Original Research

Comparative Study of Cognitive and Behavioral Outcomes in Children with ADHD: Pharmacological Treatment vs. Behavioral Therapy

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ABSTRACT

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Aim: This study aimed to compare the cognitive and behavioral outcomes in children with ADHD receiving pharmacological treatment versus behavioral therapy over a 12-month period.

Materials and Methods: A total of 80 children, aged 6-12 years, diagnosed with ADHD based on DSM-5 criteria, were randomly assigned to either a pharmacological treatment group (n=40) or a behavioral therapy group (n=40). Cognitive and behavioral outcomes were assessed at baseline, 6-month, and 12-month follow-ups using a variety of standardized measures including the Wechsler Intelligence Scale for Children (WISC-V), Continuous Performance Test (CPT), Conners' Rating Scales, and the Clinical Global Impression (CGI) scale.

Results: There were no significant differences between the two groups in cognitive outcomes, including WISC-V scores, CPT performance, and executive function tasks at both 6-month and 12-month follow-ups. Behavioral outcomes also showed no significant differences between the groups in terms of hyperactivity, inattention, and externalizing behaviors at both follow-up points. However, the pharmacological treatment group showed a more significant reduction in the severity of ADHD symptoms (p=0.04), though there were no significant differences in symptom improvement (p=0.10) or functional outcomes (p=0.25) between the groups.

Conclusion: Both pharmacological treatment and behavioral therapy were effective in improving cognitive and behavioral outcomes in children with ADHD. The pharmacological treatment group exhibited a more substantial reduction in symptom severity, while both treatments led to similar improvements in attention, hyperactivity, and overall functioning. These findings highlight the efficacy of both approaches, suggesting that medication may offer more immediate symptom relief, while behavioral therapy can also provide long-term benefits.

Keywords: ADHD, pharmacological treatment, behavioral therapy, cognitive outcomes, behavioral outcomes

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Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that is commonly diagnosed in childhood and often persists into adolescence and adulthood. Characterized by inattention, hyperactivity, symptoms of and impulsivity, ADHD can significantly impact a child's cognitive and behavioral functioning, academic performance, and social interactions. The prevalence of ADHD has been increasing globally, and its management has become a central concern for clinicians, educators, and parents alike. There is an ongoing debate about the most effective treatment options for children with ADHD, particularly when comparing pharmacological treatment and behavioral therapy. This comparative study seeks to explore the cognitive and behavioral outcomes in children with ADHD who undergo these two prevalent treatment modalities.¹Pharmacological treatment, primarily involving stimulant medications such as methylphenidate and amphetamines, has long been considered a first-line intervention for ADHD. These medications aim to address the core symptoms of ADHD by enhancing dopamine and norepinephrine activity in the brain, thereby improving focus, impulse control, and overall cognitive functioning. However, pharmacological treatment has shown while significant efficacy in managing the symptoms of ADHD, concerns remain about its long-term effects, potential side effects, and its ability to address the underlying behavioral challenges associated with the disorder. Furthermore, medication does not always

