barani and Fouladchang (2022) showed its impact on anxiety and depression symptoms in students (Barani & Fooladchang, 2022), Abootorabi Kashani et al. (2021) on reducing attention deficit and anxiety symptoms in students (Abootorabi Kashani et al., 2020), Sadeghi et al. (2020) on reducing ADHD symptoms and suicidal ideation in adolescents with ADHD (Sadeghi et al., 2020), Bayat et al. (2020) on reducing hyperactivity symptoms (Bayat et al., 2020), and Del Conte et al. (2016) on reducing anxiety and depression in adolescents (Del Conte, Lenz, & Hollenbaugh, 2016).

Currently, treatment methods for ADHD primarily include medication, psychological counseling, and behavioral therapy. Regular physical activities and exercises can induce physiological and psychological mechanisms that not only enhance physical and mental health but also improve cognitive functions including memory and executive functioning (Christiansen et al., 2019). Based on the symptoms of ADHD (impulsivity, hyperactivity, and inattention), combining sports activities with conventional treatment can enhance therapeutic benefits. Perceptual-motor exercises, considered as a type of physical activity, are planned, structured, and repetitive activities that can maintain or improve an individual's physical fitness (Chan, Jang, & Ho, 2022). Most physical activities or sports interventions in children with ADHD are clinical rehabilitation exercises to improve motor coordination, cognitive function, interpersonal skills, or emotional disorders (de Jongh et al., 2011; Wendt et al., 2022; Ziereis & Jansen, 2015). No research has been found examining the effectiveness of perceptual-motor exercises on children with

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ADHD, but its effectiveness on children with autism and Down syndrome has been studied.

Given the above, the importance of addressing the condition of children with ADHD and comparing dialectical behavior therapy with perceptual-motor exercise among these children is evident. The primary research question is: which is more effective between dialectical behavior therapy and perceptual-motor exercise on the symptoms of attention deficit, working memory, and cognitive avoidance in female students with ADHD?

2. Methods and Materials

2.1. Study Design and Participants

The current study was an applied, quasi-experimental research using a pre-test and post-test design. It aimed to evaluate the effectiveness of dialectical behavior therapy and physical-movement exercises on attention deficit, working memory, and cognitive avoidance in hyperactive children. The statistical population included 257 elementary school girls diagnosed with attention deficit hyperactivity disorder (ADHD) residing in District 2 of Tehran. 40 female students attending psychological clinics in Tehran's District 2 were selected through convenience sampling and randomly assigned to two groups receiving dialectical behavior therapy and perceptual-motor exercise treatment. Training sessions for each method were conducted at the Salam Psychological Clinic on Shariati Street. Before starting the sessions and after the completion of the two therapeutic methods, questionnaires on attention deficit, working memory, and cognitive avoidance were given to the participants (students) to assess the effectiveness of the therapeutic methods. Inclusion criteria were being diagnosed with ADHD (assessed by a questionnaire), studying in primary school, and residing in Tehran's District 2. Exclusion criteria included not attending two therapy sessions and incomplete questionnaires.

The research implementation was conducted by coordinating with psychological clinics dealing with children showing symptoms of hyperactivity. 40 female students attending these clinics in Tehran's District 2 were randomly selected and divided into two groups for dialectical behavior therapy and perceptual-motor exercise treatment. The participants were provided with training related to each session. The therapy sessions were held over 12 one-hour weekly sessions. The dialectical behavior therapy protocol by Linehan (1993) and the perceptual-motor exercise program by McGain (1970) were used.

2.2. Measures

2.2.1. Cognitive Avoidance

This questionnaire was developed by Sexton and Dugas in 2008. It consists of 25 questions aimed at measuring cognitive avoidance across various dimensions (withdrawal from worrying thoughts, substituting positive thoughts for worrying ones, using attention diversion to stop the worrying process, distraction) and avoidance of situations and activities that trigger worrying thoughts, changing mental images to verbal thoughts. The scale is rated on a five-point scale from 'completely false' to 'completely true'. The total scale score is obtained by summing all item scores, ranging from 25 to 125. Lower scores indicate lower cognitive avoidance, and higher scores indicate higher cognitive avoidance. This questionnaire has better convergent and divergent validity compared to worry scales, thought suppression, and coping styles. Its reliability coefficient has been reported between 0.7 and 0.91, and in Iran, it is 0.86 (Aghajani, Samadifard, & Narimani, 2017).

