Pediatric Cerebral Palsy and Activities of Daily Living: Rapid Systematic Review

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Key Words

- evidence-based practice
- activities of daily living
- self-care
- occupational therapy
- cerebral palsy
- intervention

Cerebral palsy (CP) is a common motor disability seen in children who often receive occupational therapy (OT) services. Because of this, there is an increased need for research on new clinical, group, and home-based OT interventions. OT practitioners play a critical role in providing developmental interventions to improve upper extremity function, balance, and motor processing for activities of daily living (ADLs), including self-care tasks and functional mobility. In order to assist OTs in making informed decisions regarding developmental interventions to improve performance, participation, and independence in ADLs for children aged zero to eighteen with CP, a rapid systematic review (RSR) was completed and includes the best available evidence within the reviewed literature. The findings of this review support functional training, education, technology, and supplemental modalities as interventions to improve performance in ADLs of children with CP. Overall, this review works to provide leading evidence supporting the use of various interventions in OT sessions

Focused Clinical Question

The purpose of this review was to systematically search the literature in order to critically appraise and consolidate the relevant studies within the past 10 years to address the following focused clinical question: What is the effectiveness of developmental interventions for improving activities of daily living (ADL) for children ages zero to eighteen years old with cerebral palsy (CP)? Within these relevant studies selected, the interventions focused on improving functional mobility, self-care tasks, and hand function in children with CP.

Statement of Problem and Background

CP is a group of non-progressive neuromuscular disorders that can affect a child's ability to move and interact with their environment and limit their ability to participate in their

occupations (Vulpen, Groot, Rameckers, Becher, & Dallmeijer, 2018; Hsin et al., 2012). According to the Centers for Disease Control and Prevention (CDC), "CP is caused by abnormal brain development or damage to the developing brain…" and the brain damage can happen "before birth, during birth, within a month after birth, or during the first years of a child's life…" (Centers for Disease Control and Prevention [CDC], 2019, p. 1). Furthermore, there are several types of CP, which are classified based on the body parts affected, movement affected and the severity of the symptoms. These include spastic CP, dyskinetic CP, ataxic CP and mixed types (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2016). Spastic CP is the most common form of the condition, which involves stiff and rigid muscles resulting in jerky movements. Forms of spastic CP are named based on body parts affected and include spastic hemiplegia, diplegia and spastic quadriplegia. Spastic hemiplegia involves stiff muscles on one side of the body, such as in the individual's arm, hand and sometimes leg. Spastic hemiplegia is highly represented in the literature by research subjects aged zero to eighteen in studies that aim to address effectiveness of occupational therapy (OT) interventions for improving ADLs. Although the information gathered from these studies is of value, there continues to be a lack of evidence for the effectiveness of interventions for children with dyskinetic, ataxic, and mixed types of CP (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2016).

The CDC's Autism and Developmental Disabilities Monitoring (ADDM) Network estimates that about 1 in 323 children are diagnosed with CP (CDC, 2019). Currently, it is estimated from studies around the world that children are born with CP in 1.5 to over 4 per 1,000 births (CDC, 2019). With CP being the most common motor disability (CDC, 2019) and there being a lack of evidence with interventions with various types of CP (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2016), there is an increased need for research on new clinical, home-based, and group OT interventions including constraint-induced movement therapy (CIMT), bimanual training, web-based and Wii Fit technology interventions, KinesioTaping (KT), aquatic therapy, parent education, child focused vs. context focus approach, goal-directed functional training, and group therapy interventions. OT practitioners play a critical role in providing developmental interventions to improve hand function, balance and motor processing in performance of activities of daily living. According to the Occupational Therapy Practice Framework, "ADLs are activities oriented toward taking care of one's own body" (American Occupational Therapy Association [AOTA], 2013, p. S19). ADLs include bathing, showering, toileting/toilet hygiene, dressing, swallowing/eating, feeding, functional mobility, personal device care, personal hygiene and grooming, and sexual activity. Because children with CP typically have many deficits that impact their coordination and movement (Abd El-Kafy, Elshemy, & Alghamdi, 2014), these deficits can cause "... impairments of grasping and finger-tip force control and impact on participation in homes, school, community life, and daily activities such as feeding, dressing, and grooming…" (Abd El-Kafy, Elshemy, & Alghamdi, 2014, p.11). This topic has implications for assisting occupational therapists (OTs) in making informed decisions regarding developmental interventions to improve performance in ADLs for children with CP and consequently improve wellbeing, occupational justice, and safe engagement in ADLs within this population.

Method for Conducting the Evidence-Based Review

This systematic review examined studies that focused on developmental interventions for children with CP and if these interventions improved the children's independence in ADLs. This topic was created by an OT and selected by students on an interest-basis for a research project at the graduate level. The systematic review was conducted by first year doctoral OT students studying at Indiana University. The search process was guided by a medical librarian, and an OT with research expertise. The research collected was agreed upon as the best available evidence to answer the focused clinical question. There are a variety of intervention strategies that OT practitioners can utilize for children with CP. This review focuses on the best interventions, as well as new approaches that can be implemented in practice that concluded the best results for this patient population. Evidence-based practice and research is a critical part of the OT profession when implementing treatment strategies and client-centered therapy. The research found consisted of multiple references for data, validity and reliability. Research is then categorized into levels of research. Within OT, evidence-based research combined with clinical expertise constructs science-driven interventions for the best outcomes for the patient.

The databases that were used to conduct this Rapid Systematic Review were PubMed and CINAHL through the Indiana University Ruth Lilly Medical Library. Pedmed is a free research site that consists of peer reviewed biomedical and life sciences topics through the National Institutes of Health (NIH). CINHAL is a database that includes articles about nursing, allied health, biomedical and healthcare topics. Our search terms listed below were created with a medical librarian, Rick Ralston to generate the most accurate and relevant evidence related to intervention strategies for children with CP to improve self-care tasks and ADLs.

The goal of this search was to surface and compile the best available evidence for the effectiveness of developmental interventions for children with CP. Once screened through covidence and appraised for

methodological quality, the data of these research articles was extracted and presented in an evidence table. See Appendix A.

