



## A comparative study using virtual reality technology versus occupational therapy on improving attention among children with adhd

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### Abstract

**Background:** Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental condition characterized by attention problems, excessive physical activity, and impulsivity. Nowadays technology is advanced, virtual reality is a part of technology which helps to improve attention. that the use of VR technologies for children with ADHD seem to be promising tools for improving the diagnosis and management of ADHD in this population. Attention is improved through occupational therapy intervention and also through virtual reality. Therefore, it is understood that virtual reality will show improvement. We are conducting this review just to get more evidence regarding this field.

**Objectives:** The purpose of this review is to analyse the effect of virtual reality on improving attention among children with ADHD.

**Study Design:** Systematic review.

**Methods:** A systemic review was conducted according to the PRISMA (Preferred Reporting Items for Systemic Reviews and Meta- Analyses) guidelines. The search was done on five databases (PubMed, Scopus, CINAHL, Web of Science & Google Scholar) to identify studies where the attention of ADHD children is affected and how virtual reality has important role in improving it using a combination of keywords of ADHD, Attention, Virtual Reality (VR).

**Results:** The review study included 250 potentially relevant articles out of which 170 studies were excluded as duplicate, 25 studies were excluded as they didn't meet inclusion and exclusion criteria, 15 articles didn't mention the intervention and 40 studies were included for review.

**Conclusion:** After going through with all the review included in this literature, the literature is supporting the effectiveness of Virtual Reality in improving attention in children with ADHD. So, it is concluded that a proper study will give positive outcomes on children with ADHD.

**Keywords:** Attention deficit hyperactivity disorder (ADHD), virtual reality (VR), cognition, paediatrics, occupational therapy (OT), attention

### Introduction

**Description of the Condition:** Among neurodevelopmental disorders, one of the most common is attention deficit hyperactivity disorder (ADHD). It is characterized by the presence of a persistent pattern of inattention and/or hyperactivity and impulsivity that interferes with cognitive functioning and participation in different activities. Attention deficits are observed, for example, because the child frequently changes the focus of attention, particularly in monotonous and repetitive activities. Occasionally, they do not pay attention to details, causing them to make mistakes or omit relevant information in the performance of tasks. It may also appear that they are not listening, even when people speak to them directly. They are easily distracted and forget details<sup>[1]</sup>.

**Prevalance:** Global prevalence of ADHD ranges from 1.2% to 7.3% in adults and 5.9% to 7.1% in children. While the majority of studies focus on children aged 7 to 17, it's important to note that adults can also have ADHD. It has been hypothesised that more adults now suffer from ADHD than there were 20 years ago. 76% of patients with

diagnosed ADHD still experience symptoms in their adult years, which contributes to some of this increase<sup>[2]</sup>.

**Aetiology:** Pre-conceptional, Gestational, and Perinatal Conditions, heavy metal exposure, sleep disorders, genetic factors and changes in brain Structure and function are some of the causes of ADHD<sup>[3]</sup>. Theories about the neurological basis of ADHD have identified the roles of the frontal-basal ganglia and dopamine pathways, with impaired functioning resulting in problems of attention control and behavioural inhibition (Lou 1996, Castellanos 1997). The brain functions as a whole: higher cortical processes require the sensory processing function that occurs at lower subcortical levels, and lower subcortical levels depend on cortical functions for interpreting sensory information (Bundy *et al* 2002). Voeller (2001) broadened the proposed neurological basis of ADHD to include prefrontal-subcortical circuits. The frontal lobe, basal ganglia and thalamus may form a system or loop, which activates and inactivates ascending/arousal and descending/inhibiting pathways (Cummings 1993). This conceptualisation links the three levels of functions/dysfunctions as interrelated components in explaining the aetiological factors of ADHD<sup>[3]</sup>. In the

past decade, scientific research has focused on strengthening the first position, with an emphasis on identifying primary genetic causes of ADHD. More-recent evidence, however, suggests that complex psychiatric disorders are mediated by a combination of genetic and environmental factors<sup>4,12,13</sup>. Scientific research into the complex and potentially multiple aetiologies of ADHD is still in early stages<sup>14</sup>; however, it is attracting a lot of attention as ADHD becomes a global phenomenon: in the past decade rates of diagnosis have increased sharply in most countries around the world. These increases are linked to parallel growth in the consumption of stimulant medications<sup>[4]</sup>.

