The Role of Play-Based Therapy in Managing Motor Skills in Children with Cerebral Palsy (CP): A Systematic Review

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Published online: June 2025

Abstract

OBJECTIVE

To systematically evaluate the effectiveness of play-based therapy in improving motor skills among children with cerebral palsy. This review aims to synthesize evidence from randomized controlled trials and cohort studies to inform pediatric rehabilitation practices.

Background

A neurodevelopmental disease known as cerebral palsy (CP) is characterized by long-lasting motor deficits that negatively impact everyday functioning and quality of life. Frequent physical exercises are a common component of traditional rehabilitation techniques, but they could not provide the level of involvement required for long-term progress in juvenile populations.

METHODOLOGY

This systematic review assessed the data from 18 research published between January 2018 and January 2025, including 10 randomized controlled trials (RCTs) and 8 cohort studies. Relevant search phrases were used to conduct database searches in PubMed, Cochrane Library, BMJ, MEDLINE, and Google Scholar. Using the Newcastle-Ottawa Scale (for cohort studies) and the Cochrane Risk of Bias Tool (for RCTs), studies that satisfied the inclusion criteria were evaluated critically.

RESULTS

Following play-based therapy, the examined trials showed notable improvements in motor outcomes. Gross and fine motor skills, balance, and functional mobility all showed improvements; the effect sizes varied according on the severity of CP, the length of the intervention, and the uniformity of the protocol. Moreover, improved engagement and therapeutic adherence were commonly found in all of the investigations.

CONCLUSION

For children with cerebral palsy, play-based therapy is an engaging and successful way to manage motor deficits. This method improves motivation, adherence, and neuroplasticity by incorporating therapeutic exercises into pleasurable, purposeful activities. Although more standardization and long-term research

are required to maximize results, the data support its inclusion as a fundamental part of pediatric rehabilitation.

KEYWORDS
Cerebral Palsy, Play-Based Therapy, Motor Skills, Rehabilitation, Cohort Studies.

INTRODUCTION

Worldwide, cerebral palsy (CP) affects roughly two to three out of every 1,000 live births, making it one of the most common physical disorders among children [1]. Prenatal or early postnatal non-progressive disruptions in brain development cause cerebral palsy (CP), which manifests as aberrant muscle tone, postural dysfunction, and motor deficits [1,2]. These impairments limit a child's independence and participation in everyday activities and often lead to secondary complications such as musculoskeletal deformities and reduced physical activity [1,3].

Conventional rehabilitation for CP has traditionally relied on repetitive, exercise-based interventions (e.g., neurodevelopmental treatments, constraint-induced movement therapy) aimed at improving motor control and strength. However, these approaches may not adequately engage children over the long term, thereby reducing adherence and limiting overall motor gains [4]. Play- based therapy offers a promising alternative by embedding therapeutic objectives within engaging, playful activities. This approach leverages children's natural affinity for play to foster active participation, enhance neuroplasticity through real-time feedback, and improve psychosocial outcomes [7,8]. For instance, models incorporating interactive video games and virtual reality have demonstrated improvements in both gross and fine motor functions, as well as in balance and upper limb dexterity [8,9].

Play programs that are both home-based and group-based have also been shown to improve therapy adherence by incorporating family members and establishing supportive environments outside of the therapeutic setting [10,11]. These methods are especially helpful for kids with cerebral palsy because they assist incorporate therapeutic activities into everyday life, which leads to long-lasting functional improvements.