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provide lasting improvements in cognitive functioning or behavioral regulation once the medication is discontinued, highlighting the need for complementary interventions.²On the other hand, behavioral therapy focuses on modifying problematic behaviors and teaching children strategies to improve their self-regulation and interpersonal skills. Behavior therapy includes a range of approaches, such as positive reinforcement, reward systems, and skills training, often administered through parent training or direct intervention with the child. Behavioral therapy is grounded in the principles of operant conditioning and cognitive-behavioral techniques, and it aims to equip children with tools to manage their behaviors without relying on medication. One of the key advantages of behavioral therapy is its non-invasive nature, avoiding the potential side effects associated with pharmacological treatments. Additionally, behavioral therapy focuses on improving social skills, emotional regulation, and executive functioning, addressing broader aspects of a child's development that are often impaired in ADHD.³Both pharmacological treatment and behavioral therapy have demonstrated effectiveness in improving ADHD symptoms, but they do so in different ways and with varying degrees of success. For instance, stimulant medications may lead to a rapid improvement in attention and hyperactivity, but these improvements may not always translate into long-term behavioral changes or improvements in academic achievement. In contrast, behavioral therapy tends to focus on sustainable changes in behavior, fostering better coping strategies and self-regulation over time. However, it is often a more time-consuming process that requires consistent effort from both the child and caregivers.⁴Research into the comparative effectiveness of these treatments has produced mixed results. Some studies suggest that a combination of pharmacological and behavioral interventions provides the most comprehensive benefits, addressing both cognitive deficits and behavioral difficulties. Others argue that one approach may be more beneficial than the other depending on the specific needs of the child, such as the severity of ADHD symptoms, the presence of comorbid conditions, and the family's preferences and resources. The heterogeneity of ADHD means that there is no onesize-fits-all approach to treatment, and outcomes can vary significantly between individuals.⁵Another critical factor to consider in this comparison is the impact of these treatments on cognitive functioning. Children with ADHD often experience deficits in executive functions such as working memory, and organization. These cognitive planning. impairments can have a profound effect on academic performance and daily life. While pharmacological treatments are designed to directly target these cognitive deficits by increasing dopamine levels, their effect on long-term cognitive development remains uncertain. In contrast, behavioral therapy indirectly

supports cognitive development by teaching children strategies to manage tasks, plan, and organize, thereby improving executive functioning over time. However, the impact of behavioral therapy on cognitive outcomes is often more gradual, and its success depends on the consistency and quality of the interventions.6Behavioral therapy also places a significant emphasis on social and emotional which are often overlooked outcomes, in pharmacological treatment. Children with ADHD often struggle with peer relationships, emotional regulation, and social interactions, which can lead to social isolation, low self-esteem, and difficulties in school settings. Behavioral therapy aims to address these issues by improving social skills, promoting emotional regulation, and enhancing self-control. By fostering these skills, behavioral therapy helps children with ADHD navigate social situations more effectively, contributing to improved overall wellbeing.^{7,8}Ultimately, both pharmacological treatment and behavioral therapy offer valuable benefits, but the most effective approach may vary depending on the individual child's needs. In some cases, a combined treatment approach may be the best option, leveraging the strengths of both pharmacological and behavioral interventions. This combined approach allows for immediate symptom relief through medication while simultaneously addressing the root causes of behavioral difficulties through therapy. Furthermore, parental involvement and support are critical in both treatment modalities, as consistent reinforcement and monitoring are necessary to maximize the effectiveness of both pharmacological and behavioral interventions.

Materials and Methods

This study was a comparative, randomized controlled trial aimed at evaluating and comparing the cognitive and behavioral outcomes in children diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD). The participants were randomized into two groups: one group received pharmacological treatment, while the other received behavioral therapy. The study was conducted over a 12-month period. A total of 80 children aged 6-12 years, diagnosed with ADHD based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria, were enrolled in the study. Participants were recruited from outpatient pediatric clinics and child psychiatry centers.

The inclusion criteria included:

- 1. Children aged 6-12 years.
- 2. Diagnosis of ADHD (combined type, inattentive type, or hyperactive-impulsive type) confirmed by a clinical interview and standardized ADHD rating scales, such as the Conners' Parent and Teacher Rating Scales.
- 3. No history of severe medical conditions, neurological disorders, or intellectual disabilities.

4. No previous history of pharmacological treatment or behavioral therapy for ADHD within the last 6 months.

Exclusion criteria included:

- 1. Children with comorbid psychiatric disorders (e.g., severe anxiety or depression) or significant medical conditions.
- 2. Children with contraindications to medications or therapies.
- 3. Non-consent from parents/guardians.

Intervention Groups

The 80 children were randomly assigned to one of the two treatment groups:

Group 1: Pharmacological Treatment

Participants in this group were prescribed a standard stimulant medication (e.g., Methylphenidate or Amphetamine-based medications) or non-stimulant medication (e.g., Atomoxetine) based on the child's response to an initial trial and physician's recommendation. The medication was administered daily, and the dose was adjusted based on individual responses and side effects. Regular follow-up visits with the prescribing pediatrician or psychiatrist were scheduled every 4 weeks to monitor efficacy and adverse effects.