Table I: Search terms

Database	Key Search Terms
PubMed	(Occupational Therapy[MeSH] OR "Occupational Therapy" OR (occupation* AND therapy) OR rehabilitation OR "Activities of Daily Living"[Mesh] OR "Activities of daily living" OR "Occupational Therapist")) AND ("cerebral palsy"[MeSH Terms] OR ("cerebral"[All Fields] AND "palsy"[All Fields]) OR "cerebral palsy"[All Fields]OR CP)) AND ("Self Care"[Mesh]OR "self care" "Activities of daily living" [MeSH] OR "Activities of daily living" OR ADL OR ADLs)) AND "last 10 years"[PDat])) AND ((Infant OR infant* OR newborn OR newborn* OR new-born* OR baby OR baby* OR babies OR neonat* OR perinat* OR postnate* OR child OR child*[TIAB] OR schoolchild* OR schoolchild OR school child OR school child* OR kid OR kids OR toddler* OR adolescent OR adoles* OR teen* OR boy*[TIAB] OR girl* OR minors OR minors* OR underag* OR under ag* OR juvenil* OR youth* OR kindergar* OR puberty OR puber* OR pubescen* OR prepubescent* OR prepuberty* OR pediatrics OR pediatric* OR paediatric* OR pediatric* OR schools OR nursery school* OR preschool* OR pre school* OR primary school* OR secondary school* OR elementary school* OR elementary school OR high school* OR highschool* OR school age OR school age OR school age* OR schoolage* OR infancy OR schools, nursery OR infant, newborn)
CINAHL	((((((Occupational Therapy OR "Occupational Therapy" OR (occupation* AND therapy) OR rehabilitation OR "Activities of Daily Living" OR "Activities of daily living" OR "Occupational Therapist")) AND ("cerebral palsy" OR ("cerebral"[All Fields] AND "palsy"[All Fields]) OR "cerebral palsy"[All Fields]OR CP)) AND ("Self Care" OR "self care" "Activities of daily living" OR "Activities of daily living" OR ADL OR ADLs))

Additional research was pulled from the Case-Smith's *Occupational Therapy for Children and Adolescents* (2020) textbook. There were several articles within the chapters of this pediatric textbook that met the criteria of our focused clinical question and were selected for review.

Inclusion criteria for this review included original research within the last 10 years, children (0-18), a diagnosis of CP, focus on ADLs or functional performance of the children, and from English speaking countries. The countries in our original search included the USA, Canada, Sweden, Australia, New Zealand, Netherlands, UK, Norway, Denmark, and Ireland. However, due to lack of evidence from these English speaking countries, an exception was also made to include the best available evidence from the countries of Korea, Taiwan, Brazil, and Turkey. Exclusion criteria included adults, conditions aside from CP, research older than 10 years, and studies outside of the selected countries. An additional limit while searching databases included selecting only peer-reviewed published journal articles within the last 10 years. Initially, we searched for all randomized controlled trials; however, lack of evidence meeting our inclusion criteria required us to include both Level II and III research studies in our final selection. After searching through the 418 article results from the databases, the articles that met the inclusion criteria and related to the clinical question were then selected and imported into a web-based software program, Covidence. Through this program, the articles were double screened, first on title and abstract and then by full text. Once the articles were fully screened, the 30 best available articles were selected and extracted to be appraised for methodological quality using the Critical Appraisal Skills Programme (CASP) checklist. The appropriate CASP was selected according to the level of evidence, which was determined using the AOTA Evidence Hierarchy and Strength of Evidence table (AOTA, 2019). The research reviewed included evidence Levels I through III which are defined as follows:

Level I: Systematic reviews, meta-analyses, randomized controlled trials
Level II: Two groups, nonrandomized studies (e.g., cohort, case-control)
Level III: One group, nonrandomized (e.g., before and after, pretest and posttest)

The data was combined using a narrative technique, specifically intervention type, to best organize the effectiveness of different developmental interventions used to improve ADL performance in children with CP. Constraint induced movement therapy (CIMT) was an intervention frequently studied without our literature review. Within our review, nine articles focused on CIMT and two articles focused on bimanual therapy. Furthermore, two articles compared these interventions, while another two articles used them together as one intervention for the child. Four articles within the

review focused on web-based or technological interventions. Three articles focused on the supplemental modalities aquatic therapy and KT. The remaining articles in this review focused on structured interventions, education, goal-directed functional training, and context-focused interventions.

Results

A total of 30 articles were included in this rapid systematic review and provided evidence directly related to our focused clinical questions. Although the reviews included published literature from both OT and other related fields, all interventions reviewed were within the practice domain of OT. Of the 30 articles, 23 of the articles (77%) were classified as Level I evidence, 4 (13%) were classified as Level II studies, and 3 (10%) were classified as Level III studies.

Table II: PRISMA diagram of data extracted

CIMT and Bimanual Training

CIMT

There is strong overall evidence for CIMT and bimanual training as interventions for improving ADLs for children ages zero to eighteen years old with CP. CIMT is a type of therapy intervention used commonly with neurological conditions, where the non-affected arm is constrained when performing activities to help facilitate movement and participation (Eliasson, A. C., Shaw, K., Berg, E., & Krumlinde-Sundholm, L, 2011).

Level I

Four Level I RCTs had strong evidence supporting the use of CIMT therapy for children with CP. A Level I RCT investigated the effects of a home-based CIMT on motor performance and daily function in children with unilateral CP (Chen et al., 2012). There was a significantly better performance by the intervention group for motor performance and daily function. The intervention group had improved for grasping performance, fine motor performance, and daily functional hand use. Another Level I RCT studied the effectiveness of home-based CIMT on functional performance and health-related quality of life in children with spastic unilateral CP (Hsin et al., 2012). The researchers found that the intervention group improved in motor efficacy, function of the affected arm, and functional performance and quality of hand use, along with overall quality of life. Further examining CIMT within the home, was a Level I RCT comparing the difference between traditional OT and Eco-CIMT. Eco-CIMT consisted of 2 hours a day of constraining the unaffected limb while the child was at home in their natural environment (Eliasson, Shaw, Berg, & Krumlinde-Sundholm, 2011). A significant effect of Eco-CIMT was found when compared to the control period for hand use and function of the children.

An additional Level I RCT studied how an adapted version of CIMT promotes functioning in children with CP (Brandao Mancini, Vaz, de Melo, & Fonseca, 2010). The children participating in the adapted version of CIMT, immobilizing the non-affected arm all day in addition to therapy, showed improvements in functional skills and independence in ADLs. Lastly, a relatively new exploratory RCT assessed whether baby CIMT or baby massage could be used as early intervention for children with early screening of CP (Eliasson et al., 2018). Baby CIMT showed evidence of a positive influence of early development of hand function that might be useful for ADLs throughout life. The final Level I RCT focusing on CIMT alone was conducted comparing intensive OT to modified CIMT. The mitt could be worn at home, at school/preschool, or in other environments where adjunct therapy could be provided (Eliasson, Shaw, Berg, & Krumlinde-Sundholm, 2011). However, there were no clinically or statistically significant between-group differences for the COPM.

