



## **Rehabilitation of Attention and Executive Functions in Preschool Children with Attention Deficit Hyperactivity Disorder (ADHD): A Systematic Literature Review**

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**Abstract**

*Attention Deficit Hyperactivity Disorder (ADHD) is considered one of the most common disorders during cognitive and behavioral development in childhood. Treatment options offered early can decrease the adverse effects of this disorder. Objective: To carry out a literary review of scientific studies published between 2015 and 2022 which examine neuro-cognitive rehabilitation techniques of preschool children with ADHD. Methods: Within the publications found, 18 articles from the databases PubMed and Med Line were selected. Results: From the 18 articles selected, 10 concern familial training (especially parental training), 6 deal with cognitive training, and 2 use alternative, “mindfulness-based” interventions. Conclusions: Existing research dedicated to treating ADHD in preschool children is scarce. The studies selected presented multiple methods, such as parent training, cognitive training, and mindfulness-based interventions. All methods showed modest improvements in ADHD symptoms. Although more specific and detailed studies are necessary for a better understanding of the subject, the benefits of cognitive training programs were significantly positive.*

**Key words:** *attention deficit hyperactivity disorder, preschool children, treatment, neuropsychological rehabilitation, cognitive training.*

**Abbreviations:**

ADHD = Attention Deficit Hyperactivity Disorder

BPT = Behavioral Parent Training

CD = Conduct Disorder

DSM = Diagnostic and Statical Manual of Mental Disorders

HNC = Helping the Noncompliant Child

IY = Incredible Years

K-CPT = Conners Kiddie Continuous Performance Test

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MCRP = Motor Cognitive Remediation Program

NFPP = New Forest Parenting Program

ODD = Oppositional Defiant Disorder

PEP = Program for Externalizing Problems

SWAN = Strengths and Weaknesses of ADHD Symptoms and Normal Behaviors Rating Scale

TEAMS = Training Executive, Attention, and Motor Skills

POET = Parental Occupation Executive Training

WWP = Werry-Weiss-Peters Activity Rating Scale.

## **Introduction**

Attention Deficit Hyperactivity Disorder (ADHD) is a neuro-behavioral disorder that generally emerges during childhood, and frequently impairs the individual throughout their entire life (American Psychiatric Association, 2013).

The disorder is characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity which is atypical to that expected in children of the same age, sex, and developmental level. The diagnosis of ADHD requires that these symptoms cause a clinically significant effect on the individual's cognitive development and functioning, within at least two environments, for example at home, at school, at work, or during social endeavors (Benczik, 2010; Barkley, 1997).

## **Etiology**

ADHD is one of the most prevalent mental disorders in youth, presenting over 60 million cases within the different regions of the world where it has been studied (Polanczyk, 2007). The disorder is strongly influenced by genetic predisposition and presents a higher incidence rate in males than females (Polanczyk, 2007).

## **Clinical Condition**

ADHD is characterized by a possible combination of two types of symptoms: Inattention and Hyperactivity-Impulsivity (Mattos, 2015).

Patients who manifest inattention symptoms often express difficulties in organization, maintenance of focus, following instructions, sustaining attention during demanding activities, and fulfilling duties. In addition, they tend to be easily distracted by irrelevant extraneous stimuli, which are easily ignored by other children, such as car horns and dog barks (Benczik, 2014).

Patients who display symptoms of hyperactivity tend to be excessively active, usually in a disorganized and purposeless manner. They are often restless, finding it difficult to contain physical or vocal expressions even when such behaviors are unnecessary and/or inappropriate (Barkley, 1997).

Lastly, patients who manifest impulsive symptoms struggle with resisting immediate temptations and delaying gratification (Barkley, 1997). They are frequently impatient and intrusive, often interrupting others and interfering in extraneous conversations which they are not directly involved in. In addition, they tend not to think before acting, and can subsequently engage in dangerous activities with little consideration for their possible consequences, which may lead to accidents (Benczik, 2014).

It is important to note that there is no known biological marker for ADHD; its clinical diagnosis is based on interviews with the patient, their family members and their teachers, in which the characteristics outlined above are analyzed in depth.

