

# The Role of Virtual Reality in Enhancing Motor Skills in Children: A Systematic Review

## El papel de la realidad virtual en la mejora de las habilidades motoras de los niños: una revisión sistemática

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**Abstract.** This research aims to analyze how virtual reality (VR) can enhance movement skills in children. We employed a systematic review model, searching for relevant articles in databases such as PubMed, Web of Science, and ScienceDirect. The search keywords included "virtual reality," "child," "social," and "motor skills." This study's inclusion criteria were articles focused on "virtual reality," "children with motor disorders," and "motor skills," published within the last five years (as of 2019). Articles from less well-known journals were excluded. We identified eight articles that met the inclusion criteria and were suitable for systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards. The findings indicate that VR plays a significant role in improving motor coordination abilities in children. Responses to VR interventions were overwhelmingly positive, showing reductions in physical, cognitive, and emotional stress. Therefore, VR proves to be a valuable tool for physiotherapists and physicians treating children with motor delays. However, some considerations need to be addressed. A few parents have raised concerns about the high costs and the substantial space requirements associated with VR setups.

**Keywords:** virtual reality, motion disorders, motor, technology, children

**Resumen.** Esta investigación tiene como objetivo analizar la implicación de la realidad virtual (VR) en la mejora del movimiento en los niños. Esta investigación utiliza un modelo de revisión sistemática. La estrategia utilizada fue la búsqueda de artículos en bases de datos de búsqueda como PubMed, Web of Science y ScienceDirect. Las palabras clave de esta búsqueda son realidad virtual, infantil, social, motricidad. Este estudio tiene criterios de inclusión: Los artículos incluidos en esta revisión sistemática son sobre "realidad virtual", "niños con trastornos motores" y "habilidades motoras" y han sido publicados en los últimos cinco años (a 2019)". Si bien los criterios de exclusión como artículos publicados en revistas menos conocidas identificamos solo ocho artículos que cumplían con los requisitos de inclusión o varios artículos que podían revisarse sistemáticamente siguiendo los estándares de Informes de elementos para revisiones sistemáticas y metaanálisis (PRISMA). que la realidad virtual tiene un papel importante en la mejora de las capacidades de coordinación motora. Los niños muestran una respuesta positiva después de recibir la realidad virtual, lo que puede reducir el estrés físico, cognitivo y emocional. Por lo tanto, la realidad virtual es útil para los fisioterapeutas y médicos que tratan a niños que experimentan retrasos motores. Pero hay algo que hay que tener en cuenta, hay algunos padres que se quejan de que los costes son bastante elevados y el espacio bastante grande.

**Palabras clave:** realidad virtual, trastornos de movimiento, motor, tecnología, niños.

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### Introduction

Technology is now deeply integrated into human life; its continuous evolution has brought forth significant innovations such as virtual reality (VR) (Lyapina et al., 2019; Ahmadpour et al., 2024). VR is an interactive technology that replicates real-world environments on a computer, offering users a richly immersive and interactive experience (Shao et al., 2023; Shoshani, 2023; Yildiz et al., 2024; Alvarez-Falcón et al., 2024). Recent studies have increasingly explored VR's potential as both a playful tool and a therapeutic option for children with movement, social, and emotional disorders (Settimo et al., 2023). It has also gained popularity in educational settings due to its engaging nature (Turdaliyev et al., 2024).

Delays in movement skills are recognized as a significant issue, particularly in children (Lawson et al., 2021; Wick et al., 2017). These delays must be proactively addressed as they can hinder children's ability to engage in activities with their peers, ultimately affecting their social interactions and development (Vanhala et al., 2024). In developed countries, it is estimated that between 6% and 13% of children suffer from motor coordination delays (Guo, Guan, & Yan, 2021). Such conditions often lead to

decreased activity levels and difficulties in movement. Fundamental movement skills, which begin to develop in early childhood and continue to evolve through late childhood, are crucial for understanding children's overall growth and development (Gandotra et al., 2020).

One effective method for addressing mobility issues is through training with VR. The use of VR has been shown to enhance movement skills in children (Storli, Sandseter, & Lorås 2024). Existing research has demonstrated the effectiveness of VR in improving children's balance, motor function, and daily activities (Komariah et al., 2024). This evidence underscores the significant role of VR in promoting movement development, highlighting the importance of VR involvement in enhancing movement capabilities. While VR contributes to the development of movement, more specific studies are needed to gather precise information. This opens up opportunities to discuss and evaluate the impacts of VR through systematic reviews, deepening our understanding of its potential benefits.

Although VR technology has been extensively covered in previous research, this study specifically focuses on consolidating existing information regarding the use of VR to improve movement skills in children. This will serve as a valuable guide for future researchers in this field.