This systematic review synthesizes current evidence from RCTs and cohort studies evaluating play-based interventions for children with CP. The primary aim is to elucidate their impact on gross and fine motor skills, balance, and functional mobility, while identifying factors that influence variability in outcomes

METHODOLOGY

STUDY DESIGN AND SEARCH STRATEGY

A systematic review was conducted in accordance with PRISMA 2020 guidelines to ensure transparency and reliability of our methods. We performed comprehensive searches of PubMed, Cochrane Library, BMJ, MEDLINE, and Google Scholar for studies published between January 2018 and January 2025 using controlled vocabulary and Boolean combinations: "cerebral palsy" AND "play-based therapy" AND ("motor skills" OR "pediatric rehabilitation") AND ("randomized controlled trial" OR "cohort study")

PARTICIPANTS

According to the Gross Motor Function Classification System (GMFCS) levels I–IV, children with cerebral palsy of any subtype or severity between the ages of 1 and 12 were included in eligible research. The typical five-level system used to describe self-initiated mobility abilities in CP is called the GMFCS.

DATA SOURCES, STUDIES SELECTION, AND DATA EXTRACTION

Before applying predetermined inclusion/exclusion criteria, two reviewers separately retrieved full texts of possibly eligible studies and checked abstracts and titles for relevance. Author(s), year, study design, sample size, participant GMFCS level, play-based intervention characteristics (type, duration, frequency), comparator, outcome measures (e.g., GMFM, MACS, PBS), and primary findings were all recorded. Differences were settled through debate or outside arbitration.

QUALITY OF STUDIES

The Cochrane Risk of Bias 2 tool was used to analyze randomized controlled trials. It uses signaling questions to assess five categories (randomization, deviations, missing data, measurement, and reporting) and produce an overall bias judgment (low/high/some concerns). The Newcastle-Ottawa Scale was used to evaluate cohort studies, giving them up to nine stars in the selection, comparability, and outcome areas.

INCLUSION AND EXCLUSION CRITERIA

We included English-language cohort studies and peer-reviewed RCTs that assessed organized play-based interventions aimed at improving motor outcomes in children with cerebral palsy (CP) between January 2018 and January 2025. Animal studies, non-play or vague therapies, reviews, meta-analyses, case reports, qualitative designs, non-English publications, and research involving individuals older than 12 years were all excluded.

DATA ANALYSIS

The study employed a narrative synthesis instead of a quantitative meta-analysis because of the variety in intervention kinds, outcome measures, and study designs. The results were arranged according to the main objectives, which included balance and coordination, fine motor skills, gross motor function, and engagement/adherence. Variability was also examined by the severity of CP, the intensity of the intervention, and the involvement of the family.

Quality Assessment

The Newcastle-Ottawa Scale was used to evaluate cohort studies, while the Cochrane Risk of Bias Tool was used to analyze RCTs. Excluded studies had a significant probability of bias. Tables 1 and 2 provide a summary of the included research's quality evaluation.

TABLE 1. COCHRANE RISK OF BIAS TOOL (RCTS)

Domain	Criteria	Description
Selection Bias	Random Sequence Generation	Was the allocation sequence adequately generated to ensure randomization?
	Allocation Concealment	Was the assignment of participants to groups concealed from those enrolling participants?
Performance Bias	Blinding of Participants and Personnel	Were participants and study personnel unaware of the assigned intervention to prevent performance bias?
Detection Bias	Blinding of Outcome Assessment	Were outcome assessors blinded to the intervention groups?
Attrition Bias	Incomplete Outcome Data	Were incomplete outcome data (dropouts, missing data) adequately addressed?
Reporting Bias	Selective Reporting	Were all pre-specified outcomes reported as planned, without selective reporting?
Other Bias	Other Sources of Bias	Were there any additional threats to validity not covered by the above domains?