**Pathophysiology:** A number of neurophysiological deficits are linked to ADHD. More recent theoretical frameworks integrate clinical symptoms and neuropsychological issues. Cognitive deficits may result from dysfunctions, particularly in fronto-striatal or meso-cortical brain networks, whereas issues with reward processing may be related to dysfunctions in the mesolimbic dopaminergic system. The Default Mode-Network (DMN) activity, which is typically prominent during rest, may interfere with activity in neuronal networks involved in task processing in ADHD, leading to difficulties in state regulation and sporadic attentional lapses. However, deficits in ADHD may already be seen in the resting brain. Studies on brain activity more specifically related to response inhibition produced conflicting findings, which may be accounted for by the methods' diversity. Studies using the Stop-Task, which calls for a frequent and therefore dominant response that must be withheld if a Stop-signal is presented, have shown that the right inferior frontal gyrus is particularly important for successfully stopping an ongoing response. According to several EEG and fMRI studies, ADHD is associated with impairments in Stop-Task performance and stop-signal related brain activity<sup>[5]</sup>. The prominent and often complete symptom overlap of ADHD with other psychopathology and the difficulties distinguishing ADHD from other pathology can be viewed as supporting the thesis that ADHD is not a distinct neurologic or psychologic disease entity. Instead, the symptoms of hyperactivity, inattention, and impulsivity might represent a final common behavioural pathway for a gamut of emotional, psychologic, and/or learning problems. Clinical experience and case studies reveal that other problems, for example, occult mental retardation, hypervigilance owing to fear or stress, and ongoing or past abuse, can masquerade as ADHD<sup>[6]</sup>.

**Description of the Intervention:** Rehabilitation is a team effort. Occupational therapy interventions (OTIs) and occupational therapists (OTs) are an integral and crucial part of the rehabilitation processes<sup>[7]</sup>. Occupational therapy (OT), which is one of the rehabilitation professions, is a client-centered profession that helps people who are suffering participation and occupational performance limitations. OT offers a wide range of rehabilitation strategies in different medical and social diagnosis<sup>[8]</sup>.

Nowadays technology is advanced, virtual reality is a part of technology which helps to improve attention. (Saeideh Goharnejad, 2022 stated that the use of VR, AR, and MR technologies for children with ADHD seem to be promising tools for improving the diagnosis and management of ADHD in this population). Attention is improved through occupational therapy intervention and also through virtual

reality<sup>[9]</sup>. VR offers the potential to create systematic human testing, training, and treatment environments that allow for the precise control of complex, immersive, dynamic three-dimensional (3-D) stimulus presentations, within which sophisticated interaction, behavioural tracking and performance recording is possible<sup>[10]</sup>. The ability to create a VR environment that can depict a situation that is similar to reality for a subject has recently become possible thanks to advancements in computer and display technology. The VR Therapy system, in contrast to currently used treatments, does not have any negative side effects and can present a subject with a variety of scenarios without the involvement of numerous people. Many children with ADHD will soon be able to receive treatment at home as the availability of personal computers rises and the cost of HMD (Head Mounted Display) and Head Trackers gradually drops<sup>[11]</sup>. VR rehabilitation can be classified in several ways. The first is the classification method according to the specific patient population. Rehabilitation practices in this class can be classified as musculoskeletal disorders, post-stroke and cognitive and psychological disorders. The second classification method concerns the priority of the applied rehabilitation protocol. VR practice in the rehabilitation protocol can only be used as an adjunct or as the basis of a rehabilitation program to retain the place of classical exercise or activity programs<sup>[8]</sup>. VR systems employ either head-mounted devices (HMDs) for fully immersive 3D views or conventional desktop systems. In the former, an individual wears the equipment immersing them completely into the VE which blocks out extraneous sights and sounds from the real environment. HMDs were reported as being enjoyable, physically and visually comfortable, easy to use, and exciting, and children wanted to use them again with several potential usages for HMDs, including relaxing and feeling calm, exploring somewhere virtually before visiting in the real world, and developing learning opportunities<sup>[12]</sup>.