Group 2: Behavioral Therapy

Children in this group underwent a structured, manualized behavioral intervention program, consisting of parent training and child-focused therapy. delivered by trained clinical psychologists. The therapy focused on improving executive function, self-control, social skills, and coping strategies using positive reinforcement, behavior modification techniques, and cognitivebehavioral strategies.Parent training was aimed at equipping caregivers with strategies for managing ADHD symptoms at home and in social settings.

Outcome Measures

Cognitive and behavioral outcomes were assessed at baseline (before treatment) and at 6-month and 12month follow-up points using a variety of standardized measures. These included cognitive assessments, behavioral assessments, and clinical evaluations to comprehensively evaluate the effects of pharmacological treatment and behavioral therapy on children with ADHD.

For cognitive assessments, the Wechsler Intelligence Scale for Children (WISC-V) was used to assess general cognitive abilities, including verbal comprehension, perceptual reasoning, working memory, and processing speed. The Continuous Performance Test (CPT) was employed to evaluate attention span, impulsivity, and reaction time, which are key areas impacted by ADHD. The Tower of London Task was utilized to assess executive function, particularly in terms of planning and problem-solving skills, both of which are often challenging for children with ADHD.

Behavioral outcomes were measured using several established tools. The Conners' Parent and Teacher Rating Scales were used to assess ADHD symptoms, including hyperactivity, impulsivity, and inattention. These scales provide valuable information from both parents and teachers to gauge the severity of symptoms in different environments. The Child Behavior Checklist (CBCL) was used to assess both externalizing and internalizing behaviors as reported by parents and teachers, offering insight into a child's overall behavior. Additionally, the Strengths and Difficulties Questionnaire (SDQ) was administered to evaluate emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior, which are critical aspects of a child's social and emotional functioning.

Clinical outcomes were assessed through the Clinical Global Impression (CGI) Scale, which provided an overall evaluation of the severity of ADHD symptoms and the degree of improvement over the course of treatment. Finally, Parent-Teacher Conferences and Reports were used to gather feedback on any behavioral changes observed and the impact of the treatments on the child's daily functioning in both school and home environments. These comprehensive measures ensured a robust evaluation of both cognitive and behavioral outcomes in children undergoing pharmacological treatment or behavioral therapy for ADHD.

Statistical Analysis

Data were analyzed using SPSS (Version 26.0). Descriptive statistics (mean \pm standard deviation) were used to summarize demographic and baseline characteristics. The differences in cognitive and behavioral outcomes between the pharmacological treatment group and the behavioral therapy group were assessed using repeated measures analysis of variance (ANOVA), with a significance level set at p < 0.05. Additionally, between-group differences were analyzed using independent t-tests for continuous variables and chi-square tests for categorical variables.

Results

Table 1: Baseline Demographic and ClinicalCharacteristics of Participants

The baseline characteristics of participants in both the pharmacological treatment and behavioral therapy groups were similar, as indicated by the non-significant p-values for age (p=0.75), gender (p=0.72), and ADHD type (p=0.53). The age distribution and gender ratio were comparable across both groups. Regarding ADHD type, the combined type was the most common among both groups, followed by the inattentive type and hyperactive-impulsive type. The mean baseline WISC-V scores (which assess cognitive abilities) and the Continuous Performance

Test (CPT) scores (which assess attention) were also very similar between the two groups, with no significant differences (p=0.67 and p=0.67, respectively), suggesting that the groups were wellmatched at the start of the study.

Table 2: Cognitive Outcomes at 6-Month Follow-up

At the 6-month follow-up, there were no significant differences between the pharmacological treatment and behavioral therapy groups on the cognitive measures assessed. For example, on the WISC-V Verbal Comprehension (p=0.52), Perceptual Reasoning (p=0.46), Working Memory (p=0.41), and Processing Speed (p=0.67), the mean scores were quite similar across both groups. Similarly, there was no significant difference in the Continuous Performance Test (CPT) mean reaction time (p=0.13), although the pharmacological treatment group had a slightly faster response time. On the Tower of London Task, which assesses executive functioning, there was also no significant difference between the groups (p=0.46), although both groups showed small improvements in performance.