There are three sub-types of ADHD: the predominantly inattentive type, characterized by inattention and sensitivity to distractions, the predominantly hyperactive-impulsive type, characterized by excessive agitation and impulsivity, and the combined type, in which the patient meets both criteria. In addition, ADHD can be classified into different degrees of severity: mild, moderate, or severe.

ADHD is often associated with other disorders in the same individual. Most commonly, ADHD comorbidities include Disruptive Behavior Disorders such as Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD). In 1999, Rohde et al. studied adolescents diagnosed with ADHD and found a comorbidity rate of 47.8% with Disruptive Behavior Disorders (Rohde et al., 1999). Other studies show a significant prevalence between ADHD and Depression (15 to 20%), Anxiety Disorders (25%), Learning Disorders (10 to 25%), and substance abuse in adolescence and/or adulthood (9 to 40%) ((Biederman et al., 1991; Pliszka, 1997; Rohde et al., 2000). The evaluation of comorbidities is not only fundamental for facilitating the patient's clinical management of their symptoms, but also for

possibly reaching a differential diagnosis. Symptoms of inattention, hyperactivity and impulsivity, due to their lack of specificity, can be found in other disorders. Therefore, it is essential to evaluate a variety of hypotheses in order to generate a differential diagnosis that is tailored to the patient.

Studies investigating the effects of ADHD over developmental stages show that ADHD symptoms tend to decrease with age (called partial remission) (Barkley et al., 1990). More overt symptoms like hyperactivity and impulsivity tend to present more significant reductions than do inattentive symptoms (remission in 70% versus 40% of patients, respectively) (Biederman et al., 2000). However, as a chronic disorder, full remission of ADHD is uncommon, and studies show that a substantial proportion (4-60%) of children with ADHD continue to present clinically significant symptoms in adulthood (Biederman et al., 2000; Rasmussen and Gillberg, 2000; Kessler et al., 2006).

Depending on the environment in which the child is situated, ADHD can induce changes in cognitive potential, skills, and behavior, which may subsequently affect school performance and engagement, emotional development, self-esteem, and interpersonal social and familial relationships (Miotto, 2017). However, treatments delivered early possess the potential to lessen the side effects of ADHD.

### **Rehabilitation Techniques**

A variety of methods exist to rehabilitate ADHD patients. When it comes to preschool patients, cognitive (cognitive training), familial (parent training) and alternative (“mindfulness-based”) interventions are the most relevant.

Cognitive Training aims to reduce the cognitive deficits that are displayed by a patient. Children with ADHD tend to have difficulties in organizing themselves, staying focused, following instructions, and fulfilling their duties, symptoms that can easily affect the child's school life and performance. This can lead to difficulties keeping up with classmates of the same age group and, consequently, poor grades. Cognitive training aims to improve the executive functions of patients with ADHD, such as attention, concentration, memory, organization and language, aiming to remediate the cognitive deficits that tend to present as obstacles in the patient's scholarly and social performance. Cognitive training also helps the individual learn to use compensatory strategies more effectively, which can thus be extended to tasks of daily life (Sohlberg, 2009).

Familial Training programs aim to educate the parents of children with ADHD about techniques that help to reduce maladaptive behaviors and encourage positive, functional behaviors in the child. Parents and children influence each other, and this interaction plays an important role in a child's development

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(Denham, 2000). Given this information, the existing literature highlights that the engagement of parents in the psychotherapeutic interventions that their children receive brings great benefits, including yet not limited to increasing the effectiveness of the treatment (Eyberg, 2008).

Mindfulness-based interventions are alternative rehabilitation techniques, such as yoga, meditation, and physical exercise (amongst others). These techniques enable the individual to better understand their own internal states, such as their emotions and impulses, characteristics that are often affected by ADHD. These therapies encourage ADHD patients to obtain a greater autonomy and awareness over their choices and attitudes.

Another type of intervention that was omitted from this article is an intervention mediated by the child's school, whereby training is given both to the teacher and to the institution. This technique can optimize the child's school performance and reduce the various difficulties that arise during learning. However, no studies were found that addressed this technique for preschool children.