Level II

Two Level II studies were also selected as best available evidence regarding CIMT therapy. A Level II clinical cohort studied the effectiveness of ACQUIRE, a version of pediatric CIMT, included the complete full arm-to-finger restraint of the least affected upper extremity (DeLuca, Ramey, Trucks, & Wallace, 2015). The authors reported a significant effect in the addition of new movement patterns, added functional abilities, improvement in quality of movement, and increased use of impacted upper extremity in ADLs. Some children did experience loss of skills in between treatment but were able to regain skills and some even added additional skills after subsequent treatment. The final study focusing on CIMT alone, was a pretest-posttest cohort design, in which the subjects engaged in traditional OT services, followed by CIMT, and finished with traditional therapy (Lowes et al., 2014). Participants had statistically significant improvements in fine motor skills (grasp pattern, motor planning, hand-eye coordination) and gross motor skills (beginning to crawl, pull to stand) in the

affected extremity following the CIMT protocol compared to traditional rehabilitation.

Bimanual
Level I
Bimanual therapy is used to incorporate both arms when performing activities during intervention to facilitate integration and functional use of both arms together. A Level I quasi-randomized trial studied the effectiveness of hand-arm bimanual intensive therapy including lower extremity (HABIT-ILE) intervention, in children with bilateral CP (Bleyenheuft et al., 2017). The authors reported a significant improvement of perceived difficulties of bimanual tasks in ADLs. Children in the treatment group also showed improvement in functional skills, and perceived occupational performance and satisfaction in ADLs.

Level III
A Level III single group pre and posttest design studied the effectiveness of an AMC, a magic-themed HABIT, intervention (Hine, Bundy, Black, Haertsch, & Wallen, 2019). Families identified ADLs as a priority in their child's lives. After the study, parents reported an overall improvement in satisfaction and performance in ADLs. There was also an improvement in the perceived difficulties of bimanual tasks in ADLs.

Combining CIMT and Bimanual Therapy
Level I
Although several studies researched CIMT and bimanual therapy separately, three articles focused on CIMT and bimanual therapy as combined intervention. For example, a Level I RCT study compared therapy that included both mCIMT and BiT with usual care (Aarts, Jongerius, Geerdink, van Limbeek, & Geurts, 2010). This study showed that an mCIMT-BiT intervention aids in improving bimanual abilities in self-care in children with CP. In a second Level I RCT, participants with congenital hemiplegia were allocated to either a CIMT protocol or bimanual training group (Sakzewski et al., 2011). Both groups demonstrated improvements on personal care.

Level III
Further examining CIMT and bimanual therapy as a combined intervention was a Level III pretest/posttest study was conducted to examine effectiveness of combining both CIMT and bimanual training daily in a "day camp" structure, meaning the children had 36 hours of therapy over a 5 day therapy (Geerdink, Aarts, van der Burg, Steenbergen, & Geurts, 2015). Compared to baseline there were improvements in hand dexterity and overall self-perceived performance in all ADLs.

Comparing CIMT to Bimanual Therapy
Level I
In contrast to combining the therapy interventions, these articles separated CIMT and bimanual therapy to determine which intervention would yield the greatest improvements in various outcome measures. A Level I RCT intervention compared a home-based constraint-induced therapy (CIT) intervention, focused on training the more affected arm through shaping and repetitive task practice to a dose-matched home-based control intervention in which the children engaged in functional unilateral or bilateral arm training based on activities focused on function, neurodevelopmental training (NDT), and motor learning techniques (Lin et al., 2011). The children in the CIT intervention group showed improvements in motor efficacy and unilateral functional capacity as well as improvement in grasping skills and motor performance in both unilateral and bilateral functional activities. Lastly, a Level I RCT compared these two interventions and showed improvements for daily functioning outcomes for both groups (Brandao, Gordon, & Mancini, 2012). However, there were greater improvements in the HABIT group for satisfaction and performance outcomes.

While conducting this rapid systematic review, the most common intervention across the literature was CIMT. Several studies focused on the benefits of CIMT alone, while other researchers worked to combine or compare bimanual interventions to the well-established CIMT intervention. Overall, strong evidence supports both CIMT and bimanual therapy training in improving ADL performance in children with CP.

Web-Based
Level I
Moderate evidence from a Level I RCT and a Level II non-randomized controlled trial indicate that 'Move it to improve it' (Mitii), a web-based home therapy program, improves motor skills, functional use of affected upper extremity and performance of ADLs in children with CP (James, Ziviani, Ware, & Boyd, 2015). One Level I RCT investigated the effectiveness of Mitii on occupational performance, upper limb function, and visual perception in children with unilateral CP. The results indicate that ADL task performance may be enhanced, improved function of the dominant upper extremity and some improvement on the impaired upper extremity, and improvements in ADL performance and satisfaction. (James et al., 2015).

Level II
A Level II, non-randomized controlled trial focused on upper limb, lower limb and balance training by engaging participants in a Mitii program in the home. The Mitii group demonstrated significant improvements in motor skills, hand function of the affected extremity and lower extremity strength that resulted in neuroplastic changes for 12 weeks (Lorentzen et al., 2015).

Wii-Fit

Level I

Strong evidence from two Level I RCTs indicate that using the Nintendo Wii as a therapeutic intervention improves independence in ADLs and function of the affected upper extremity in children with CP. A Level I RCT conducted a study to determine the effectiveness of incorporating Wii-Fit games to the end of traditional OT in place of conventional balance training for children with CP (Tarakci, Ersoz Huseyinsinoglu, Tarakci , & Razak Ozdincler, 2016). Wii-Fit balance-based video game training was completed in the last 20 minutes of an OT session, after 30 minutes of NDT training. There were significant improvements in balance function and. In another Level 1 RCT, participants engaged in WiiSports games (basketball, boxing and tennis) in conjunction with their PT program to improve balance, equal weight shifting and function of the hemiparetic arm (Atasavun Uysal & Baltaci, 2016). There were statistically significant improvements throughout this study indicating that WiiSports is effective for improving functional balance.

KinesioTaping

Level I

Supplemental modalities, such as KT and aquatic therapy is a support to therapy that helps promote the rehabilitation process. Strong evidence from two Level I RCTs indicated that using NDT therapy along with KT, a form of modality that uses latex-free tape to enhance stability of joints, improves gross motor function, proper sitting position (ŞŞimşşek, Türkücüoğğlu, Cokal, Üstünbaşş, & ŞŞimşşek, 2011), and impacts function of self-care activities (Kaya Kara et al., 2015). While this type of intervention has not had much research associated with CP this article concluded there is evidence of improvement when administered for these children.

Aquatic Therapy

Level II

Moderate evidence from a Level II quasi-experimental prospective study indicated that aquatic therapy improves gross motor functioning skills, independence in ambulation, and participation safely while playing with peers (Lai et al., 2014). There were significant changes seen in the improvement in gross motor function and enjoyment of therapy in the intervention group. The results support that pediatric aquatic therapy for children with CP can be an effective supplement to OT.