VR is defined in paediatric rehabilitation as 'An interactive simulation allowing users to feel experiences similar to real-life environments or objects ones with systems which consist in computer hardware and software. Virtual reality systems (VRS) are mostly used in paediatric rehabilitation program due to these properties. Pediatric rehabilitation is a concept that covers a wide range of applications and includes treatments for various diagnoses or disorder, such as children with neurological, orthopaedic or developmental disabilities<sup>[8]</sup>. The use of it in children with disabilities provides motor learning, postural and motor control and improves sensorial-perceptual-motor-cognitive-communication skills. So that children become more independent individuals in their daily lives. VR can lessen the burden on the instructor by presenting exercises in a consistent and predictable manner while maintaining the child's attention and engagement. Having both flexibility and control of the VR program helps instructors and therapists to address two key concerns of paediatric treatment programs. The first is the problem of generalization, or the transfer of newly learned skills to new environments. This is the most challenging outcome of treatment; therefore, incorporating specific strategies to maximize generalization is a significant part of intervention planning. Because VR applications are fundamentally designed to simulate real-life situations, there is a high degree of ecological validity: the degree to which the VE simulates the real environment<sup>[13]</sup>.

**Methods**

The systematic review followed the PRISMA guidelines for conducting systematic reviews. A comprehensive search was conducted in electronic databases, including PubMed, Online Journals, Google Scholar, and ResearchGate, to identify relevant articles. The following keywords were used in the search: Attention deficit hyperactivity disorder (ADHD), Virtual Reality (VR), Cognition, Paediatrics, Occupational Therapy (OT), Attention. The inclusion and exclusion criteria were pre-defined to ensure the selection of studies that directly addressed the research question.

**Inclusion Criteria**

- Age (6-12) years
- Both male and female
- Guardian consent obtained
- Patient from urban area

**Exclusion Criteria**

- Children below 6 years and above 12 years
- Children having any physical and mental impairment
- Children having vision problem
- Children below IQ  $\leq 70$
- Guardian consent not obtained

Data extraction and quality assessment were performed by two independent reviewers. The selected articles were

evaluated for relevance, appropriateness, clarity, and methodology. Articles that did not meet the inclusion criteria were excluded from the review.

**Results**

The initial search yielded 250 potentially relevant articles. After eliminating duplicates and applying the inclusion and exclusion criteria, 10 studies were included in the systematic review.

The systematic literature review lead us to configure and subdivide features regarding VR in order to generate models which improve the attention process among ADHD children in multidimensional ways. The components of immersion processes must be approached from the user experience, configuring adaptations of these interdisciplinary research areas to develop interactions and imaginaries in this medium. Designing models and approaches for developing immersive environments in this medium, connecting user experience, narrative, ergonomic and cognitive factors, and expressive power, as well as technological development, are the current challenges for an emerging medium in which a theory is being developed. For this purpose, categories must be defined in order to go into depth in defining the forms of this new medium and exploring its possibilities in both creative and research approaches.