### **Aim**

Given the information outlined above, this article aims to conduct a literary review of studies published between the years 2015 and 2022 regarding techniques commonly used for the neuropsychological rehabilitation of attention and other executive functions in preschool-aged children with Attention Deficit Hyperactivity Disorder (Nahas, 2004).

### **Methods**

We conducted a systematic review of the available literature concerning the rehabilitation of attention, impulsivity, and hyperactivity in preschool-aged children with Attention Deficit Hyperactivity Disorder (ADHD). Articles were selected to include: (a) original studies investigating the rehabilitation of children with ADHD or ADHD symptoms; (b) reviews of the literature on the rehabilitation of children with ADHD or ADHD symptoms.

The survey of scientific articles for this study was carried out using the databases PubMed and MedLine. Original articles and literary reviews regarding the "Rehabilitation of Attention, Impulsivity and Hyperactivity in preschool children with Attention Deficit Hyperactivity Disorder" were selected for revision.

The databases PubMed and Medline were searched using the following entry terms: “Attention Deficit Hyperactivity Disorder,” “Rehabilitation,” “Preschool Children,” “Cognitive Training,” “Parent Training,” and “Mindfulness.” The following combinations of descriptors were used: “Attention Deficit Hyperactivity Disorder AND Preschool Children,” “Attention Deficit Hyperactivity Disorder AND Preschool Children AND Training,” and “Rehabilitation AND Attention Deficit Hyperactivity Disorder.”

All abstracts were reviewed independently and selected to include studies that satisfied the following inclusion criteria: (a) use of a standardized procedure for symptom assessment OR diagnostic, such as the DSM-V; (b) inclusion of children aged 2.5 to 7.0 years; (c) published during the period from 2015 to 2022; (d) published in either Portuguese or English. Articles that addressed other disorders, studies that included medicated patients, and studies using ADHD patients of other ages, were excluded.

**Results**

In this article, studies investigating the neuro-cognitive rehabilitation of preschool-aged children with ADHD symptoms were reviewed. Among the publications found, eighteen articles were selected that investigate neuropsychological rehabilitation techniques in preschool children with ADHD. Results are summarized in Figure 1 of this article.

<b>Study</b>	<b>Methods</b>	<b>Objectives</b>	<b>Participants</b>	<b>Results</b>
<b>Capodieci et al. (2017)</b>	Cognitive Training	Verify the effectiveness of an intervention to train working memory.	5-year-old children with ADHD symptoms assessed by a parental interview and information from teachers.	The cognitive training intervention promoted a significant improvement in tasks measuring executive functions (attention, inhibition, impulsivity).
<b>Chevalier et al. (2017)</b>	Cognitive Training	Evaluate the effectiveness of the Motor Cognitive Remediation Program (MCRP) on attention.	5-year-old children with ADHD symptoms assessed by K-CPT criteria.	The MCRP program promoted a significant improvement in orientation (selective attention) and executive control (inhibition, interruption, and mental operations).
<b>Halperin et al. (2019)</b>	Cognitive Training	Analyze the effectiveness of the TEAMS cognitive training program.	Children aged 4 to 5 years diagnosed with ADHD.	TEAMS training promoted a significant improvement in severity of ADHD neuro-cognitive symptoms.
<b>Shuai et al. (2020)</b>	Cognitive Training	Assess the effectiveness and feasibility of executive function training.	Children aged 4 to 5 years diagnosed with ADHD using DSM-V criteria.	Executive function training promoted a significant improvement in visual-motor accuracy, and a reduction in ADHD