Structured Interventions

Level I

There is moderate evidence from three Level I RCTs that structured practice interventions for children with CP improve satisfaction and performance on the COPM. However, there is weak evidence to support improved functional hand movement of the affected limb with SPG intervention. A Level I RCT studied the effectiveness of structured practice intervention (SPG), receiving skill progression and goal training while engaging in fine and gross motor bimanual activities, vs. unstructured practice interventions (UPG), received the same therapeutic activities but did not receive the skill progression and goal training (Brandao et al., 2014). The SPG and UPG groups had similar results suggesting that the use of structured practice as an intervention may not lead to improvements in dexterity, bimanual hand use, daily functioning and functional goals in children with USCP. Another Level I RCT studying the effectiveness of structured HABIT training compared to bimanual activity training, they found that both groups demonstrated significant improvements in bimanual hand use and hand dexterity. However, only the structured HABIT group showed functional improvements on the COPM (Friel et al., 2016). In an additional Level I RCT, both the SPG and UPG showed significant improvements in hand function of the affected upper extremity, while the SPG group demonstrated higher quality movements (less trunk involvement and greater movement/control of the elbow) during task practice (Hung et al., 2017).

Education

Level I

There is strong evidence from one Level I RCT that investigated how the addition of an education program for primary caregivers to conventional rehab would improve self-care and mobility in children with CP (Saquetto et al., 2018). The children in the intervention group showed significant improvements in self-care and mobility, compared to the control group receiving conventional rehab with no caregiver-education component.

Child-focused Approach vs. Context-focused Approach

Level I

There is strong evidence from a Level I RCT that studied the implementation of a child-focused approach where therapists focused on remediation of impairments and building children's skills and abilities through practice of functional activities to a context-focused approach where the treatment focused on changing the identified constraints within the task (identified using COPM) and / or environment (Law et al., 2011). The results of this study indicated that both context- or child-focused therapy interventions resulted in equivalent and significant improvements in self-care, mobility, and participation outcomes of the children

Goal-directed functional training

Level II

There is weak evidence from two Level III studies on the effectiveness of goal-directed functional training in improving participation in and performance in ADLs including functional mobility and self-care. One Level III study found that functional-power training in a group setting significantly improved ability to participate in ADLs (Vulpen, Groot, Rameckers, Becher, & Dallmeijer, 2018). It was also determined that there was improved functional mobility in the community and significant decreased mobility limitations. Another Level III study found improved quality of movement and quality of upper extremity function after receiving intensive, goal-directed, activity-focused group-based intervention (Sorsdahl, Moe-Nilssen, Kaale, Rieber, & Strand, 2010). There were significant improvements in self-care and reduced need for caregiver's assistance in self-care and mobility.

Group Therapy

Level I

There is strong evidence from a Level 1 RCT indicating improvement of task training scores that children selected (Ko et al., 2020). While group therapy is not a common approach used within pediatric OT for children with CP, the article demonstrated that group therapy impacts participation through "healthy competition" and motivation.

Discussion

Overall, this RSR provides leading available evidence when researching in the databases, PubMed and CINAHL on the topic of intervention strategies to improve ADLs for children with CP. Our findings conclude that CIMT, bimanual training, technology based, modalities and group therapy are effective interventions. Additionally, there is moderate evidence for other approaches such as education for caregivers, client and goal-focused sessions, and group therapy which positively influence children and family members' lives. Our main findings indicate that integrating occupation-based activities, family involvement and activity-based therapy sessions increases independence in the children's' ability to complete or engage in ADLs. Our systematic review encompasses twenty-three Level I articles, which provides therapists with robust data that can be implemented into practice. Depending on the results, a therapist can make an evidence-based decision on administering treatment that will be effective and show client improvement.

Clinical Implications

The key implications for OT practitioners are that a variety of rehabilitative interventions can be used to improve motor skills, functional mobility, and improve engagement in ADLs. Additionally, it is beneficial for OTs to be aware of which rehabilitative interventions have had success while working as a supplement with NDT. OTs who are implementing NDT should consider adding the rehabilitative interventions as supplemental interventions to NDT because there is strong evidence showing an improvement in hand function and ADLs. Also, the findings are important to OTs working with children with CP in both home-based and clinical settings. At a universal level, it is important that OTs are cognizant of not only the positive results when using these rehabilitative interventions, but the low-cost benefit, so therapists may implement these when working in pediatric or home-based settings with children who are having issues engaging in functional mobility and ADLs. The low-cost benefit of these interventions presents an opportunity for OTs to work with a wider range of clients. Furthermore, implementing these interventions could result in caregivers having less responsibility for self-care of the child because of strides in functional mobility and independence. Overall, educating and training OTs to implement these rehabilitative interventions in their practice could increase the participation and independence in daily functioning of children with CP. Further research is needed to determine the effect of therapy on different diagnoses of CP in order to determine the overall clinical significance.

Limitations

One limitation within the available literature was the exclusion of children with severe impairment of the upper extremity, as most studies included children with only mild to moderate impairment. This created heterogeneity among the groups within each study. Small sample size was a limitation in several of the level one research designs due to the difficulty of recruiting children with CP. Another limitation to the pool of evidence was the lack of focus on OT and ADLs. The studies addressed interventions to improve functional mobility and self-care skills, but never specifically categorized it as an occupation within the practice framework of OT. Finally, there was a lack of research studies conducted within the United States.

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Appendix

Evidence table

Author/Year	**Level of Evidence/Study Design/ Participants/Inclusion Criteria**	**Intervention and Control Groups**	**Outcome Measure**	**Results**
Aarts, Jongerius, Geerdink, van Limbeek, & Geurts (2010) https://doi.org/10.1177/1545968309359767	Level: I RCT *N* = 50 Intervention, *n* = 28 Control, *n* = 22 *Inclusion Criteria*: Children 2.5 to 8 years with diagnosis of CP with unilateral or severe asymmetric, bilateral spastic movement impairment; Scores of I, II, or III in the Manual Ability Classification System (MACS) *Exclusion Criteria*: Those with intellectual disabilities that hindered the completion of simple tasks. Those who were unable to combine the regular school program with study protocol. Those who were unable to independently walk without the use of a walking aid.	*Intervention*: (mCIMT-BiT group) The use of modified constraint-induced movement therapy (mCIMT) for 6 weeks and then followed by 2 weeks of bimanual task-specific training (BiT). For 8 weeks, individual therapy was delivered in groups of 6 by 4 occupational therapists, 1 physical therapist and 1 therapy assistant. Therapy occurred in the afternoon for 3 hours x 3 days/week. During the mCIMT, participants' least affected arm was constrained with a sling and they were given a play sword; they were told they were pirates and that their best hand was injured. The sword was used to encourage targeted movements while singing pirate songs. The last two weeks consisted of bi-manual training without restraint .	**Primary outcomes**: Assisting Hand Assessment (AHA), ABILHAND-Kids **Secondary outcomes**: Melbourne Assessment of Unilateral Upper Limb Function, Canadian Occupational Performance Measure (COPM),Goal Attainment Scale	The intervention group showed statistically significant improvements at posttest (7 weeks) in all primary and secondary outcomes compared with the control group. The focus will be on the outcome measuring ADL. Regarding the bimanual abilities in self-care, assessed by the ABILHAND-Kids questionnaire, the mCIMT-BiT group showed a 36% improvement after the intervention at week 9 (CI = 95%), this was 7 times greater than the UC group. The mCIMT-BiT group also showed a high effect size (Cohen's *d* = 1.01). There were no significant differences between and within groups in the ABILHAND-Kids questionnaire between post-intervention (9 weeks) and the 17-week follow-

