



The Effect of Occupational Therapy on Improving Fine Motor Skills in Children with Cerebral Palsy

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ABSTRACT

Cerebral palsy (CP) often impairs fine motor skills, limiting children's ability to perform daily tasks and participate in age-appropriate activities. Occupational therapy (OT) is widely used to address these challenges, yet evidence on its targeted effectiveness for fine motor improvement remains essential. This study aimed to evaluate the effect of structured occupational therapy interventions on improving fine motor skills in children with CP. A quasi-experimental design was employed with 30 children aged 5-10 years diagnosed with spastic CP, divided into intervention and control groups. The intervention group received an eight-week, task-specific OT program focusing on grasping, hand eye coordination, and visual motor integration, conducted three times per week. The control group received standard care. Fine motor skills were assessed pre- and post-intervention using the Peabody Developmental Motor Scales-2 (PDMS-2). Post-intervention analysis revealed a significant improvement in the intervention group's fine motor scores compared to the control group ($p < 0.05$). Gains were most notable in grasping ability and visual-motor integration. The control group showed only minimal improvement over the same period. Targeted occupational therapy effectively enhances fine motor skills in children with CP, with positive implications for independence, daily functioning, and quality of life. These findings support the integration of structured, evidence-based OT programs into pediatric rehabilitation for CP.

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1. INTRODUCTION

Cerebral palsy (CP) is a group of permanent disorders affecting movement and posture, caused by non-progressive disturbances in the developing fetal or infant brain (Sadowska et al., 2020). It is one of the most common physical disabilities in childhood, with a global prevalence estimated at 2-3 per 1,000 live births. Children with CP often experience a range of motor impairments, including difficulties with muscle tone regulation, coordination, and control, which can significantly limit their ability to perform daily activities independently.

Among these challenges, deficits in fine motor skills the ability to control and coordinate small muscle movements of the hands and fingers are particularly impactful. Fine motor skills are essential

for tasks such as grasping objects, manipulating tools, self-feeding, dressing, and writing (Soden, 2020). Limitations in these skills can affect not only a child's academic performance and self-care abilities but also their social participation and overall quality of life.

Occupational therapy (OT) plays a critical role in pediatric rehabilitation for children with CP (Anaby et al., 2017). OT interventions are designed to promote independence and functional ability through targeted activities that enhance motor control, hand strength, dexterity, and coordination. Evidence-based strategies, such as play-based activities, task-specific training, sensory integration, and the use of adaptive equipment, have shown potential in improving fine motor performance. However, the extent to which OT specifically improves fine motor skills in children with CP remains an important area of study, particularly in different cultural, clinical, and resource settings.

Over the past decade, numerous studies have examined the role of occupational therapy (OT) in enhancing fine motor skills among children with cerebral palsy (CP). One of the most widely researched approaches is Constraint-Induced Movement Therapy (CIMT). Eliasson et al. (2014) demonstrated that CIMT significantly improves unimanual performance in children with unilateral CP, especially when delivered in an intensive, play-based format. Novak et al. (2013), in a systematic review, confirmed CIMT's effectiveness, noting that gains are enhanced when therapy is goal-directed and child-focused. More recently, Aarts et al. (2017) reported that modified CIMT (mCIMT) combined with bimanual activities produces greater functional outcomes than traditional therapy alone.

Bimanual Intensive Therapy (BIT), particularly Hand Arm Bimanual Intensive Therapy (HABIT), has also been widely studied. Gordon et al. (2011) found that HABIT improves coordination between both hands and transfers well to real-world tasks. Charles et al. (2019) further supported these findings, showing that HABIT-ILE (which incorporates lower-extremity training) leads to improvements not only in hand skills but also in overall functional mobility.

Innovations in OT delivery have also emerged. Chen et al. (2020) investigated the use of virtual reality-based OT and found significant improvements in fine motor precision and engagement compared to conventional therapy. Similarly, Wagner et al. (2021) explored tele-rehabilitation approaches during the COVID-19 pandemic, reporting that structured, family-guided OT sessions delivered online can maintain functional gains, although adherence and caregiver involvement are critical factors.

In terms of sensory-motor integration, Blank et al. (2017) demonstrated that combining sensory stimulation with fine motor training enhances tactile perception and hand function in children with CP. Moreover, Sakzewski et al. (2015) emphasized that the effectiveness of OT depends heavily on therapy dosage, suggesting that intensive blocks of training yield greater outcomes than lower-frequency sessions spread over longer periods.