**Table 1:** Studies published between 2010 and 2022 were included in the review

SL. No.	Study/ Author	Year of publication	Research design	No. of participants	Sample character	Theme	Sub theme
1	Saeideh Goharinejad et.al	2022	Systemic Review	2378	ADHD	Evaluation of the studies on the use of VR, AR, and MR technologies for children with ADHD.	The aim is to clarify the current knowledge about the use of these three innovative technologies for the diagnosis and treatment of children with ADHD
2	Vineeta Pandey et.al	2021	Descriptive Study	NA	Autism	Need for resources to aid in the additional professional development of occupational therapists to enable them to be active participants in VR-based SST interventions	The aim is to intend to empower occupational therapists in becoming efficient and confident in using VR technology for addressing social skills deficits in people with ASD
3	Dulce Romero-Ayuso et.al	2021	Systematic Review	125	ADHD	Effectiveness of VR-based interventions in improving cognitive performance in ADHD	This review aims to evaluate the effectiveness of virtual reality-based interventions (VR based interventions) on cognitive deficits in children with attention deficit hyperactivity disorder (ADHD).
4	Vanessa Bayo-Tallón et.al	2020	Pilot study	8	ADHD	This study reveals the clinical effectiveness and safety of the suggested MT program as well as providing preliminary data on the design's viability.	(a) to assess short-term effects and persistence of an MT program on neuropsychological (hyperactivity index through the Conners' Global Index [CGI]) and neurophysiological (time-frequency domain parameters of heart rate variability [HRV]) variables in ADHD children, and (b) to test the feasibility of the design. This study was approved by the Parc Tauli Corporation Clinical Research Ethics Board
5	Thomas D. Parsons et.al	2019	Comparative Study	NA	ADHD	Need for additional well-designed and adequately powered studies investigating the efficacy of virtual classroom CPTs for assessing attentional performance in	The objective is to address the empirical void and compare 3D virtual classroom CPTs to traditional 2D CPTs

						neurodevelopmental disorders	
6	Orkun Tahir Aran et.al	2017	Descriptive Study	NA	Paediatric, Geriatric, Adult	Benefits of using VR in different rehabilitation settings and enabling and active participation in rehabilitation, enriched environments and making rehabilitation fun are the greatest motives to use VR for rehabilitation	The aim is to focus on usage of virtual reality in occupational therapy, history and recent developments, types of virtual reality technologic equipment, pros and cons, usage for paediatric, adult and geriatric people.
7	Azadeh Bashiri et.al	2017	Narrative Review	NA	ADHD	VR technology can aid in the treatment of ADHD in children	The aim of this study was to highlight the opportunities for VR in the rehabilitation of children with ADHD
8	Bibi Leila Hoseini et.al	2014	Review Survey	NA	ADHD	Children with ADHD who struggle to function at home and in school may benefit greatly from early detection and treatment.	The study is to determine the need of behavioral interventions to deal with symptoms.
9	Rosa Angela Fabio et.al	2014	Analytical Study	280	ADHD	The findings show an impairment in the executive processes since it takes the people with ADHD longer to alter their focus when the environment is inconsistent.	The aim of this work is to analyse the three dimensions of attention, namely vigilance, selectivity and orienting in ADHD
10	ANNA EK et.al	2013	Qualitative approach and semi-structured interview	12	ADHD	The findings demonstrate how people with ADHD can develop coping mechanisms to increase their independence when performing daily tasks.	To determine how adults with ADHD can find strategies to become more independent in their performance of everyday activities

## Conclusion

The systemic review provides relevant results for scientific advancement in the design and implementation of new VR-based interventions. VR-based interventions were effective in improving cognitive performance in ADHD, such as sustained vigilance, which showed a decrease in omission. The new VR-based interventions should allow graduating these cognitive and social demands according to the age of the child and the deficits severity; and new studies should include follow-up measures to determine if the improvement is maintained over time. All of these recommendations will help researchers and clinicians to design studies and tools with greater ecological validity. Our analysis into the reported issues and limitations of VR systems also yielded interesting results, with problems pertaining to cost, training and software and hardware usability accounting for much of the data. Particularly prevalent was the occurrence of software usability issues; occurring nearly twice as frequently as most of the other issue reported. Several authors also reported that students found the implementations to be insufficiently realistic, and claimed that this was a result of the limited time and resources available to them. Future research should therefore investigate the application of design hypotheses such as the Uncanny Valley, or utilize alternatives to computer graphics to provide increased realism, such as spherical immersive (360°) video.

Given the currently available data, it appears that the literatures is supporting the effectiveness of virtual Reality in improving attention in children with ADHD. So, it is concluded that a proper study will give positive outcomes on children with ADHD.

**Conflict of Interest:** The authors declare no conflicts of interest.

**Data Availability:** Data sharing is not applicable to this article as no new data were created or analysed in this systematic review.

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