## Method

This study conducted a systematic review in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Page et al., 2021), as illustrated in Figure 1. The inclusion criteria for articles considered in this review were: the focus on "virtual reality," "children with motor disorders," and "motor skills," with publications dating from the last five years (as of 2019). Meanwhile, the exclusion criteria involved rejecting articles published in less well-known journals.

A total of 615 articles obtained from the Web of Science, PubMed, and ScienceDirect databases were successfully identified. Finally, a total of eight articles that satisfied the inclusion requirements, or at least a certain portion of them, were selected for systematic review.

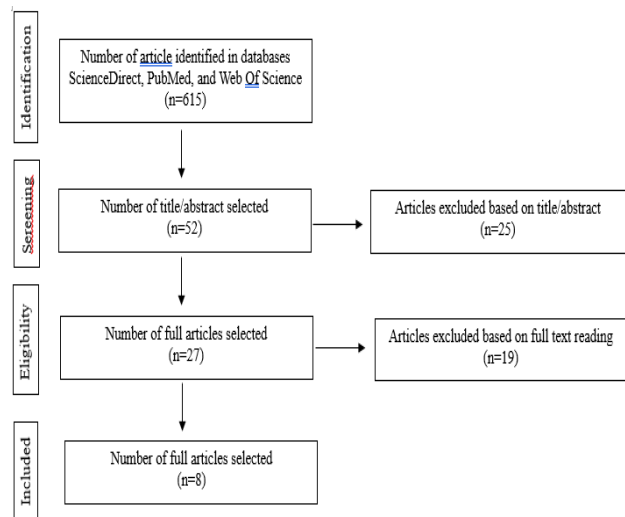


Figure 1. Article selection flowchart

## Results

The research results in the literature review are presented in Table 1.

Table 1  
Results of research on VR involvement in improving children's motor skills

Author	Age	Sample Size	Study Objectives	Findings/Results
(Bailey et al. 2019)	4–6 Year	VR (n= 12 women and 14 men) TV (n= 13 women 13 men)	The aim of this research was to determine how immersive technology such as VR can influence children's engagement with familiar character content compared to two-dimensional TV media, which is less immersive.	The research results showed that children have different cognitive and social responses to content based on the technology they use. Herein, 92.00% of children enjoyed the VR experience and 88.46% of children in case of the TV condition reported that the game was considerably enjoyable. Children who used TV yielded better results than children who had TV with inhibitory control. Children who used VR technology yielded better results than TV in terms of children's social compliance.
(EbrahimiSani et al. 2020)	7–10 year	40 girls with developmental coordination disorders	This study aimed to determine the effect of VR training on children with developmental coordination disorders	The results of the study showed that the VR group improved significantly compared with the control group in case of hand rotation performance (faster), and the VR group improved significantly in terms of three components total time on target (TOT), consecutive time on target (CTT), and distance from target (DT) compared with the control group. However, there was no significant difference in walking distance among the two groups. From the findings it can be said that VR appeared to be an appropriate training tool to be applied in the home environment for children with motor coordination disorders
(Kamel and Basha 2021)	7–14 Year	Xbox Group (n=17), TOT (n=16), Control Group (n=17)	Evaluating Xbox Kinect, TOT in pediatric hand burns, in improving hand functions such as activity satisfaction, range of motion, grip strength, and pinch strength.	Significant differences in the Xbox and TOT groups in terms of Duruoz hand index (DHI) scores and Canadian Occupational Performance Measure (COPM) satisfaction (p<0.05). However, there were no significant differences between the Xbox and TOT groups with Jebsen-Taylor Hand Function Test (JTHFT) scores, activity performance, grip strength, and range of motion (ROM) (p>0.05). The Xbox and TOT groups experienced greater improvements than the control group on all outcomes.
(Basha et al. 2022)	10–16 Year	Xbox group (n=20) and control group (=20)	Testing the impact of Xbox Kinect on cardiopulmonary fitness, muscle strength, lean body mass, quality of life, and enjoyment in children with severe burns	Xbox training exhibited a significant increase in cardiopulmonary (p<0.001), and a significant increase in fat marker body mass (p<0.001). Meanwhile, the control group exhibited a