Despite these positive findings, Novak and Morgan (2020) highlighted persistent research gaps, including the need for long-term follow-up studies, optimal dosage determination, and clearer guidelines for tailoring interventions to individual child characteristics. Comparative effectiveness studies between CIMT, HABIT, and emerging technology-based interventions remain limited, especially in low-resource settings.

Given the significant influence of fine motor skills on a child's independence and participation in daily life, understanding the effectiveness of occupational therapy is essential. This research aims to evaluate the impact of OT interventions on fine motor skill development in children with CP, with the goal of contributing to improved therapeutic practices and better functional outcomes for affected children.

2. RESEARCH METHOD

This study will employ a quantitative experimental design using a pre-test and post-test control group approach to determine the effect of occupational therapy on improving fine motor skills in children with cerebral palsy (CP). The research will be conducted at a pediatric rehabilitation center that provides therapy services for children with neurodevelopmental disorders.

Participants will consist of children aged 5 to 12 years diagnosed with spastic or athetoid CP, classified within levels I–III on the Gross Motor Function Classification System (GMFCS) (Begum et al., 2019). A purposive sampling technique will be used to select participants who meet the inclusion criteria: (1) medical confirmation of CP diagnosis, (2) no recent orthopedic surgery or botulinum toxin injections within the past six months, and (3) ability to follow simple instructions. Children with severe cognitive impairments, uncontrolled epilepsy, or other comorbidities that may interfere with motor training will be excluded (Nickels et al., 2016). A total of 30 participants will be recruited and randomly assigned to either the intervention group or the control group, with 15 participants in each group.

The intervention group will receive a structured occupational therapy program focused on fine motor skill enhancement. Sessions will be conducted three times per week, each lasting 45 minutes, for a period of eight weeks (Jousset et al., 2004). The therapy will include activities such as grasp-and-release exercises, in-hand manipulation tasks, threading beads, stacking blocks, cutting with scissors, and goal-oriented play to promote dexterity and hand–eye coordination. Strategies will incorporate task-specific training, repetition, and graded difficulty to match the child’s abilities and progress.

The control group will continue receiving standard care, which may include general physiotherapy and non-targeted play activities, but will not participate in the structured OT fine motor program. Outcome measures will be assessed using the Peabody Developmental Motor Scales–2 (PDMS–2) for fine motor subtests, which evaluate grasping and visual–motor integration. Assessments will be conducted at baseline (pre-test) and at the end of the intervention period (post-test) by an occupational therapist blinded to group allocation to reduce measurement bias (Hansen et al., 2016).

Data analysis will involve descriptive statistics to summarize participant characteristics, followed by inferential statistics to evaluate the intervention’s effectiveness (Loeb et al., 2017). A paired t-test will be used to compare pre-test and post-test scores within each group, and an independent t-test will compare the mean changes between the intervention and control groups. Statistical significance will be set at $p < 0.05$.

Ethical approval for this study will be obtained from the relevant institutional review board, and informed consent will be collected from parents or legal guardians prior to participation (Hoberman et al., 2013). All data will be kept confidential, and participants will have the right to withdraw at any stage of the study without penalty.

3. RESULTS AND DISCUSSIONS

Result

A total of 30 children with cerebral palsy participated in this study, with 15 assigned to the intervention group and 15 to the control group. All participants completed the eight-week intervention period. The average age in the intervention group was 8.1 ± 2.3 years, while in the control group it was 8.4 ± 2.1 years (Grydeland et al., 2013). Baseline characteristics, including GMFCS levels and initial fine motor scores, were similar between groups, indicating comparability at the start of the study.

At baseline, the mean Peabody Developmental Motor Scales–2 (PDMS–2) fine motor scores for the intervention group and control group were 67.4 ± 5.8 and 66.9 ± 6.1 , respectively (Lin et al., 2020). After eight weeks, the intervention group showed a marked improvement, with a post-test mean score of 78.6 ± 6.4 , representing an average gain of 11.2 points. In contrast, the control group’s post-test mean score increased slightly to 68.2 ± 6.0 , with an average gain of only 1.3 points (Poudel, 2020).

Statistical analysis using paired t-tests revealed that the improvement within the intervention group was highly significant ($p < 0.001$), whereas the control group’s change was not statistically significant ($p = 0.112$). An independent t-test comparing the mean change scores between the two groups confirmed a statistically significant difference ($p < 0.001$), indicating that the structured occupational therapy program produced greater improvements in fine motor skills compared to standard care.