				diagnostic criteria presented. However, ADHD symptoms and other executive functions did not show significant improvement.
<b>Tamm et al. (2015)</b>	Cognitive Training	Examine the effectiveness of cognitive training on executive functions (cognitive flexibility, auditory and visual attention, selective sustained attention).	Children aged 3.8 to 6.6 years diagnosed with ADHD using DSM-IV criteria.	Cognitive training promoted a significant improvement in attention and emotion regulation. Moderate effect on inhibition, memory, planning, and hyperactivity-impulsivity.
<b>Vibholm et al. (2018)</b>	Cognitive Training	Analyze the effectiveness of the TEAMS cognitive training program.	Children aged 3 to 6 years diagnosed with ADHD using DSM-V criteria in Denmark.	TEAMS training did not promote significant improvement in ADHD symptoms.
<b>Abikoff et al. (2015)</b>	Parent Training	Evaluate the short- and long-term effectiveness of the NFPP program compared to the HNC clinical intervention.	Children aged 3 to 4 years diagnosed with ADHD using DSM-IV criteria.	Both interventions promoted an improvement in ADHD and ODD symptoms (assessed by parents). NFPP was not significantly better than HNC.
<b>Daffner et al. (2019)</b>	Familial Training	Evaluate the effectiveness of a sibling-mediated intervention in reducing negative social behaviors and promoting positive social behaviors.	Children aged 4.0 to 6.11 years diagnosed with ADHD using DSM-V criteria.	The intervention promoted an increase in positive social behaviors, but there was no reduction in negative social behaviors.
<b>DuPaul et al. (2017)</b>	Parent Training	Examine the effectiveness of a face-to-face and an online parent training program compared to a control.	Children aged 3.0 to 5.11 years who meet DSM-V criteria for ADHD, based on a clinical interview and parent assessments.	Both intervention formats promoted a reduction in hyperactivity-impulsivity, and an improvement in self-control and mood.
<b>Eichelberger et al. (2016)</b>	Parent Training	Evaluate the effectiveness of the PEP program for conduct problems.	Children aged 3 to 6 years diagnosed with ADHD using DSM-IV criteria.	Reduction in conduct problems (assessed by parents) was most significant in children with severe ADHD symptoms.
<b>Frisch et al. (2019)</b>	Parent Training	Evaluate the effectiveness of the POET parent training program.	Children aged 3.8 to 7.0 years diagnosed with ADHD using DSM-IV criteria.	POET training promoted a significant improvement in executive functions.
<b>Huang et al. (2021)</b>	Parent Training	Evaluate the long-term effectiveness of a behavioral	Children aged 4.8 to 6.3 years diagnosed	The program promoted a behavioral improvement and a significant reduction



		intervention delivered through parental training.	with ADHD using DSM-V criteria.	in ADHD symptoms (Attention, hyperactivity-impulsivity)
<b>Lange et al. (2018)</b>	Parent Training	Evaluate the effectiveness of the NFPP parent training program.	Children aged 3 to 7 years diagnosed with ADHD in Denmark.	NFPP promoted an improvement in parent-rated ADHD symptoms. No effect on teacher-rated ADHD symptoms.
<b>Rimestad et al. (2016)</b>	Parent Training	Evaluate the effectiveness of parent training as an early intervention.	Children aged 2.5 to 6 years diagnosed with ADHD or with ADHD symptoms.	Short-term: significant effect on parent-rated ADHD symptoms and conduct problems. Long-term: significant effect on parent-rated ADHD symptoms, but insignificant effect on parent-rated conduct problems.
<b>Sonuga-Barke et al. (2017)</b>	Parent Training	Compare the effectiveness and cost of an individually administered parent training program (NFPP) versus a generic, group-based program (IY).	Children aged 2.9 to 4.6 years with symptoms of ADHD (score $\geq 20$ on WWP rating scale)	Both parental training programs promoted reductions in ADHD symptoms. Individually administered parental training showed no significant difference from group administered training.
<b>Van der Veen-Mulders et al. (2017)</b>	Parent Training	Examine the effectiveness of BPT parent training on disruptive behaviors.	Children aged 2.9 to 4.6 years with ADHD symptoms as assessed by a parental interview.	BPT promoted a significant improvement in behavioral problems reported by parents.
<b>Cohen et al. (2018)</b>	Mindfulness-Based Intervention	Evaluate the effectiveness of Yoga in improving control of attention and conduct problems (assessed by parents and teachers).	Children aged 3 to 5 years diagnosed with ADHD by the ADHD Rating Scale-IV.	Yoga promoted a significant improvement in sustained attention but did not promote an improvement in impulsivity. Children with more severe symptoms showed greater improvement.
<b>Lo et al. (2017)</b>	Mindfulness-Based Intervention	Examine the feasibility of a family intervention on symptoms of inattention and hyperactivity	Children aged 3 to 5 years with high scores on SWAN rating scale.	The intervention promoted a significant improvement in inattention and hyperactivity.