		Control: Usual care, participants received OT or PT 2x/week for 1.5 hours.		up, both groups showed a 3% improvement.
Atasavun Uysal & Baltaci (2016) https://doi.org/10.1089/g4h.2015.0102	Level I Single-blind Randomized Control Trial *Risk of Bias:* Low *Participants:* N=24, aged 6-14 years.(M age= 9.13 of control group and 10.11 of the control group. Male=42%, Female 58%) *Inclusion Criteria:* Children diagnosed with Cerebral Palsy between the ages of 6-14 years, classified as level I or II on the Gross Motor Classification System (MACS) for adequate functional hand use to use Wii remotes. Children and their families who agreed to participate in the study and signed consent forms, and children who were able to follow verbal directions.	*Intervention Setting:* Outpatient Clinic *Intervention:* received training with the NW gaming console with Wii Sports games in conjunction with their PT program, 2 days a week in 30-minute sessions, for 12 weeks. Games were played for 10 minutes each session and difficulty in the games increased every 4 weeks. Wii games played included basketball, boxing and tennis to improve balance, equal weight shifting and function of the hemiparetic arm. *Control Group:* received their regularly scheduled physical therapy program.	*Occupational Performance* Canadian Occupational Performance Measure *Functional Mobility* Pediatric Balance Scale *ADLs* Pediatric Evaluation of Disability Gross Motor Classification System Expanded and Revised	*Significant Findings:* Individuals in the NW group intervention demonstrated significant improvements in their performance in the PBS measure after 12 weeks compared to the control=.0003. Wii sports intervention is effective in regard to functional balance and COPM scores. *Non-Significant Findings:* Individuals in the NW group showed improvements in PBS and COPM scores following intervention when compared to the control group. All PEDI scores (mobility and self-care improved) except for social selection. NW intervention is not superior to traditional physical therapy programming except for functional balance.
Bleyenheuft, Ebner-Karestin, Surana, Paradis, Sidiropoulos,	Level: I	*Intervention*: PT/OT students, two OTs, and one	**Primary outcomes**: Gross Motor	The authors reported a significant effect

Renders, Friel, Brandao, Rameckers, Gordon (2017) https://doi.org/10.1111/dmcn.13379	Quasi-randomized trial N= 20 Intervention, *n* = 10 Control, *n* = 10 *Inclusion criteria*: Children aged 6 to 16 years with a diagnosis of bilateral CP in GMFCS levels II to IV. Children had to be able to understand games, follow instructions, complete testing, lift the more affected side at least 15 cm above a table surface and grasp a light object. *Exclusion Criteria*: Children who suffered from uncontrolled seizures. Any child who had orthopedic surgery or botulinum neurotoxin injections in the previous 6 months or during the study. Any child with visual problems that would hinder their ability to complete the study. Any child who was unable to walk a few steps, could use a walker.	PT provided HABIT-ILE intervention for 13 days, children received a total of 84 hours of HABIT-ILE intervention. The children also received usual OT/PT therapy at 3-month follow-up. *Control*: Usual care, PT or OT (2.8 hours/week)	Function Measure (GMFM), ABILHAND-Kids **Secondary upper-extremity outcomes**: Pediatric Evaluation of Disabilities Inventory (PEDI), Box and Blocks Test (BBT), Jebsen-Taylor of Hand Functioning (JTTHF) **Secondary lower-extremity outcomes**: ABILOCO-Kids, Pediatric Balance Scale, 6-Minute Walk Test Canadian Occupational Performance Measure (COPM)	mainly in the upper extremity outcomes ($p < 0.001$) of the ABILHAND-Kids questionnaire score. The authors noted the posttest and follow up scores were significantly higher than at the pretest. The follow up scores were higher than at the immediate posttest scores. There were no significant differences between the three scores in the control group. There was also a significant effect in the self-care domain of the PEDI($p = 0.001$). A post-hoc test indicated that the PEDI posttest and follow up scores were significantly higher than the pretest scores in the HABIT-ILE group. No difference was found in the control group.
Brandao, Ferre, Kuo, Rameckers, Bleyenheuft, Hung, Friel, Gordon (2014) https://doi.org/10.1177/1545968313516871	Level: I RCT N = 20 Intervention, n = 10 Control, n = 10 *Inclusion criteria*: Children who were	*Intervention*: Structure practice group (SPG) receive therapy that included skill progression and goal training while engaging in fine and gross motor bimanual activities.	**Primary outcomes**: Jebsen-Taylor Test of Hand Function (JTTHF), and the Assisting Hand Assessment (AHA)	The SPG and UPG groups showed similar improvements. There were no statistical differences in the outcomes measured. This study suggests

	ages 6 to 13 with a diagnosis of congenital hemiplegia. Children had to be able to follow instructions, be enrolled in mainstream school, be able to grasp light objects, and had to be able to lift the more impaired arm 15 cm above a table. *Exclusion criteria:* Children who suffered health problems that were not related to CP, had severe muscle tone, suffered from current or untreated seizures, had visual problems, if the more impaired hand had orthopedic surgery within 1 year or had botulinum toxin within the past 6 months or within the study period.	*Control*: Unstructured practice group (UPG) received the same therapeutic activities but did not receive the skill progression and goal training.	**Secondary outcomes**: Canadian Occupation Measure (COPM), Pediatric Evaluation of Disability Inventory (PEDI), and ABILHAND-Kids	that the use of structured practice as an intervention may not lead to improvements in dexterity, bimanual hand use, daily functioning and functional goals in children with USCP.
Brandao, Gordon, & Mancini (2012) http://doi.org/10.5014/ajot.2012.004622	RCT Level I study **Participants:** 16 children with hemiplegia were entered into the trial. All participants were included in the results. **Inclusion Criteria:** 1. To be included in this trial the participants needed to have a difference of at least 50% between each limb	**Intervention** The 16 participants were randomized using offsite allocation, stratified by age and severity. The participants were randomized within 2 groups, hand-arm bimanual intensive training (HABIT), and constraint-induced movement therapy (CIMT). The interventions were given for 15 days, 6 hours a day, totaling 90 hours. With 1 hours of daily exercises at home.	The study used the Canadian Occupational Performance Model (COPM) to measure functional goals in relation to performance and satisfaction scales. To determine improvement the goals needed to improve 2 or more points. The Pediatric Evaluation Disability Inventory (PEDI) to measure	**Daily Functioning Outcomes:** Before intervention, both groups were similar to the PEDI. Both groups showed improvements after intervention with PEDI, (CIMT M= 60.12, SD= 6.13; HABIT M=63.5, SD=5.01) p=.0001. This outcome did not reach significance.