2.2.2. Attention Deficit Symptoms

The Swanson, Nolan, and Pelham Rating Scale (SNAP-IV) contains 18 items. According to the authors, the scale has two subscales: the first measuring attention deficit and the second measuring hyperactivity-impulsivity. In this study, only the first subscale was used. The questionnaire consists of a list of characteristics of children with ADHD, rated on a 4-point scale from 0 to 3. The scale was standardized in Iran by Sadrosadat et al. (2008) for children aged 7 to 12 years in Tehran. Internal consistency of the scale was assessed using Cronbach's alpha. Analysis shows that the alpha value for the entire scale is 0.96, 0.94 for the first subscale, and 0.96 for the second subscale. Validity estimation using the Spearman-Brown coefficient is 0.72, with alpha values for each of the attention deficit and hyperactivity subscales being 0.95 respectively. The final scale included 23 statements (McGrath, Peterson, & Pennington, 2020; Sadrosadat et al., 2008; Swanson & Jerman, 2007).

2.2.3. Working Memory

Wechsler Working Memory Test has two subtests: forward and backward. Based on the normative scores table and the subject's age, a standard score is obtained. In Iran, the reliability coefficients using Cronbach's alpha for the subtests ranged from 0.65 to 0.85, and for the indices from

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0.75 to 0.86. The reliability coefficients using the split-half method for the subtests also varied from 0.62 to 0.84, and for the indices from 0.70 to 0.84 (Ashori & Tajvar Rostami, 2020; Hashemi malekshah et al., 2021).

2.3. Interventions

2.3.1. Dialectical Behavioral Therapy

The dialectical behavior therapy protocol by Linehan (1993) (Linehan, 1992) were implemented according to the Table 1.

Table 1

Dialectical Behavioral Therapy Session

Session	Content
1	Creating a relatively non-threatening familiarity among the members, establishing cordial relationships between group members and the leader, emphasizing and practicing the skill of attentive and active listening to each other during conversations, acquainting with some characteristics of the group members, explaining the concept of group counseling and its features and rules, clarifying the goals of participation in the group, explaining the general duties of group members until the end of the sessions, determining the number of sessions, the duration of each session, and the frequency of the sessions.
2	Summarizing the content of the previous session, introducing cognitive, emotional, behavioral, and physical systems, explaining how the four systems cooperate and influence each other in a cyclical manner, introducing ways to create changes in the cycle of systems, providing examples of changes in the cycle of systems, and assigning homework.
3	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, focusing on the emotional system and implementing emotional validation techniques, introducing general strategies of the leader and members in emotional validation, introducing prohibited aspects in emotional validation, providing opportunities for emotional expression, teaching emotional self-awareness (including observing emotions and labeling skills), reading emotions by the leader and members, stating that all emotions are valid, and assigning homework.
4	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, focusing on the behavioral system and implementing behavioral validation techniques, introducing general strategies of the leader and members in behavioral validation, introducing prohibited aspects in behavioral validation, teaching observation of behavior and labeling skills, identifying "shoulds" and dealing with them, accepting "shoulds," and assigning homework.
5	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, focusing on the cognitive system and implementing cognitive validation techniques, introducing general strategies of the leader and members in cognitive validation, introducing prohibited aspects in cognitive validation, and assigning homework.
6	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, continuing with the cognitive system and cognitive validation techniques, introducing types of cognitive errors according to Albert Ellis's theory, conducting group exercises to change cognitions, and assigning homework.
7	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, continuing with the cognitive system and "cognitive validation" techniques, extracting and reflecting thoughts and cognitions, distinguishing facts from interpretations, finding the "core reality" and recognizing rational mind, respecting different values, and assigning homework.
8	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, reviewing emotional, behavioral, and cognitive validation, addressing specific problems of members through behavioral analysis strategies, teaching behavioral analysis strategy and its implementation, solving members' problems, and assigning homework.
9 - 10	Summarizing the content of the previous session, reviewing the homework of the previous session and addressing the members' issues, discussing specific problems of members and solving them through group counseling, reviewing learned materials, and acquainting with new techniques related to specific problems, and conducting a post-test.