**Figure 1:** Table summarizing all articles selected for this review.

## **Cognitive Training**

Capodieci et al. (2017) aimed to verify the effectiveness of an intervention to train working memory in 5-year-old children with symptoms of ADHD. Working memory temporarily stores and manages information necessary for carrying out complex executive functions, such as learning, planning and reasoning. Deficits in working memory are related to characteristic symptoms of ADHD, such as difficulties in organization and focus (Barkley, 2006). The study showed that cognitive training promoted a significant improvement in tasks measuring executive functions (such as attention, inhibition, and impulsivity).

Chevalier et al. (2017) sought to investigate the effectiveness of the Motor Cognitive Remediation Program (MCRP) in the attentive functions of preschool children with ADHD symptoms. The study points out that the MCRP promoted a significant improvement in orientation (selective attention) and executive control (inhibition, interruption and involvement of mental operations).

Halperin et al. (2019) analyzed the preliminary effectiveness of TEAMS training. The study showed that TEAMS training promoted a significant improvement in the severity of ADHD neuro-cognitive symptoms in children aged 4 to 5 years diagnosed with ADHD by the ADHD Rating Scale-IV.

Shuai et al. (2020) sought to evaluate the effectiveness and feasibility of executive function training in 4- to 5-year-old children diagnosed with ADHD using the DSM-V. The study shows that cognitive training promoted a significant improvement in visual-motor accuracy. The intervention also promoted a reduction in the ADHD diagnostic criteria presented by the patients. However, the intervention did not stimulate a significant improvement in the patients' ADHD symptoms or other executive functions.

Tamm et al. (2015) examined the effectiveness of cognitive training on the executive functions of children aged 3 to 7 years diagnosed with ADHD by the DSM-IV. The executive functions measured included cognitive flexibility, sustained attention, and selective attention. Cognitive flexibility is the ability of an individual to alter cognitive processing strategies to adapt to new environments and/or situations (Canas et al., 2003). The lack of cognitive flexibility in ADHD patients can be caused by the characteristic inattention of ADHD, which induced issues in cognitive functioning and memory. Sustained attention refers to the ability to focus on a stimulus for a relatively long time, the lack of which is commonly the main source of ADHD inattention symptoms. Selective attention, on the other hand, refers to the process of inhibiting responses to irrelevant stimuli contained around us, in order to guide concentration only towards the target stimulus (Nahas, 2004). People with ADHD have difficulties maintaining sustained, selective attention, and are easily attracted by irrelevant external

stimuli. In the study by Tamm et al., cognitive training promoted a significant improvement in inattention and emotion regulation, and had a moderate effect on inhibition, memory, planning, and hyperactivity/impulsivity.

Vibholm et al. (2018) investigated the effectiveness of TEAMS training in relation to the treatment as usual in children aged 3 to 6 years, diagnosed with ADHD by the DSM-V in Denmark. The findings suggest that the TEAMS cognitive training program does not differ significantly from treatment as usual with respect to ADHD symptomology.

### **Parent Training**

Abikoff et al. (2015) aimed to evaluate the short- and long-term effectiveness of a parent training program called New Forest Parenting Program (NFPP), as compared to a clinical intervention called the Helping the Noncompliant Child (HNC) in pre-school aged children with ADHD. The patients in this study ranged from 3 to 4 years and were diagnosed with ADHD using the DSM-IV. The results of this study show that both interventions promoted an improvement in ADHD symptoms, as rated by the children's parents. NFPP was not significantly better than HNC and was, in fact, less effective than HNC on some measures of the study.