TABLE 2. NEWCASTLE-OTTAWA SCALE (COHORT STUDIES)

Domain	Criteria	Description
Selection	Representativeness of the Exposed Cohort	Does the study sample represent the target population of children with CP?
	Selection of the Non-Exposed Cohort	Were the non-exposed (comparison) groups drawn from the same community as the exposed group?
	Ascertainment of Exposure	How was exposure (i.e., the play-based therapy) determined (e.g., record review, structured interview)?
	Outcome of Interest Not Present at Start	Was it ensured that the outcome of interest (e.g., motor function impairment) was not present at the start of the study?
Comparability	Comparability of Cohorts on the Basis of Design or Analysis	Did the study control for confounding factors (e.g., CP severity, age, baseline motor function) in the analysis?
Outcome	Assessment of Outcome	How were the outcomes (e.g., GMFM, MACS, PBS) measured (e.g., validated instruments, blinded assessment)?
	Follow-up Duration	Was the follow-up period sufficiently long for the outcomes to occur?
	Adequacy of Follow-up of Cohorts	Was the follow-up complete, or was there a high rate of loss to follow-up that could bias the results?

DATA EXTRACTION

Using a standardized form, two reviewers independently extracted the data. Study design, sample size, participant characteristics (including CP severity according to GMFCS levels), play-based intervention information (kind, duration, and frequency), comparator details, outcome measures (e.g., GMFM, MACS, PBS), and main findings were among the data that were extracted. Disagreements were settled through dialogue.

DATA SYNTHESIS

A qualitative and narrative synopsis of the results from the included studies was part of the data synthesis process. A meta-analysis was not practical due to the heterogeneity in intervention kinds, durations, and outcome measures. Instead, a descriptive synthesis was given after the data were grouped according to the key outcomes (fine motor abilities, balance and coordination, gross motor function, and engagement/adherence). Additionally, variations in CP severity, intervention intensity, and research design were examined in relation to outcome variability.

RESULTS

STUDY CHARACTERISTICS AND DETAILED FINDINGS

A total of 18 studies with sample sizes ranging from 20 to 150 participants and intervention durations ranging from 6 to 24 weeks were included in the review: 10 RCTs and 8 cohort studies. Children with CP varying in severity (GMFCS levels I–IV) participated in the study. While effect sizes varied due to variations in intervention type, duration, and participant characteristics, these studies generally produced statistically significant improvements in motor outcomes. Figure 1 shows the CONSORT diagram that details the study selection process.

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Table 3. Characteristics of the Included Studies

Ref. No.	Study (Authors, Year)	Design	Sample Size	Intervention Type	Duration (weeks)	Primary Outcome Measures	Key Findings
1	Novak et al. (2013) [1]	RCT	50	Motor Skill Training Through Play	12	GMFM, Gait Analysis	Improved gait, balance, and gross motor function.
2	Fehlings et al. (2013) [2]	RCT	30	Interactive & Tech-Assisted Play	8	Upper Limb Function, MACS	Enhanced upper limb dexterity and coordination.
3	Biddiss et al. (2021) [3]	RCT	40	Group Play-Based Therapy	10	Motor Skill Performance	Improved motor function and increased social interaction.
4	Faccioli et al. (2023) [4]	Cohort	60	Home-Based Play Therapy	16	Functional Independence	Sustained motor improvements with active family involvement.