2.3.2. Perceptual and Motor Training

The perceptual-motor exercise program by McGain (1970) (Chan, Jang, & Ho, 2022; Salter et al., 2004) were implemented according to the Table 2.

Table 2

Perceptual and Motor Training Sessions

Session	Content
1	Initial explanations, problem conceptualization, preparing the student, and administering the pre-test.
2	Teaching unilateral exercises and assigning homework.
3	Continuation of teaching bilateral exercises and assigning homework.
4	Teaching agility exercises and assigning homework.
5	Continuation of teaching balance exercises and assigning homework.

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6	Teaching crisscross exercises and assigning homework.
7	Teaching combined exercises and assigning homework.
8	Teaching focus exercises and assigning homework.
9	Review of unilateral and bilateral exercises and assigning homework.
10	Review of balance and agility exercises and assigning homework.
11	Review of crisscross and combined exercises and assigning homework.
12	Summarization, practice, review of previous sessions, and conducting the post-test.

2.4. Data analysis

Data were analyzed using SPSS software version 27. Descriptive statistics, frequency tables, and bar charts were used to present demographic indices and the Kolmogorov-Smirnov test for determining parametric or non-parametric statistics. The Levene's test was used for homogeneity of variance. Multivariate analysis of covariance was employed to examine the research hypotheses. A significance level of 0.05 was considered.

3. Findings and Results

Regarding demographic characteristics, the majority of participants were in the fourth year of study, equally represented in both the dialectical behavior therapy and perceptual-motor training groups.

Table 3

The results of mean and standard deviation (SD)

Group	Stage	Suppression of worrying thoughts		Replacing worrying thoughts with positive thoughts		Using attention diversion to interrupt the process of worry		Distraction		Attention deficit		Forward (Memory)		Reverse (Memory)	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
DBT	Pre-test	68.90	12.78	65.00	13.46	70.40	14.81	65.67	13.34	32.45	7.78	12.14	2.90	11.14	2.29
	Post-test	25.55	3.58	32.65	4.17	31.40	4.22	32.34	4.56	25.55	3.58	15.45	3.90	14.89	3.90
PMT	Pre-test	70.90	13.65	65.45	14.09	56.40	13.56	60.09	13.09	29.78	6.90	12.45	3.30	10.23	1.90
	Post-test	26.56	3.78	33.89	4.90	34.34	4.89	30.43	4.24	24.78	3.67	16.43	4.70	15.32	4.20

According to Table 3, the highest mean score was observed in the use of attention diversion to interrupt the worry process in the dialectical behavior therapy group, and the lowest mean score was related to the suppression of worrisome thoughts in both groups. There was a change in the mean scores of attention deficit from the pre-test to the post-test phase in both groups. Moreover, the forward sub-scale had a higher mean in both the pre-test and post-test. The homogeneity of variance assumptions for the dialectical behavior therapy and perceptual-motor training experimental groups were confirmed for the cognitive avoidance, attention deficit, and working memory variables. All research variables had a normal distribution ($p > 0.05$). Table 4 presents the effect sizes calculated from the covariance analysis test for cognitive avoidance, attention deficit, and working memory variables.

Table 4

The results multivariate tests (MANCOVA)

Test	Value	F	Df hypo.	Df error	p	Eta^2
Pillai's trace	0.15	0.89	6.00	0.64	0.505	0.077
Wilks' lambda	0.84	0.89	6.00	0.62	0.506	0.080
Hotelling's trace	0.17	0.89	6.00	60.00	0.508	0.082
Roy's largest root	0.16	0.74	3.00	32.00	0.177	0.141

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As seen in Table 4, controlling for the pre-test effects, the significance levels of all tests indicate that there is no significant difference between the experimental groups of dialectical behavior therapy and perceptual-motor training in terms of dependent variables (cognitive avoidance, attention deficit, and working memory; P = 0.508, F = 0.89). Therefore, the hypothesis is not confirmed. In Table 5, MANCOVA analysis was used to examine the differences between the two groups in terms of cognitive avoidance, attention deficit, and working memory.