Daffner et al. (2019) studied the effectiveness of a sibling-mediated intervention in reducing negative social behaviors and increasing positive social behaviors of pre-school children with ADHD. In this case, the siblings were devoid of ADHD symptomatology, and the patients ranged from 4.0 to 6.11 years, diagnosed with ADHD using the DSM-IV. It was found that the intervention promoted an increase in positive social behaviors in children with ADHD, but there was no reduction in negative social behaviors.

DuPaul et al. (2017) investigated the efficacy of a face-to-face and online parenting training program as compared to a control group. They evaluated 3.0- to 5.11-year-old children who met the DSM-V criteria for ADHD, based on a clinical interview combined with parent ratings. In this study, both the face-to-face and online intervention formats promoted a reduction in hyperactivity and impulsivity, and improved self-control and mood.

Eichelberg et al. (2016) aimed to study the effectiveness of a parental training program called Prevention Program for Externalizing Problem Behavior (PEP) in preschoolers aged 3-6 years diagnosed with ADHD using the DSM-IV. The patients in this study displayed a reduction in conduct

problems (as assessed by the Domestic Situations Questionnaire, HSQ); this reduction was most significant in children with severe ADHD symptoms.

Frisch et al. (2016) analyzed the efficacy of a parent training program called POET in preschoolers aged 3.83 to 7.08 years that were diagnosed with ADHD using the DSM-IV. The results of this study suggest that the parent training intervention led to a significant improvement in executive functions. The intervention also provoked a change in the parental perceptions regarding the cognitive difficulties that are faced by children with ADHD.

Huang et al. (2021) sought to evaluate the long-term effectiveness of a behavioral intervention delivered through parental training and guidance. The patients in this study ranged from 4.75 to 6.3 years of aged, and were diagnosed with ADHD using the DSM-V. This study found that the parental training intervention promoted a behavioral improvement, and also led to a significant reduction in ADHD symptoms of inattention and hyperactivity-impulsivity.

Lange et al. (2018) analyzed the effectiveness of a parent training program called NFPP as compared to usual treatment (TAU) of 3- to 7-year-old children diagnosed with ADHD in Denmark. Children receiving the NFPP parenting training exhibited a greater improvement than those that received treatment as usual (TAU) with respect to parent-rated ADHD symptoms. No significant effect was observed for teacher-rated ADHD symptoms.

Rimestad et al. (2016) sought to evaluate the efficacy of a parent training technique as an early intervention for children with ADHD aged 2.5 to 6 years. They found that in the short term, the parent training intervention had a moderate and significant effect on parent-rated ADHD symptoms, and a moderate and significant effect on parent-rated conduct problems. In the long term, the parent training intervention had a positive and significant effect on parent-rated ADHD symptoms, and a positive but insignificant effect on parent-rated conduct problems.

Sonuga-Barke et al. (2017) aimed to compare both the effectiveness and cost of two types of parent training interventions (individualized versus group), as compared to treatment as usual (TAU) for 2.9- to 4.6-year-old children that scored highly on the WWP scale for ADHD symptoms. The interventions studied were the individually administered New Forest Parenting Program (NFPP), as well as the generic, group-administered parent training called Incredible Years (IY). The results of this study indicate that both individually- and group-administered parental training programs led to significant reductions in ADHD symptoms as compared to the TAU group, and both training methods showed no significant difference from one another.

Van der Veen-Mulders et al. (2017) investigated the effectiveness of a parent training intervention called BPT in reducing disruptive behaviors in children aged 2.9 to 4.6 years with ADHD symptoms. The patient's symptoms were assessed using a semi-structured interview with their parents (the Dutch version of the Parent Interview for Child Symptoms, PICS-4). The results of this study show that the parent training intervention led to a significant improvement in the behavioral problems reported by the patient's parents.

### **Mindfulness-based Interventions**

Cohen et al. (2018) aimed to investigate the effectiveness of yoga in controlling attention and disruptive behavior pre-school children with ADHD, as evaluated by their parents and teachers. The patients in this study were aged 3 to 5 years and were all diagnosed with ADHD via the ADHD Rating Scale IV. This study found that the practice of yoga led to a significant improvement in sustained attention, in the form of faster reaction times and fewer omissions measured on a distraction task. However, yoga did not lead to an improvement in impulsivity, in the form of commission errors on the same distraction task. Children with more severe symptoms exhibited a greater improvement.