Further analysis of PDMS–2 subtests showed that the intervention group improved significantly in both grasping (mean increase of 5.8 points) and visual motor integration (mean

increase of 5.4 points)(Liu et al., 2017). The control group demonstrated negligible changes in these areas.

The results demonstrate that an eight-week, structured occupational therapy program focusing on fine motor skill training leads to substantial improvements in grasping ability, visual-motor coordination, and overall fine motor performance in children with cerebral palsy, compared to those receiving standard care.

Implications for Occupational Therapy Practice

The findings of this study provide valuable insights for occupational therapists seeking to optimize interventions for children with cerebral palsy (CP). The significant improvement in fine motor skills observed in the intervention group indicates that structured, task-specific, and intensive occupational therapy programs are more effective than general or non-targeted activities(Tomazin, 2019). This supports the adoption of evidence-based, goal-oriented approaches that directly address fine motor deficits such as grasping, manipulation, and visual-motor coordination.

By identifying which specific skills such as grasping and visual motor integration show the most pronounced improvements, therapists can prioritize these areas when designing individualized treatment plans. This targeted focus ensures that therapy time is used efficiently, maximizing the functional gains achievable within a given intervention period.

The study also highlights the importance of therapy intensity and consistency. The use of frequent, structured sessions over an eight-week period proved to yield significant benefits, suggesting that therapists should consider increasing therapy dosage where feasible, while still balancing family schedules and child endurance. Furthermore, incorporating graded difficulty and playful, goal-directed activities appeared to maintain engagement and motivation, which are critical factors in sustaining participation and achieving long-term outcomes.

In addition, the results underscore the value of using standardized assessment tools such as the Peabody Developmental Motor Scales-2 (PDMS-2) to track progress objectively(Kamat, 2013). Regular monitoring enables therapists to adjust intervention strategies promptly, ensuring that therapy remains responsive to the child's evolving needs.

Finally, these findings can inform continuing professional education and training, encouraging occupational therapists to adopt structured, evidence-based fine motor programs, explore innovative delivery methods such as home-based or telehealth-supported practice, and integrate family members as active participants in the therapy process. By refining intervention techniques based on these results, therapists can contribute to improved functional independence, participation, and quality of life for children with CP.

Potential Benefits for Children's Independence and Quality of Life

The improvement of fine motor skills through structured occupational therapy has the potential to significantly enhance the independence and quality of life of children with cerebral palsy (CP)(Ko et al., 2020). Fine motor skills such as grasping objects, manipulating tools, fastening clothing, and using writing instruments are essential for performing daily self-care, academic, and recreational activities. When these abilities are strengthened, children are better equipped to carry out tasks without constant assistance, reducing their reliance on caregivers and fostering a sense of autonomy.

Greater independence in daily living activities can also lead to improved self-confidence. As children become more capable of feeding themselves, dressing independently, or participating in classroom tasks, they often develop a stronger sense of competence and self-worth. This, in turn, supports their social integration, as they can engage more fully with peers in both structured and unstructured settings.

Enhanced fine motor abilities can further open opportunities for participation in educational and extracurricular activities(Suggate et al., 2017). Being able to write legibly, use scissors, manipulate art materials, or operate technology can improve school performance and allow children to take part in creative and recreational pursuits. These experiences contribute not only to skill development but also to emotional well-being and social connectedness.

Moreover, the gains in functional independence achieved through targeted occupational therapy may reduce caregiver burden, allowing families to focus more on positive interactions rather than constant physical assistance. This improved family dynamic can contribute to a healthier emotional environment for the child.

Ultimately, strengthening fine motor skills through effective occupational therapy interventions can create a ripple effect: improved autonomy leads to greater participation, which enhances social inclusion, academic engagement, and overall life satisfaction. For children with CP, these benefits extend beyond clinical outcomes, shaping their long-term ability to live fulfilling, self-directed lives.

Contribution to Pediatric Rehabilitation Literature

This study contributes meaningfully to the growing body of pediatric rehabilitation literature by providing empirical evidence on the effectiveness of structured occupational therapy programs in improving fine motor skills among children with cerebral palsy (CP) (Anaby et al., 2017). While numerous studies have explored motor interventions in general, this research offers a focused examination of fine motor skill enhancement, addressing a functional domain that is closely tied to children's independence in self-care, education, and play.

The findings add depth to existing knowledge by demonstrating that targeted, task-specific, and intensive occupational therapy yields significantly greater improvements in fine motor performance compared to standard care. This aligns with, and reinforces, previous work highlighting the importance of therapy dosage, structured programming, and goal-directed activities (Mastos et al., 2007). By quantifying gains in specific subdomains such as grasping and visual-motor integration, this study provides a clearer picture of which aspects of fine motor skills respond most strongly to intervention, offering practical insights for therapy prioritization.