	when timed on motor tasks. 2. Have the ability to extend the wrist at least 20 degrees and fingers 10 degrees from full flexion 3. Normal cognitive abilities, participating in mainstream school settings.	**Intervention 1CIMT:** Children's non affected UEs were restrained during unimanual activities with cotton slings. **Intervention 2 HABIT:** For the HABIT group there were no physical restraints used when participating in training. Training was separated in different rooms. Therapists included occupational, and physical therapists. Therapists were trained on the specific interventions. Both treatments utilized group activities, games, arts to elicit motivation. The interventions also consisted of whole-task and part-task activities.	functional skills and independence in self-care. The changes needed to be greater than 2 standard errors of measurement to qualify as significant.	**Satisfaction and Performance Outcomes:** Both groups showed improvements in performance (CIMT, M= 5.54, SD= 1.7; HABIT, M= 6.58, SD= 1.110) $p < .000$. There was data to show that there were greater improvements in the HABIT group than CIMT. **Functional Goals and Practice:** Both groups showed improvements in satisfaction. (Mean pre-post improvement for CIMT= 2.0, SD= 2.21; for HABIT =3.07 Sd= 1.88). Overall, this study showed improvements in functional and independent self-care skills with both CIMT, and HABIT. The parents of the HABIT group rated children's performance on a higher level, although CIMT group parents were satisfied with performance. The children of the HABIT group showed a greater improvement than CIMT in the category of

				functional goal performance scale.
Brandao Mancini, Vaz, de Melo, & Fonseca (2010) https://doi.org/10.1177/0269215510367974	Level I RCT Single-blinded *N* = 15 children ages 4 yr. - 8 yr. 8 mo. ~53% male, ~47% female *M* age = 5 yr. 6 mo. (intervention), 6 yr. 7 mo. (control) Intervention group, *n* = 8 Control group, *n* = 7 *Inclusion Criteria*: Medical diagnosis of spastic hemiplegic cerebral palsy and able to comprehend simple verbal commands and execute activities proposed during intervention	*Intervention* Non-affected arm was restricted for 10 hours / day while the affected arm was intensively trained for 3 hours / day for 2 weeks. *Control* Children maintained regular OT routines, receiving one treatment session of 45 minutes each week.	Measurement 1: Pediatric Evaluation of Disability Inventory (self-care domain) Measurement 2: Jebsen-Taylor test (adapted version)	The children participating in the adapted version of CIT intervention showed statistically significant impro vements in functional skills and independence in activities of daily living.
Chen, Kang, Hong, Chen, Chen, & Wu (2012) https://doi.org/10.1177/0269215512455652	Level I RCT N= 47 children ages 6 to 12 years with unilateral cerebral palsy 49% Male, 51% Female M age= 8.8 years for control group 8.7 years for intervention group	**Control:** Traditional rehabilitation 3.5-4 hours/day, 2 days/week for 4 weeks by therapist at home **Intervention:** Participants received constraint-induced therapy 3.5-4 hours/day, 2 days/week for 4 weeks by a therapist at home	**Primary Outcome Measures:** Motor performance and daily function measures: Peabody Developmental Motor Scale, Second Edition (PDMS-2) • Graspin g subscale (PDMS-G)	**Primary Outcome Results:** There was a significantly better performance and large effect for the intervention group for motor performance and daily function for both the PDMS-2 Grasping subscale, ($p < 0.001$, $n^2 = 0.59$) and for hand use ($p < 0.001$, $n^2 = 0.27$) and quality

	Intervention group, n= 24 Control group, n=23 Inclusion Criteria: 1. A diagnosis of spastic unilateral cerebral palsy 2. considerable nonuse of the affected upper limb 3. the ability to actively extend the wrist and metacarpophalangeal joints 10 degrees above neutral 4. no excessive muscle tone before the beginning of the intervention		• Visual Motor Integration subscale (PDMS-VMI) Pediatric Motor Activity Log (PMAL) Reaching Kinematics • Reaction time • Movement time (nms.) • Movement unit (nMU) • Peak velocity	of hand use ($p< 0.001$, $n^2= 0.22$) on the PMAL. For reaching kinematics, the intervention group had shorter reaction time($p< 0.001$, $n^2= 0.50$), shorter normalized movement time($p< 0.001$, $n^2= 0.33$), and higher peak velocity ($p= 0.004$, $n^2= 0.17$) than the control group. These results were significant and had large effects in favor of the intervention group. These results indicate that this intervention improved grasping performance/fine motor performance, daily function/functional hand use, and temporal and spatiotemporal control of reaching.
DeLuca, Ramey, Trucks, & Wallace (2015) https://doi.org/10.5014/ajot.2015.019323	Level: II Clinical cohort *N* = 28 Two treatments, *n* = 20 Three treatments, *n* = 8 *Inclusion Criteria*: Children with CP	*Intervention*: The implementation of ACQUIREc (a 20- or 21- day treatment over 4 weeks), a version of Pediatric Constraint-Induced Movement Therapy, included the complete full arm-to-finger restraint of the least affected upper extremity during	**Primary outcomes:** Emerging Behavior Scale (EBS), Pediatric Motor Activity Log (PMAL)	The authors reported there was a significant effect in the EBS, scale used to count the number of new upper extremity movement patterns and functional abilities (i.e., wrist extension, finger isolation, finger feeding, and pushing buttons),