Lo et al. (2017) sought to analyze the feasibility of a mindfulness-based family intervention for symptoms of inattention and hyperactivity in 3- to 5-year-old children that scored highly on the Strengths and Weaknesses of ADHD Symptoms and Normal Behaviors Rating Scale (SWAN). The results of this study show that the alternative rehabilitation technique used promoted a significant improvement in inattention and hyperactivity.

### **Discussion**

This review provides a systematic overview and important guidelines for future research in the neuropsychological rehabilitation of attention in preschool-aged children with ADHD.

In this research, three different types of non-pharmacological techniques for the neuropsychological rehabilitation of ADHD in preschool children were investigated: cognitive training, familial training, and mindfulness-based interventions.

The results indicate that cognitive training programs have significant potential to remediate the cognitive impairments that are common in ADHD patients, such as attention and executive functions. Mindfulness-based interventions can support the rehabilitation of preschool children with ADHD,

providing safe learning environments that minimize errors and costs, while also improving motivation and impulse-suppression.

Familial training programs seek to address not only the cognitive symptoms of ADHD but also target other delays common to these patients, such as behavioral and social dysfunctions. However, from the point of view of neuropsychological rehabilitation, these programs seem limited in their ability to offer cognitive remediation and training. Of the ten familial training studies selected for this research, eight overtly measured effects in the patients' behavioral issues, while only two concerned cognitive symptom remediation.

Despite a growing realization that ADHD can be neuropsychologically rehabilitated as early as in the preschool age, it is still quite challenging to assess the impact that different rehabilitation techniques have on young children. That is because a variety of confounding factors exist, such as current or pre-existing stimulant drug use (Chang et al., 2019), psychiatric comorbidity (Johnson et al., 2005), as well as the participant's gender and IQ level (Biederman et al., 2002). The scarcity of available literature regarding ADHD rehabilitation in the preschool age group further proves the challenges involved such research.

Given the present findings, further studies are necessary to clarify certain aspects about study design and methodology. For example, 12 studies highlighted that the small sample size possibly affected the statistical power of the trial, and 7 studies had issues in the homogeneity of group characteristics, such as the ratio of males to females included, and parental educational level and socioeconomic status. These characteristics make it difficult to interpret the study results and evaluate the efficacy of each rehabilitation technique.

In addition, most of the studies reviewed failed to inform their participants' ADHD sub-type population (mostly inattentive, hyperactive-impulsive, or combined). Future studies should also aim to include a more representative sample of ADHD subtypes, taking into consideration the current distribution of sub-type populations in this particular age group.

Another limiting factor in the studies reviewed is the wide variety of outcome measurement techniques employed. Some studies employed family and teacher rating scales, others used cognitive tests, and some used a combination of both; this could lead to inconsistent results. In the studies that used cognitive tests, some measured the outcome on attention and executive functions only, and others included other ADHD symptomatology. Furthermore, of the studies that utilized rating scales, most of which concerned familial training programs, some employed only the participant's family to evaluate

the results, others also employed teacher evaluations. In future studies, it is imperative not to limit future research to the subjective perceptions of one assessor only so as not to incur a responder bias in the test results.

Despite the limitations stated above, the results of this study provide a generous overview of the efficacy and feasibility of different programs for neuropsychologically rehabilitating preschool ADHD.

## **Conclusion**

The scarcity of studies found confirms that the neuropsychological rehabilitation of children of the preschool age group is not yet a widely tested practice. It is extremely important that more research is carried out so as to encourage new directions for future studies.

Although more studies are necessary, the rehabilitation technique that has been studied in the most depth appears to be familial training interventions, including yet not limited to parent training.

The findings above indicate that all rehabilitation techniques have significant potential to rehabilitate the attention and executive functions of pre-school aged children with ADHD. However, given the results displayed above, cognitive training programs appear to be the most effective in rehabilitating the cognitive functions of preschool-aged children with ADHD, thus most greatly remediating the disorder's functional impairments.

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