Table 3: Cognitive Outcomes at 12-Month Follow-up

At the 12-month follow-up, the results for cognitive outcomes were again similar between the two groups. The WISC-V scores for Verbal Comprehension (p=0.63), Perceptual Reasoning (p=0.54), Working Memory (p=0.35), and Processing Speed (p=0.45) showed no significant differences between the pharmacological treatment and behavioral therapy groups. Likewise, the CPT mean reaction time (p=0.21) and Tower of London Task scores (p=0.43) did not differ significantly, indicating that both groups showed similar progress in cognitive outcomes over time.

Table 4: Behavioral Outcomes at 6-Month Followup

In terms of behavioral outcomes at the 6-month follow-up, no significant differences were observed between the two groups on the Conners' Rating Scales for Hyperactivity (p=0.39) and Inattention (p=0.27). Both treatment groups showed improvement in these areas, but the differences between the groups were not statistically significant. For externalizing behaviors (as measured by the Child Behavior Checklist), the

pharmacological treatment group showed slightly higher scores (12.3 ± 4.2) compared to the behavioral therapy group (10.9 ± 3.8) , but this difference was not significant (p=0.13). Similarly, internalizing behaviors and the total difficulties score on the Strengths and Difficulties Questionnaire (SDQ) did not show significant between-group differences (p=0.33 and p=0.35, respectively), suggesting that both interventions were effective in reducing behavioral problems but to a similar extent.

Table 5: Behavioral Outcomes at 12-MonthFollow-up

At the 12-month follow-up, there were again no significant differences between the pharmacological treatment and behavioral therapy groups for behavioral outcomes. For example, the Conners' Rating Scale scores for Hyperactivity (p=0.41) and Inattention (p=0.22) did not differ significantly between groups, suggesting that both treatments resulted in similar improvements in attention and hyperactivity. Externalizing behaviors (Child Behavior Checklist) and internalizing behaviors showed similar results (p=0.14 and p=0.26, respectively). The total difficulties score on the SDO was also not significantly different between groups (p=0.23). This suggests that both treatment modalities had comparable effectiveness in improving behavior over the 12-month period.

Table 6: Clinical Outcomes at 12-Month Follow-up A significant difference was found in the Clinical

A significant difference was found in the Clinical Global Impression (CGI) rating of the severity of symptoms (p=0.04), with the pharmacological treatment group showing a more substantial reduction in the severity of ADHD symptoms compared to the behavioral therapy group. This indicates that the pharmacological treatment may have led to more significant symptom reduction in terms of overall severity. However, when it came to improvement in symptoms (CGI - Improvement in Symptoms), the difference between the groups was not statistically significant (p=0.10), suggesting that both treatments were associated with some level of symptom improvement. Additionally, parent-teacher feedback on daily functioning showed no significant difference between the groups (p=0.25), indicating that both interventions had a similar impact on functional outcomes in school and home environments.

 Table 1: Baseline Demographic and Clinical Characteristics of Participants

Characteristic	Pharmacological Treatment Group (n=40)	Behavioral Therapy Group (n=40)	Total (n=80)	p- value
Age (Mean ± SD)	9.2 ± 1.6	9.1 ± 1.5	9.15 ± 1.55	0.75
Gender (Male/Female)	30/10	32/8	62/18	0.72
ADHD Type				0.53
- Combined Type	20	22	42	
- Inattentive Type	12	10	22	
- Hyperactive-Impulsive	8	8	16	

Mean WISC-V Score	88.5 ± 15.2	87.3 ± 16.1	87.9 ± 15.6	0.67
Mean CPT Score (Mean RT	0.80 ± 0.15	0.78 ± 0.17	0.79 ± 0.16	0.67
in sec)				

Table 2: Cognitive Outcomes at 6-Month Follow-up			
Measure	Pharmacological Treatment	Behavioral Therapy	p-value
	Group (n=40)	Group (n=40)	
WISC-V Verbal Comprehension	92.5 ± 14.3	91.2 ± 15.7	0.52
WISC-V Perceptual Reasoning	93.4 ± 13.5	91.5 ± 14.2	0.46
WISC-V Working Memory	90.6 ± 14.1	88.7 ± 14.3	0.41
WISC-V Processing Speed	86.2 ± 12.8	85.1 ± 13.2	0.67
CPT Mean Reaction Time (sec)	0.70 ± 0.12	0.75 ± 0.13	0.13
Tower of London Task (Mean	7.8 ± 2.2	8.2 ± 2.1	0.46
Score)			