	who passed the screening for suitability for pCIMT. The pCIMT screening assessed stable health, bilateral and asymmetry in functional abilities and no frequent uncontrolled seizures. Children were not excluded if they have comorbid conditions *Exclusion Criteria*: Children with fragile health conditions such as, being tube fed or being dependent on respiratory assistance.	the first 18 day. The last couple of days were used to focus on bimanual therapy activities without restraint. The upper extremity was restrained with a lightweight cast. Shaping, repetitive tasks, and prolonged periods of time are all key components of pCIMT. The data was collected from children whose parents sought out multiple pCIMT treatments over an 8-year period. .		scores in favor of pCIMT Treatment 1 ($p < 0.001$). A significant addition of new skills after Treatment 2 and Treatment 3 was also noted. The PMAL subscales (assesses 22 arm and hand activities such as holding a cup or bottle and putting an arm through a sleeve of clothing) Quality of Movement and Amount of use scores significantly improved at all three treatments. Children did experience loss of skills in between treatment but were able to regain skills and some even added additional skills after subsequent treatment.
Eliasson, Nordstrand, Ek, Lennartsson, Sjöstrand, Tedroff, & Krumlinde-Sundholm (2018) http://doi.org10.1016/j.ridd.2017.11.006	Explorative Student with randomized design : parallel-group trial Level 1 study **Participants**: N= 37 during matching N=30 accounted for in results (lost due to exclusion) **Inclusion Criteria:** 1. Age: 3-8 months of corrected age	**Intervention 1: Baby- CIMT** For 30 minutes a day, 6 days a week for 12 weeks the children received CIMT. THe non-affected arm was restrained by using a mitten or something similar. Training was conducted by the parents at home, who received education and coaching, as well as supervision by an OT. Children were to be seated upright	The study used the HAI, which was administered every 6 weeks for a total of 4 times during the full duration of the study, 18 weeks. The HAI is a standardized observation-based test for infants as risk for developing CP. The Parenting Sense of Competence Scale (PSCS) was complete	The infants who received the baby-CIMT showed better development with the Affected hand score, than the massage group. The baby-CIMT group was high, Cohen's $d = 0.64$ and $p=0.041$. The parents in the baby-CIMT group showed improvement in competence of being a parent for

	2. A ≥15% difference between the two hands assessed by the Hand Assessment for Infants 3. High risk for developing unilateral CP using Alberta Infant Motor Scale (AIMS) or Hammersmith Infant Neurological Examination (HINE)	and stable. Activities included a focus on grasping and toy exploration. **Intervention 2: Baby-massage** THe infant received a full-body massage one time each day, 6 days a week, for 12 weeks. The sessions' durations depended on the child's mood, it could last 5-30 minutes. The parents would document the massage in a diary to keep track. They also received 3 sessions for instructions by a certified instructor in baby-massage.	pre and post intervention by the parents. There were neuroimaging conducted at different points during the first year as well. This was how the brain lesions were characterized. The children were examined by a pediatric neurologist at one year of age (corrected prematurity). This examination furthered the exclusion criteria by using HINE assessment. Follow-up assessments at 18 months of age were performed using the Assisting Hand Assessment (AHA). The AHA scored how effectively children with CP use their affected hand in bimanual activities. At baseline, the AIMS was used to describe gross motor development.	fathers. (p=0.002). This therapy has shown evidence of a positive influence of early development of hand function that might be useful for later development of hand function.
Eliasson, Shaw, Berg, & Krumlinde-Sundholm (2011)	Randomized controlled crossover	Training was implemented in regular pediatric	**Assisting Hand Assessment (AHA):** Used to	A significant effect of Eco-CIMT was found

http://doi.org/10.1016/j.ridd.2011.05.024	design Level 1 study All children were involved in the study for eight months. Group 1 started with 2-months of Eco-CIMT, and Group 2 started as controls for two months. After a 4-month "washout period", there was a crossover in which the control group (Group 2) received Late Eco-CIMT and the Eco-CIMT group (Group 1) served as controls. N= 33 randomized children, 25 reached analysis, all children accounted for. **Inclusion Criteria:** Inclusion criteria for children were age 18 months to five years, any severity level of decreased hand function, ability to cooperate in the testing procedure, and parents willing to commit to the eight-week intervention procedure.	services by the child's parents or preschool teacher and supervised by the regular therapist. **Control:** Ordinary therapy treatment. Children would see a physical therapist twice a month and an occupational therapist once a month. **Experimental:** The Eco-CIMT was provided for 2 hours a day over a period of 2 months. Training took place in the child's regular environment (home or preschool). Parents or preschool teachers are responsible for carrying out the training on a daily basis. Supervision from the child's ordinary therapist takes place once a week. Education for training is provided to the parents/preschool teacher and plans are created by the regular therapist but carried out by the parents or teacher.	quantify how the hands function together, in an observation-based test design. This assessment quantifies the effectiveness of assisting hand use in performing bimanual activities. The activities were conducted by a therapist not involved in the experiment and scored by a blinded expert evaluator. **Dimensions of Mastery Questionnaire (DMQ):** The DMQ measures the child's general motivation and attitude on 45 items using a five-level rating scale in which three is the value given to typically developed children. The items are divided into seven scales: cognitive persistence, gross motor persistence, social persistence with adults and social persistence with children, mastery	when compared to the control period (both Group 1 and Group 2 included) ($p < 0.001$). The AHA-units (0–100 scale) improved for Eco-CIMT from 53(10) to 59(9) in Group 1 and from 49(20) to 56(19) for Group 2. The changes during the control period were from 61(8) to 63(7) for Group 1 and from 45(21) to 46(21) in Group 2. The estimated treatment effect was 5.47 AHA-units. This gives an effect size of 1.26. Parents' rating of their perceptions of children's mastery of behaviors deviated only slightly from norms. Ten children were within the norms on all subscales.

			pleasure and negative reactions to failure and the scale of general competence.	
Friel, Kuo, Fuller, Ferre, Brandão, Carmel, Bleyenheuft, Gowatsky, Stanford, Rowny, Bassi, Murphy, Lisanby, Gordon & Luber (2016) http://doi.org/10.1177/1545968315625838	RCT Level 1 study Children were assessed prior to treatment, within 2 days after treatment, and 6 months after treatment by a physical therapist blinding to group allocation. Interventionists, parents, children, and motor skill assessors were blind to therapy groups. N=20 children with USCP There were 10 children in each group, but 2 children did not complete the TMS mapping part of the study and were both in the structured skill group. **Inclusion Criteria:** Inclusion criteria included congenital USCP, ability to lift arms 15 cm above table surface and grasp light objects, and cognition similar to their age-specific peers in school.	All participants engaged in age-appropriate bimanual training 6 hours/day for 15 days (90 hours). In both groups activities were chosen that required use of both hands. If a child stopped using one hand during therapy, interventionists would immediately reminded the child to use both hands. **Control:** Engaged in intensive use of both hands, without focus on skill. Activities were selected based on the child's interest. Children were only instructed to use both hands. The participants did not practice functional goals or part-task practice of movement components. There were no increases in task complexity, no guidance on how to use the affected hand, and no graduation of demands. **Experimental:** Structured HABIT involved a progression of task	**Jebsen Taylor Test of Hand Function (JTTHF):** Used to assess unilateral dexterity. Participants use one hand to perform functional movements, measuring in seconds the length of completion. **Assisting Hand Assessment (AHA):** Used to quantify how the hands function together. This assessment quantifies the effectiveness of assisting hand use in performing bimanual activities. The activities are videotaped and scored by a blinded expert evaluator. **Canadian Occupational Performance Model (COPM):** Used to measure the performance and satisfaction levels in	Both groups showed significant improvements in bimanual hand use and hand dexterity. Only the structured group showed the most functional improvements on the COPM and had the largest changes in map size. There was a trend toward a significant interaction between COPM-Performance and training type (F[2, 17] = 3.2, P = .068). The structured skill group trended toward greater improvement than the unstructured group in functional use of the affected hand. There was an overall improvement in the JTTHF in the affected hand after training across all subjects a clinically meaningful amount(AHA, P< 0.05) and hand dexterity (JTTHF, P < .001). However, the structured group showed increases in the size of the