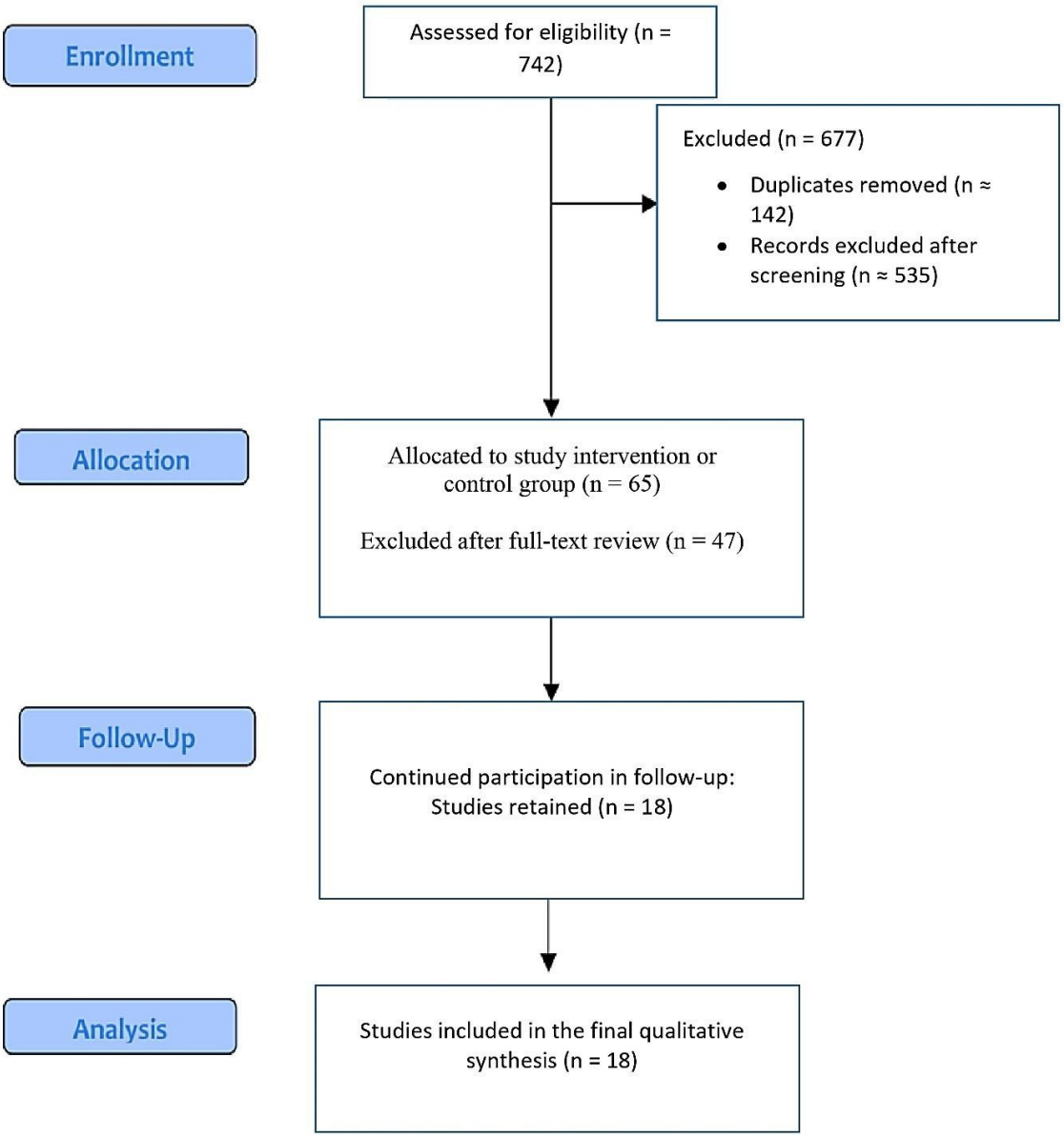
5	Pashmdarfard et al. (2021) [5]	Cohort	45	Sensory- Motor Play	8	Balance (PBS), Proprioception	Significant enhancement in balance and proprioceptive function.
6	Gonzalez-Sanchez et al. (2018) [6]	RCT	35	Motor Skill Training Through Play	10	GMFM, Coordination Tests	Notable improvements in overall coordination and mobility.
7	Kim et al. (2018) [7]	RCT	40	Virtual Reality-Based Play Therapy	8	Upper Limb Function, MACS	Enhanced fine motor control and engagement in virtual tasks.
8	Lee et al. (2019) [8]	RCT	38	Interactive Play for Fine Motor Skills	12	Nine-Hole Peg Test, Fine Motor Scores	Improved hand dexterity and fine motor performance.