Table 3: Cognitive Outcomes at 12-Month Follow-up

Measure	Pharmacological Treatment Group (n=40)	Behavioral Therapy Group (n=40)	p- value
WISC-V Verbal Comprehension	95.3 ± 13.2	94.0 ± 14.5	0.63
WISC-V Perceptual Reasoning	96.4 ± 12.6	94.8 ± 13.0	0.54
WISC-V Working Memory	94.2 ± 13.0	91.9 ± 14.1	0.35
WISC-V Processing Speed	89.5 ± 12.3	87.3 ± 13.0	0.45
CPT Mean Reaction Time (sec)	0.68 ± 0.10	0.72 ± 0.11	0.21
Tower of London Task (Mean Score)	8.6 ± 2.0	8.9 ± 2.1	0.43

Table 4: Behavioral Outcomes at 6-Month Follow-up

Measure	Pharmacological Treatment	Behavioral Therapy	р-
	Group (n=40)	Group (n=40)	value
Conners' Rating Scale (Hyperactivity)	7.2 ± 2.5	6.8 ± 2.4	0.39
Conners' Rating Scale (Inattention)	7.8 ± 2.6	7.0 ± 2.5	0.27
Child Behavior Checklist (Externalizing	12.3 ± 4.2	10.9 ± 3.8	0.13
Behaviors)			
Child Behavior Checklist (Internalizing	9.1 ± 3.7	8.3 ± 3.5	0.33
Behaviors)			
Strengths and Difficulties Questionnaire	15.6 ± 5.1	14.2 ± 4.8	0.35
(SDQ) - Total Difficulties Score			

Table 5: Behavioral Outcomes at 12-Month Follow-up

Measure	Pharmacological Treatment	Behavioral Therapy	р-
	Group (n=40)	Group (n=40)	value
Conners' Rating Scale (Hyperactivity)	5.4 ± 2.0	4.9 ± 1.9	0.41
Conners' Rating Scale (Inattention)	6.1 ± 2.2	5.3 ± 2.1	0.22
Child Behavior Checklist (Externalizing	8.7 ± 3.0	7.2 ± 2.7	0.14
Behaviors)			
Child Behavior Checklist (Internalizing	6.2 ± 3.1	5.4 ± 2.9	0.26
Behaviors)			
Strengths and Difficulties Questionnaire	12.8 ± 4.4	11.0 ± 4.1	0.23
(SDQ) - Total Difficulties Score			

Measure	Pharmacological Treatment	Behavioral Therapy	p-value
	Group (n=40)	Group (n=40)	
Clinical Global Impression (CGI) –	2.5 ± 0.8	3.0 ± 0.9	0.04
Severity of Symptoms			
Clinical Global Impression (CGI) –	1.6 ± 0.7	1.9 ± 0.8	0.10
Improvement in Symptoms			
Parent-Teacher Feedback	7.3 ± 1.9	6.8 ± 2.2	0.25
(Improvement in Daily Functioning)			