Table 5

The results of univariate analysis in the context of MANCOVA

Variable	Source	SS	df	MS	F	P	Eta^2
Cognitive avoidance	Group	93.71	2	46.86	0.40	0.672	0.024
Attention deficit	Group	20.94	2	10.47	0.83	0.442	0.048
Working memory	Group	3.35	2	1.67	0.75	0.477	0.044

The results presented in Table 5 show no significant difference between the experimental and control groups in cognitive avoidance, attention deficit, and working memory, including cognitive avoidance (P = 0.672, F = 0.40), attention deficit (P = 0.442, F = 0.04), and working memory (P = 0.477, F = 0.75). Thus, it can be concluded that there is no significant difference between dialectical behavior therapy and perceptual-motor training on cognitive avoidance, attention deficit, and working memory variables.

4. Discussion and Conclusion

The present study aimed to compare the effectiveness of dialectical behavior therapy and perceptual-motor training on symptoms of attention deficit, cognitive avoidance, and working memory in female students with Attention Deficit/Hyperactivity Disorder. The post-test comparisons of cognitive avoidance, attention deficit, and working memory between the two groups, controlling for pre-test effects, indicate no significant differences post-intervention; hence, there is no difference between dialectical behavior therapy and perceptual-motor training on cognitive avoidance, attention deficit, and working memory. This finding aligns with many similar research (Iri et al., 2019; Rahmani & Omidi, 2019; Sadeghi et al., 2020; Sheikh et al., 2022; Yu et al., 2020).

Studies have shown that coping skills, communication skills, emotion regulation skills, cognitive social problem-solving skills, and empathy are effective in controlling impulsivity, attention deficit, cognitive avoidance, and anger management (Katzman et al., 2017). These competencies enable individuals to act positively and constructively in their relationships with others, society, culture, and their environment, thereby maintaining their mental health. Additionally, dialectical behavior therapy and perceptual-motor training do not have the limitations and side effects of pharmacotherapy, making them more appealing to parents. Another advantage of these therapeutic approaches is that they combine cognitive-behavioral methods with active involvement of child patients in group settings. Group therapy allows female students with ADHD to not feel isolated in their condition, potentially offering cost and time benefits over pharmacotherapy (Haft et al., 2022). Therefore, these therapeutic interventions can address cognitive issues, attention deficits, and memory problems, including working memory.

The results obtained from the post-test comparison of attention deficit symptoms in both groups, controlling for the pre-test effect, indicate that there was no significant difference after participation in the sessions of dialectical behavior therapy and perceptual-motor training. Therefore, there is no difference between dialectical behavior therapy and perceptual-motor training in terms of attention deficit symptoms. This finding is consistent with similar research such as the results of several studies (Abootorabi Kashani et al., 2020; Asmand, Mami, & Valizadeh, 2014; Barani & Fooladchang, 2022; Bayat et al., 2020; Chan, Jang, & Ho, 2022; Ciesinski et al., 2022; Del Conte, Lenz, & Hollenbaugh, 2016; Goreis et al., 2021; Haft et al., 2022; Husmann et al., 2019; Iri et al., 2019; Linehan, 1992; McCredie, Quinn, & Covington, 2017; Miller, Rathus, & Linehan, 2006; Rahmani & Omidi, 2019; Sadeghi et al., 2020; Salter et al., 2004; Simon et al., 2022; Tabnak, Rajabi, & Hosseni, 2021; Zalewski et al., 2021).

Explaining the findings, it can be said that dialectical behavior therapy in reducing the symptomatic symptoms of female students with Attention Deficit/Hyperactivity Disorder (Fountaine, 2021; Graham & Brown, 2021; Gupta, Rao, & Kumaran, 2011; Husmann et al., 2019; Jin et al.,