			after hospital discharge.	significant increase in cardiopulmonary ( $p=0.002$ ) and lean body mass ( $p<0.001$ ). The Xbox group reported significant improvements, whereas the Control group did not. In these findings, no side effects were reported during treatment in both groups.
(Flores-Gallegos, Rodríguez-Leis, and Fernández 2022)	6,9–10,9 Year	11 children	To explore the effects of VR game training on children with reading learning disability (RLD), focusing on the effects on reading ability, balance, gross motor coordination, spatial attention, and self-perception.	There was a significant effect in case of the experimental group when performing attention tasks on the movement speed, coordination, and balance; the control group indicate no changes. No significant changes in reading ability were observed.
(Park et al. 2022)	8–13 Year	35 children	Aimed to determine the effect of a VR training program based on cognitive and social skills on the motor coordination of children with intellectual and developmental disabilities (IDD).	The cognitive function and social skills-based virtual reality exercise system (CS-VR) intervention group showed significant improvements in motor coordination such as (extended horizontal jump, hop, and overarm throw) following cognitive function and social skills-based VR training. Children who were provided interventions that were tailored to the individual's level of cognitive function and social skills exhibited a positive effect in terms of increasing motor coordination for movements of varying complexity.
(Hocking et al. 2022)	10–17 Year	9 men 1 girl	To determine the feasibility of using the GaitWayXR intervention to improve the motor skills of children and adolescents with autism spectrum disorder (ASD)	The acceptance results showed that the majority of young participants understood and would continue to play at home. However, parents had different views as they did not want to adopt VR for therapy owing to costs and space requirements. VR intervention did not show significant results on motor skills, unless the variables mentioned above were controlled. Certain considerations need to be made such as key stakeholders (children, doctors, service providers and others).
(Lee and Jin 2023)	7–12 Year	11; control group 12; experimental group	To determine changes in children who undertook a VR-based physical activity program in motor skills, particularly locomotor skills and physical activity levels, in children with developmental disabilities.	The results of the study showed that the intervention provided positive and significant changes on the locomotor scale and the gross motor index, which increased from 3.2 to 11.3. Ball skills also improved but not that significantly. For physical activity, both groups experienced a significant increase following the intervention. Children with developmental disorders can be trained by implementing a VR-based physical activity program.

## Discussion

This study aimed to analyze literature concerning the use of Virtual Reality (VR) to enhance motor movement in children. The goal was to provide an overview and references for implementing this technology in therapeutic settings for children with motor disorders. The review revealed that children responded positively to VR, experiencing minimal physical, cognitive, social, and emotional stress (Gerçeker et al., 2020; Salimi-Jazi et al., 2024; Wong et al., 2020). Additionally, incorporating VR with Xbox and TOT training significantly improved motor performance, particularly in motor coordination and locomotor skills. Overall, the use of technology—including VR, Xbox, and TOT games—has shown great potential in enhancing motor skills and physical activity among children with developmental and motor disorders (Kamel & Basha, 2021).

Several previous studies have highlighted the advantages of game-based VR over non-game applications such as VisuALL, particularly in adult populations (Alvarez-Falcón et al., 2024). Additionally, VR technology has been found

suitable for preschool children due to its engaging and fun nature, which facilitates prosocial learning through virtual scenarios (Shoshani, 2023). Children with HCP have demonstrated improvements in hand function, balance, functionality, and daily activities after participating in VR programs (Roostaei et al., 2023). It has also been observed that using VR before entering the treatment room yields better results than using it within the treatment room (Kaya & Karaman Özlü, 2023). Furthermore, studies have shown that anxiety levels during training with SpeakApp-Kids are lower compared to control group conditions (Sülter, Ketelaar, & Lange 2022).

The use of VR is recognized as a motivating, satisfying, and entertaining tool for children (García-Pazo et al., 2023). It offers the convenience of use at home, eliminating the need to go outside. VR has advanced significantly in educational technology, particularly in facilitating movement exploration for children with disabilities (Hocking et al., 2022). Without VR, children experiencing movement delays may become isolated from their peers

(Vanhala et al., 2024). VR technology, operable via a computer in real time, can control and enhance the understanding of movement skills (Nègre et al. 2023; Yan et al. 2024). This period is critical for children to master movement skills, which are essential for engaging in other sports activities.

The findings in this review conveyed the pivotal role of current technologies such as VR as a supportive tool for children with movement delays. By using VR, children can practice their movement skills indoors and are encouraged to initiate movements independently. VR is also invaluable in physiotherapy for treating children with movement delays. However, considerations such as the cost and the space required for setting up VR systems are significant concerns for parents and must be addressed in future research. Given the remaining unanswered questions and the potential of VR, further research is highly recommended to explore these areas more deeply.

## Conclusions

The use of VR has proven to be highly important for improving motor skills in children, particularly those experiencing movement delays. It is well-suited for home environments, making it a valuable tool for physiotherapists and doctors treating such children. This systematic review highlights the effectiveness of VR in these therapeutic contexts. However, the requirement for a fairly large space to use VR can be a challenge for some families. For future research, we recommend a more in-depth review that includes searching for additional keywords and gathering information from various databases such as ERIC, EB-SCO (SPORTDiscus and Psychology & Behavioral Sciences Collection), and other relevant sources. Moreover, further studies are needed to explore VR's role in enhancing children's movement skills more comprehensively.

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## Conflict of interests

There is no conflict of interest

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