**Effect of Virtual Reality on Upper Extremity Function in Children With Cerebral Palsy: A Meta-analysis**

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**Title**

The title of the study effectively conveys key elements of the research, including the intervention, outcome, population, and study design. It clearly indicates that the study is a meta-analysis but does not explicitly state that it is a systematic review. While meta-analyses are typically part of systematic reviews, the title could be adjusted to make this clearer by explicitly including "systematic review and meta-analysis."

**Introduction**

This systematic review enhances previous research by including additional studies and offering a comprehensive evaluation of virtual reality (VR) interventions on upper extremity function in children with cerebral palsy. It not only incorporates new studies but also calculates effect sizes and classifies outcomes using the ICF model. Furthermore, it examines key factors influencing VR effectiveness, such as the child's age, the VR system used, and the therapy setting.

**Methods**
Eighteen studies, including RCTs and case studies, met the inclusion criteria. Key variables such as intervention duration, therapy intensity, and VR type were analyzed. Pre-intervention scores were used for case studies, while RCTs were assessed using Cohen’s d to compare VR and conventional therapy. Meta-regression and subgroup analyses explored factors influencing effect sizes, including age, CP type, and intervention dosage.

**Results**

This Meta-Analysis included 14 research articles, 3 Randomized Controlled Trials and 11 Case Series. The effectiveness of VR on UE fuction in the 3 RCTs showed a statistical significance in comparison with Conventional therapy. The VR effect was also strong in children in Pre and Post-VR Intervention. In addition, VR at home or laboratory setting was more effective than in a clinic setting and the use of Engineer-built System had a strong effect than Commercially Systems.

**Discussion**

Virtual reality interventions can improve upper extremity function in children with CP. Meta-analysis showed that VR therapy was effective compared to conventional therapy. The best results were achieved with home-based or laboratory training, especially with engineer-designed systems, although these are expensive. Younger children benefited more from VR than older ones, supporting the importance of early rehabilitation. Small sample sizes and varying methods are limitations, and further research is needed. Large-scale studies are recommended, particularly home-based VR interventions for young children.

**Our own critical thinking and thoughts**

The meta-analysis provided promising evidence that virtual reality can improve upper extremity function in children with cerebral palsy, but several limitations must be considered. Only 3 out of 14 studies included in the meta-analysis were randomized controlled trials, all with small sample sizes and varying methodological quality. The use of highly heterogeneous and sometimes non-validated outcome measures weakens the comparability and reliability of results. Furthermore, although home-based VR showed strong effects, access to high-quality, engineer-built systems may not be feasible for all families, raising concerns about equal access to care. These factors highlight the need for more rigorous, large-scale studies to confirm the effectiveness and practical applicability of VR interventions in pediatric rehabilitation.

**References**

Yu-ping Chen, Shih-Yu Lee & Ayanna M. Howard 2014. Effect of virtual reality on upper extremity function in children with cerebral palsy: a meta-analysis. Pediatric Physical Therapy 26 (3): 289-300. DOI: 10.1097/PEP.0000000000000046. Referred to 2.4.2025.