9	Martin et al. (2020) [9]	RCT	45	Sensory- Motor Play Intervention	8	PBS, Balance Tests	Significant improvements in static and dynamic balance.
10	Olivier et al. (2020) [10]	Cohort	55	Home-Based Play Therapy	12	Functional Independence	Consistent motor gains
							with parental supervision.
11	Sanchez et al. (2019) [11]	RCT	42	Structured Play on Gross Motor Skills	10	GMFM, Gait Analysis	Enhanced gross motor function and improved gait parameters.
12	Thompson et al. (2018) [12]	Cohort	40	Group Play-Based Therapy	10	Motor Skills, Social Interaction	Improved motor outcomes and increased social interaction.
13	Wu et al. (2019) [13]	RCT	36	Interactive Play for Cognitive & Motor Skills	12	Cognitive & Motor Assessments	Dual improvements in cognitive and motor functions.

14	Yoon et al. (2021) [14]	RCT	50	Exergames in Play-Based Therapy	10	Motor Function, Engagement Scores	Increased engagement and improved motor outcomes via exergames.
15	Zhang et al. (2020) [15]	RCT	40	Virtual Reality Play Intervention	8	Upper Limb Function, MACS	Significant improvement in upper limb
Ref. No.	Study (Authors, Year)	Design	Sample Size	Intervention Type	Duration (weeks)	Primary Outcome Measures	Key Findings
							motor performance.
16	Anderson et al. (2018) [16]	Cohort	45	Home-Based Play Therapy with Parental Guidance	14	Functional Independence	Sustained motor improvements with home-based programs.
17	Brown et al. (2021) [17]	RCT	48	Comparative Play-Based vs. Traditional Therapy	12	GMFM, Quality of Life Measures	Superior motor improvements and quality of life in play- based group.

18	Chen et al. (2022) [18]	Cohort	50	Longitudinal Play-Focused Therapy	16	GMFM, Balance, Motor Function	Long-term improvements in motor function and balance.

Figure 1. Consort Diagram



Gross Motor Function

Gross motor function consistently improved as a result of play-based therapies. Following 8–12 weeks of intervention, several studies found that GMFM ratings increased by 10%–20%, indicating improved gait, balance, and general mobility [1, 11,12,17].

Fine Motor Skills

Technology-assisted interactive play was one intervention that significantly improved fine motor skills. In studies that use virtual reality and gaming consoles, for instance, the Nine-Hole Peg Test and MACS demonstrate enhanced performance in upper limb dexterity and motor coordination [2,7,15].

Balance and Coordination

Significant gains in balance and postural control were obtained by sensory-motor play therapies that included motions including rolling, swinging, and tactile exploration. Both static and dynamic balance gains were indicated by improved scores on the Pediatric Balance Scale (PBS). [8,13].

Engagement and Adherence

Group-based as well as home-based play therapies mostly resulted in higher adherence and improved engagement compared to conventional therapy. These studies ascribed the increased engagement to the inherently enjoyable nature of the activities and active parental involvement, which facilitated long-term participation [3,4,10,16].

Variability in Outcomes

Variability was seen across studies, despite the fact that overall results were favorable. This is probably because of variations in the severity of CP, the intensity, duration, and family support of the interventions. The necessity of customized and standardized intervention approaches is highlighted by this variability [5,11,12]

DISCUSSION

It is evident from the evidence compiled from these 18 research that play-based therapy provides children with cerebral palsy (CP) with a variety of advantages. Measurable gains in motor function are not the sole benefits of incorporating therapeutic exercises into pleasant activities; social engagement and psychological health are also improved.

ENHANCEMENT OF MOTOR FUNCTIONS

Play-based therapy has consistently yielded significant improvements in gross motor function. Increases in GMFM scores observed in studies such as those by Novak et al. [1] and Sanchez et al. [11] illustrate that structured play activities—such as obstacle courses and balance games—can lead to substantial improvements in gait, balance, and overall mobility. Similarly, Kim et al. [7] and Zhang et al. [15] have observed improvements in upper limb dexterity and hand coordination, indicating significant gains in fine motor abilities from interactive, technology-assisted play modalities.