Table 6: Clinical Outcomes at 12-Month Follow-up

Discussion

The present study aimed to compare the cognitive and behavioral outcomes of pharmacological treatment versus behavioral therapy in children with ADHD over a 12-month period. Both treatments showed positive effects, but there were no significant differences between the groups in most of the outcomes assessed. The results from the cognitive outcomes assessed at both 6-month and 12-month follow-ups align with previous studies that have compared cognitive improvements in children with ADHD treated with medication or behavioral interventions. For instance, Tamm et al. (2017) emphasized that cognitive-behavioral therapy (CBT) can lead to improvements in executive function and working memory, which are commonly impaired in children with ADHD.8 However, our study did not observe significant differences between pharmacological treatment and behavioral therapy on measures such as verbal comprehension, perceptual reasoning, working memory, or processing speed at either follow-up point (p-values ranged from 0.35 to 0.67). This finding contrasts with the results of Verret et al. (2014), who reported modest but consistent improvements in cognitive functioning in children receiving behavioral therapy. However, it is worth noting that the improvements observed in our study were small but similar across both treatment groups, indicating that both pharmacological and behavioral interventions might result in comparable cognitive gains, albeit at a modest level.⁹Additionally, the results for the Continuous Performance Test (CPT) and the Tower of London Task, which assess attention and executive functioning, respectively, were also similar between the two groups. These results are consistent with the systematic review by Jensen et al. (2005), which found that while medication tends to have more immediate effects on attention and impulse control, behavioral interventions, such as CBT, also show improvements over time but may take longer to manifest.¹⁰ The non-significant differences observed in this study (p-values for CPT and Tower of London ranged from 0.13 to 0.46) suggest that while both treatments can lead to improvements in cognitive performance, pharmacological treatments may result in more rapid or sustained effects, as was suggested by Charach et al. (2008).¹¹ In terms of behavioral outcomes, both pharmacological and behavioral therapies led to improvements, but these changes were not significantly different between groups. The Conners' Rating Scales and Child Behavior Checklist indicated reductions in hyperactivity, inattention, and externalizing behaviors across both groups. This aligns with findings from a meta-analysis by Verret et al. (2014), which demonstrated that behavioral treatments for ADHD are effective in reducing behavioral problems, including hyperactivity and impulsivity. The absence of significant differences between the treatment groups in this study (with pvalues ranging from 0.13 to 0.41) suggests that both

pharmacological and behavioral interventions are similarly effective in managing ADHD symptoms related to behavior.9 Moreover, Sonuga-Barke and Dalen (2002) found that stimulant medications significantly improve hyperactivity and inattention, which was observed in our study's pharmacological treatment group, although not to a greater extent than the behavioral therapy group. This suggests that, while stimulant medications might have a faster onset of action, behavioral therapies, particularly those that involve parent training and cognitive-behavioral strategies, might also lead to long-term improvements in behavior, as seen in our data (with no significant differences between groups).12 The Clinical Global Impression (CGI) scale revealed a significant difference between the two groups in terms of the severity of ADHD symptoms (p=0.04), with the pharmacological treatment group showing a greater reduction in symptom severity. This finding supports the conclusion of several studies, including those by Sayal et al. (2022) and Rajendran et al. (2023), which demonstrated that pharmacological treatments, particularly stimulant medications, result in greater reductions in the severity of ADHD symptoms compared to behavioral therapies.^{13,14}For example, in their review, Rajendran et al. (2023) found that pharmacological treatments, especially stimulants, often provide more immediate symptom relief, which aligns with our findings of a more substantial reduction in symptom severity in the pharmacological group.¹⁴ However, despite the significant difference in symptom severity, the improvement in symptoms, as measured by the CGI Improvement scale, did not show a statistically significant difference between the groups (p=0.10). This suggests that while the pharmacological treatment group achieved a greater reduction in severity, both treatments were similarly effective in improving overall symptoms, a finding consistent with the meta-analysis by Sonuga-Barke and Dalen (2002), which reported that both medication and behavioral treatments were associated with moderate improvements in ADHD symptoms.¹² Additionally, the parent-teacher feedback on daily functioning did not show significant differences between the two groups (p=0.25). This finding is in line with Kratochwill et al. (2021), who found that both types of interventions positively impact a child's daily functioning, but the differences between pharmacological and behavioral therapies were not substantial. This indicates that while pharmacological treatments may lead to quicker symptom relief, behavioral therapies may have long-term benefits for functional outcomes, particularly in social and academic settings.¹⁵

Conclusion

In conclusion, both pharmacological treatment and behavioral therapy were effective in improving cognitive and behavioral outcomes in children with ADHD. While the pharmacological treatment group

showed a more significant reduction in symptom severity, both treatments led to similar improvements in attention, hyperactivity, and overall functioning. These findings suggest that while medication may offer more immediate symptom relief, behavioral interventions can also be highly effective, particularly in the long term.

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