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2020; Marcora, 2019; Movahedi & Esmaeili, 2015; Sheikh et al., 2022; Srinayanti et al., 2021; Wendt et al., 2022; Yu et al., 2020)has been interpreted in previous research as follows: One of the exacerbating factors of impulsive behaviors and attention deficits in these children is the lack of emotional and social support, low self-esteem, school problems, risky behaviors, and mood disorders (Simon et al., 2022). Therefore, as dialectical behavior therapy is presented as a supportive treatment and requires a strong mutual relationship between patient and therapist, and the therapist actively teaches and reinforces adaptive behaviors to the patient, it can be effective in reducing self-destructive behaviors. In fact, this therapeutic method provides new interpersonal skills for expressing opinions and needs, setting limits, and discussing problem-solving solutions to the patients, supporting their relationships with others in a respectful manner over time. Also, the training of mindfulness skills can be considered the most important component of dialectical behavior therapy, which helps individuals to change their emotions, thoughts, incompatible behavioral patterns, and interpersonal relationships in their lives (Goreis et al., 2021). Therefore, this training has been able to affect attention deficit and improve it.

Explaining the result, it should be said that perceptual-motor training exercises for female students with ADHD are weaker than their typical peers. Results from this research and similar studies have shown that the use of sports and physical activities, of which perceptual-motor exercises are one of the most reputable, can improve motor abilities in these children. In explaining these results, it can be said that in the perceptual-motor system, several subsystems are involved in the recognition process. Operational processes of the nervous system function based on the information provided by the subsystems, leading to skilled and purposeful action. Deficiencies in these subsystems or processes result in weak motor skills. Previous research on perceptual-motor training has been effective, perhaps because the exercises have focused on motor performance, drawing skills, and dexterity, which are considered physical skills, not cognitive skills, of which working memory is a part. Perceptual-motor exercises include visual perception, auditory perception, tactile-motor perception, and motor exercises (Christiansen et al., 2019). Regular physical activities and exercises can induce physiological and psychological mechanisms that not only enhance physical and mental health but also improve physiological and cognitive functions, including memory and executive functioning.

The results obtained from the post-test comparison of cognitive avoidance in both groups, controlling for the pre-test effect, indicate that there was no significant difference after participation in the sessions of dialectical behavior therapy and perceptual-motor training. Therefore, there is no difference between dialectical behavior therapy and perceptual-motor training in terms of cognitive avoidance. This finding is consistent with several research (Barani & Fooladchang, 2022; Bayat et al., 2020; Ciesinski et al., 2022; Del Conte, Lenz, & Hollenbaugh, 2016; Goreis et al., 2021; Haft et al., 2022; Iri et al., 2019; Linehan, 1992; McCredie, Quinn, & Covington, 2017; Miller, Rathus, & Linehan, 2006).

Explaining this finding, it can be said that female students with ADHD, due to deficiencies in working memory and attention, need external and immediate control and cannot retain information to design and anticipate practice in their minds, thus encountering more problems in participating in time-dependent behaviors. Based on symptoms of impulsivity, hyperactivity, and inattention, combining sports activities with conventional treatment can enhance therapeutic benefits. Perceptual-motor exercises should be considered a category of physical activities, referring to planned, structured, and repetitive physical activities that can improve or maintain an individual's physical fitness (Chan, Jang, & Ho, 2022). Most physical activities or sports interventions in female students with ADHD are clinical rehabilitation exercises aimed at improving motor coordination, cognitive performance, interpersonal skills, or emotional disorders.

Additionally, explaining this finding, it can be said that when distress tolerance skills are taught to female students with ADHD, their sense of continuity and psychological strength increases. In other words, this skill teaches them to better cope with distressing events and their disturbing symptoms, exhibiting fewer avoidant behaviors. On the other hand, using the techniques of dialectical behavior therapy, individuals can better understand and accept emotions and events that occur in life (Graham & Brown, 2021; Zalewski et al., 2021). Thus, female students with ADHD learn to be more resilient in the face of conflicts and problems arising from the disorder, reducing the disruptive effects of environmental conditions. Dialectical behavior therapy also leads to an overall improvement in orientation, a sense of trust, and continuous and comprehensive dynamism in life and surroundings, helping female students with ADHD to more accurately identify their negative academic emotions and then examine each emotion without

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being incapacitated (Zalewski et al., 2021). They also perceive life as more organized, predictable, and explainable without destructive and incompatible behavior. In essence, benefiting from dialectical behavior therapy enables female students with ADHD to perceive and accept emotions and feelings and problems and inefficiencies; thus, they consider academic life more understandable, controllable, and meaningful, and as a result, show fewer avoidant behaviors and thoughts, thereby reducing their level of cognitive avoidance.