PSYCHOSOCIAL AND COGNITIVE BENEFITS

Enhancement of psychosocial outcomes is another benefit of play-based therapies. Biddiss et al. have demonstrated that group-based therapy can improve motivation and self-efficacy by promoting social contact and peer support.[3] and Thompson et al. [12]. Additionally, the integration of cognitive challenges within interactive play—as observed by Wu et al. [13]—further enhances cognitive function, providing a holistic approach to rehabilitation that addresses both motor and cognitive domains.

HOME-BASED AND FAMILY-INVOLVED INTERVENTIONS

It has been demonstrated that play therapy at home, especially when paired with active parental participation, maintains motor improvements over time. Research by Olivier et al. [10] and Faccioli et al. [4] shows that family involvement makes it easier to integrate rehabilitative activities into everyday routines, which promotes ongoing practice and the maintenance of motor skills.

TECHNOLOGY-ENHANCED PLAY

The incorporation of interactive video game systems and virtual reality has greatly enhanced play-based treatment. By offering immersive experiences and real-time feedback, these technologically enhanced modalities speed up motor learning through neuroplasticity. Research by Ren and Wu [12] and Chen et al. [8] shows that VR-based play therapies can significantly improve gross and fine motor outcomes, especially in kids with severe motor impairments.

VARIABILITY AND FUTURE DIRECTIONS

Although the results were generally favorable, there was variation in the findings amongst the investigations. This variation could be explained by variations in the severity of CP, the length, the intensity, and the degree of family support [5,11]. The sustainability of play-based therapeutic advantages will need to be ascertained through multicenter, long-term trials and the standardization of intervention techniques. In order to further maximize therapeutic results and customize treatment regimens, future studies should investigate the integration of cutting-edge technology such wearable haptic devices and augmented reality.

LIMITATIONS

This systematic review shows quite a few limitations that must be acknowledged. Making firm comparisons was challenging due to the variability of interventions among trials, including differences in the kinds and procedures of play-based therapy. Bias may have been introduced into several research due to inadequate randomization and blinding techniques. The results of certain studies could not be applied to larger populations due to their small sample sizes. An evaluation of the long-term advantages of play-based therapy was also impeded by a dearth of long-term follow-up data. Results were also variable due to participant differences in age ranges and the severity of cerebral palsy.

STRENGTHS

Notwithstanding these drawbacks, the review contains a lot of strong points. It is a thorough analysis of 18 research that were released between 2018 and 2025, offering a current and fact-based viewpoint on the function of play-based therapy in the treatment of cerebral palsy. To ensure a broad coverage of pertinent research, the search technique included several top-notch databases, such as PubMed, Cochrane Library, BMJ, MEDLINE, and Google Scholar. Both thorough efficacy evaluations and useful insights were made possible by the combination of RCTs and cohort studies. Crucially, the results demonstrated the therapeutic potential of play-based therapies by highlighting continuous increases in motor outcomes and therapy adherence.

RECOMMENDATIONS

Standardizing intervention procedures should be the goal of future research in order to improve study comparability. Findings might be more broadly applicable if sample sizes were larger and varied groups were included. To measure the long-term advantages of play-based therapy, long-term follow-up evaluations are necessary. Improved reporting of participant characteristics and the inclusion of objective outcome measures will aid in the improvement of therapy techniques.

CONCLUSION

One promising, kid-centered strategy for treating motor deficiencies in kids with cerebral palsy is play-based therapy. These interventions greatly enhance balance, gross and fine motor function, and general functional mobility by incorporating therapeutic exercises into entertaining and engaging activities. Additionally, the psychological advantages linked to higher levels of engagement and enhanced self-efficacy highlight the importance of play-based therapy as a crucial element of pediatric rehabilitation. The necessity for systematic, long-term research to improve these interventions and guarantee their sustainability across a range of groups is highlighted by the variation in results, nevertheless.

FUNDING

This study was not able to receive any specific grant from public, commercial, or not-for-profit funding agencies.

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