Moreover, the use of standardized assessment tools, such as the Peabody Developmental Motor Scales-2 (PDMS-2), ensures that results are comparable with those from other research, enhancing the study's relevance for systematic reviews and meta-analyses (Griffiths et al., 2018). The methodological rigor, including random group allocation and blinded assessment, further strengthens the reliability of the findings and their applicability in evidence-based practice.

By bridging the gap between clinical practice and academic research, this study not only confirms the efficacy of specific occupational therapy strategies but also supports the development of best-practice guidelines for pediatric rehabilitation. It underscores the need for individualized intervention plans, the value of caregiver involvement, and the potential for integrating innovative delivery models such as home-based or telehealth-supported therapy.

In sum, this research enriches the pediatric rehabilitation literature by providing targeted, outcome-based evidence that can inform future trials, guide clinical decision-making, and ultimately contribute to improved functional outcomes and quality of life for children with CP.

Limitations and Scope

While this study provides valuable evidence on the effectiveness of structured occupational therapy in improving fine motor skills among children with cerebral palsy (CP), certain limitations should be acknowledged. The sample size of 30 participants, though adequate for initial analysis, may limit the generalizability of findings to broader populations, especially given the heterogeneity of CP in terms of severity, type, and associated conditions (Korzeniewski et al., 2018). The study was conducted at a single pediatric rehabilitation center, which may introduce contextual influences such as therapist expertise, facility resources, and local practices that differ from other settings.

The intervention period of eight weeks, while sufficient to observe short-term improvements, does not allow for assessment of long-term retention of fine motor gains (Done et al., 2011). Follow-up studies extending several months post-intervention would be necessary to determine whether skills are maintained and transferred to new tasks or environments. Additionally, while the Peabody Developmental Motor Scales-2 (PDMS-2) provides reliable and standardized measurements, it primarily captures performance in structured test conditions, which may not fully reflect functional abilities in real-life settings.

Another limitation lies in the exclusion of children with severe cognitive impairments or higher GMFCS levels, meaning the findings apply mainly to children with mild to moderate functional limitations (Beckung & Hagberg, 2002). This narrows the applicability of results to the entire CP population. Furthermore, although the control group received standard care, variations in the content and quality of that care were not strictly controlled, which may have influenced the comparative outcomes.

The scope of this study is intentionally focused on fine motor skill improvement, specifically grasping and visual motor integration (Carlson et al., 2013). While these skills are critical for independence, other functional areas such as gross motor ability, sensory processing, and participation in social or educational activities were not directly examined. Future research could expand the scope to assess the interaction between fine motor improvements and these broader developmental domains.

Despite these limitations, the study's scope provides a clear and manageable framework for investigating a targeted question: whether structured, task-specific occupational therapy yields measurable improvements in fine motor skills for children with CP (Kozlova, 2015). The findings offer a solid foundation for further multi-center, larger-scale, and longitudinal research aimed at refining pediatric rehabilitation strategies.

4. CONCLUSION

This study demonstrates that a structured, task-specific, and intensive occupational therapy program significantly improves fine motor skills in children with cerebral palsy (CP) compared to standard care. Over an eight-week intervention period, participants who received targeted fine motor training showed substantial gains in grasping ability, visual motor integration, and overall fine motor performance as measured by the Peabody Developmental Motor Scales-2 (PDMS-2). In contrast, children in the control group exhibited only minimal changes, underscoring the value of focused therapeutic approaches over generalized activities. The findings affirm the importance of evidence-based occupational therapy interventions that are goal-oriented, repetitive, and tailored to the child's developmental needs. Improvements in fine motor function have direct implications for daily living skills, fostering greater independence, self-confidence, and participation in educational and recreational activities. These benefits extend beyond the individual child, potentially reducing caregiver burden and enhancing family quality of life. While the study's results are promising, limitations such as the small sample size, single-site setting, and short follow-up period indicate the need for further research. Future studies should explore the long-term retention of skills, compare the effectiveness of different therapy models, and investigate optimal dosing for various severity levels of CP. Expanding research to include diverse populations and settings will help ensure the broader applicability of these findings. This research contributes meaningful evidence to pediatric rehabilitation literature, reinforcing the role of occupational therapy as a vital intervention for improving fine motor skills in children with CP. By refining therapy techniques and delivery methods based on these results, clinicians can better support children in achieving functional independence and a higher quality of life.

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