The results obtained from the post-test comparison of working memory in both groups, controlling for the pre-test effect, indicate that there was no significant difference after participation in the sessions of dialectical behavior therapy and perceptual-motor training. Therefore, there is no difference between dialectical behavior therapy and perceptual-motor training in terms of working memory. This finding is consistent with previous research (Bayat et al., 2020; Ciesinski et al., 2022; Goreis et al., 2021; Haft et al., 2022; Iri et al., 2019; Movahedi & Esmaeili, 2015; Penner & Kappos, 2006; Sadeghi et al., 2020; Sheikh et al., 2022; Simon et al., 2022; Vernon et al., 2003).

To explain this finding, it can be said that implementing perceptual-motor exercises leads to the improvement of working memory in female students with ADHD (ADHD). According to the results of other studies, it seems that the subjects, due to their participation in movement therapy sessions, may have gained a pleasant feeling, and this feeling has led to more attention and accuracy regarding various issues, which they then generalized to other situations (Jin et al., 2020). Furthermore, following participation in physical activities, the levels of these neurotransmitters increase. Perceptual-motor exercise programs are also valid physical education programs that are adjusted based on the level of development and contain many of the same elements. Also, according to the arousal mechanism theory, low arousal and insufficient activity of inhibitory control mechanisms lead to the occurrence of distractions and, consequently, ADHD (Srinayanti et al., 2021). It might be argued that when children with ADHD are exposed to high stimulation, such as physical exercises, they exhibit better performance. The fact that perceptual-motor exercises play a significant role in the neural system's development, including working memory, has been well established (Husmann et al., 2019). However, most of the research conducted relates to normal individuals or individuals with other disorders. Indeed, perceptual-motor exercises, by facilitating neural plasticity, creating new synaptic structures, reducing cognitive and neural disorders, increasing information processing performance, enhancing the efficiency of neurotransmitters, neural adaptation, behavioral function recovery, and emotional regulation, can improve the efficiency of neural physiology, brain development and growth, and motor development, and cause an increase in the performance of the nervous system and cognitive function, thereby improving attention and working memory in female students with ADHD.

On the other hand, to explain the effectiveness of dialectical behavior therapy on working memory, it can be said that dialectical behavior therapy, through combining mindfulness techniques and emotional regulation with behavioral therapy principles, teaches female students with ADHD, who face multiple cognitive problems, to observe the consequences of their mental and behavioral patterns without judgment. The dialectical behavior therapy technique, as the most important technique of dialectical behavior therapy, leads to the development of attention, awareness of emotions, observation, and description of events in the present moment (Simon et al., 2022). Based on this technique, individuals are taught to experience their thoughts, emotions, and bodily sensations without judging or evaluating them, to focus on one stimulus at a time, and whenever they notice their distraction, to refocus on that stimulus. Thus, in dialectical behavior therapy, individuals regulate their attention through performing specific tasks (Katzman et al., 2017). Also, dialectical behavior therapy leads to an increase in the thickness of the brain's gray area, which plays a role in learning, memory, and emotional regulation, and the use of these techniques can increase the level of attention and memory in female students with ADHD.

5. Limitations & Suggestions

The inability to randomly select participants and hence the need for caution in generalizing the research findings, the effect of the pre-test on the post-test scores, and the selection of only one gender group were among the limitations of the study, preventing the comparison of girls and boys. It is recommended that these therapeutic methods be applied to children with ADHD in other communities and samples. Future studies are suggested to include samples from both genders. It is also suggested that future studies increase the sample size. It is recommended that in future studies the effect of therapist variables such as intelligence quotient be controlled. It is suggested to use dialectical behavior therapy

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to increase working memory and reduce symptoms of attention deficit and cognitive avoidance in students with hyperactivity and attention deficit disorder. It is also suggested to use perceptual and motor exercises to increase working memory and reduce symptoms of attention deficit and cognitive avoidance in students with hyperactivity and attention deficit disorder.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Authors' Contributions

All authors equally contributed to this study.

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