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Effectiveness of robotic exoskeletons for improving gait in children with cerebral palsy: A systematic review

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1. Introduction

Robotic exoskeletons have been developed to assist locomotion and address gait abnormalities in children with cerebral palsy (CP) [1,2]. These wearable assistive devices provide powered assistance to the lower-extremity joints, as well as support and stability. Previous systematic reviews evaluating the effectiveness of robotic exoskeletons to improve gait in children with CP have predominately focused on studies which involved robotic-assisted gait training (RAGT) [3–6]. These studies measured gait outcome parameters pre-and post-RAGT intervention and not the direct effect of the exoskeleton on gait. To complement previous systematic reviews, this review focused solely on studies which assessed gait during robotic exoskeleton walking.

2. Research question

Does exoskeleton-assisted walking improve gait in children with CP?

3. Methods

The PRISMA guidelines were used to conduct this systematic review [7]. Articles were obtained in a search of the following electronic databases: Embase, CINAHL Complete, PubMed, Web of Science and MEDLINE in May 2020. Studies were screened independently by two researchers (M.H. & L.E.). Only studies investigating spatiotemporal, kinematic, kinetic, muscle activity and/or physiological parameters during exoskeleton-assisted walking in children with CP were included. All articles were assessed for methodological quality using an adapted version of the Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group, provided by NIH [8].

4. Results

Eleven studies, from two research groups, were included [1,2,9–17]. They involved the use of the following exoskeletons: tethered knee exoskeleton, untethered ankle exoskeleton, WAKE-Up ankle module and WAKE-Up ankle & knee module. Methodological quality varied, with key limitations in sample size and allocated time to adapt to the exoskeleton. There was a consensus that robotic exoskeletons improve gait, given careful optimisation of exoskeleton torque and sufficient exoskeleton practice time for each participant. Improvements in gait included reduced metabolic cost of walking [9,10], increased walking speed [9,12], and increased knee and hip extension during stance [1, 13–16]. Furthermore, exoskeletons with an actuated ankle module were shown to promote normal ankle rocker function [2,11,17].

5. Discussion

Robotic exoskeletons have the potential to improve the mobility of CP children, and therefore increase community participation and improve quality of life [18]. However, the transfer of these exoskeletons to the daily clinical practice has not occurred yet. More work is needed to demonstrate the effectiveness of these devices in improving gait. Future research should involve larger controlled intervention studies utilising robotic exoskeletons to improve gait in children with CP. These studies should ensure sufficient exoskeleton practice time for each participant.

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