		difficulty, repeated practice of isolated movements, and practice of functional goals.	functional goals. All children set functional goals but only the structured groups practiced these goals during the intervention. **TMS Motor Mapping:** Single-pulse TMS was used to evoke movements of selected digit and wrist muscles of the affected hand to address whether training changed their motor map. Motor responses were measures with surface EMG	affected hand motor map and amplitudes of motor evoked potentials ($P<0.01$). Improvements in all measures were maintained 6 months after therapy, as there were no statistically significant changes between the immediate post training and 6 months post training measures for either group.
Geerdink, Aarts, van der Burg, Steenbergen, & Geurts (2015) http://doi.org/10.1016/j.ridd.2015.06.013	Pretest/posttest Level 3 study Children were assessed at baseline, one-week post intervention, and four months post intervention N= 20 children with UCP 2 participants were lost to follow up at four months post intervention and 1 child broke her arm and could not attend one-week post intervention **Inclusion Criteria:** had to diagnosed with unilateral CP, aged between 8-18 years, able to walk	**Experimental:** The intervention program consisted of a combination of CIMT (3 hours a day) followed by BiT (5 hours a day). During the first 3 hours, children wore their unaffected UL in a sling and worked individually or in couples while training specific unimanual skills with their affected UL. Skills were individually determined based on the COPM interview. BiT followed which consisted of part-task and whole-task training with both hands, embedded in	**Canadian Occupational Performance Model (COPM):** Assesses both subjective performance and satisfaction with performance of relevant problematic activities as experienced by the child. Selected as the primary outcome measure. **Box and Block test (BBT):** Assesses unimanual capacity for	Compared to baseline there were significant improvements on all outcome measures. The largest effect sizes were found for the COPM-performance (Cohen's d= 2.09) and COPM-satisfaction (Cohen's d= 2.42). The effect size was large for the ABILHAND-kids (d=0.86). All effects were retained at the four-month post intervention assessment. The BBT values revealed that the efficiency to grasp, hold and

	independently, able to formulate individual goals related to relevant and age-appropriate activities involving the UL, attend regular education or special education	games, regular daily activities, and activities selected as personal goals from COPM. Self-management training was also incorporated in the Bit. All children trained on average 36 hours during the one-week intervention, 5 consecutive days. The remaining 4 hours were spent on instructions, feedback, and breaks between activities.	ages 3-19. Tests gross manual dexterity as the child transports as many blocks as possible in 60 seconds from one compartment to another. **14 item Modified House Classification scale:** Used to assess unimanual function capacity. Set of 14 items based on the original MHC, a valid tool for children with unilateral CP. The child is asked to use several objects and to show its best capacity to use the affected UL handling the objects. **ABILHAND kids' questionnaire:** Used to assess bimanual functional performance. Focuses on a child's manual ability to execute 21 daily activities that require the use of the upper limbs. Items are scored on a three-level scale, as impossible, difficult, easy	release significantly increased over time as the affected hand transported more blocks per minute ($F(2,38) = 17.230$, $p < 0.001$). The 14-item MHC scale merely showed a 'small' effect of Time; positive post-intervention changes in functional capacity accumulated to a significant effect at four months post intervention ($F(2,36) = 6.079$, $p = 0.005$). Repeated measures ANOVA of time was used to determine the effectiveness of treatment. The effect size (Cohen's D) was measured as using mean scores baseline – 4 months post intervention. COPM-performance and satisfaction had a p-value of <.001.

Hines, Bundy, Black, Haertsch, & Wallen (2019) https://doi.org/10.1080/01942638.2018.1505802	Level: III Single group pre and posttest design *N* = 28 Cities: Sydney, *n* = 8 Melboume, *n* = 11 Brisbane, *n* = 9 *Inclusion Criteria*: Children aged between 7 years 6 month and 16 years who had a diagnosis of unilateral CP with predominant spasticity, attended school, could follow 2-3 step directions, were interested in learning magic, spoke and understood English, and committed to the total duration of the study (10 days of AMC and 6 additional sessions). *Exclusion Criteria*: Children who had any upper limb interventions (splinting, casting, Botulinum toxin A injections) in the past 3 months or who were expected to receive interventions in the next 6 months. Children who had previously participated in the 2014 AMCs pilot in Australia. Children who had intellectual impairments were also excluded.	*Intervention*: The use of AMC, a magic-themed hand-arm bimanual intensive therapy (HABIT). Children received AMC for 6 hours/day for 10 days in a theater space. AMC consists of selecting specific activities (magic tricks) that target specific movements that are difficult with this population, incorporating whole and part-task practice, grading the magic tricks, offering feedback and encouraging home practice through homework. After the 10 days of AMC, children participated in 6 additional monthly sessions for 3.5 hours. OT students trained in AMC provided one-to-one support. A trained investigator, an administrative assistant, and an OT collaboratively coordinated the intervention. Two professional magicians thought magic tricks and encouraged practice. *Control*: N/A	Assisting Hand Assessment (AHA), Box and Blocked Test (BBT), Canadian Occupational Performance Measure (COMP), ABILHAND-Kids, Children's Hand-use Experience Questionnaire (CHEQ),	The following areas were identified as priority areas on the COPM: 62% bimanual dressing tasks, 20% food preparation tasks, and 17% bimanual use of utensils. There was a significant difference in parent satisfaction and performance scores ($p < 0.001$) between T1 and all follow-up times. Although not statistically significant, there was a clinically meaningful improvement in 8 out of 9 children in the COPM performance section and 5 out of 9 children in the COPM satisfaction section. There was also a significant difference ($p < 0.001$) in the ABILHAND-Kids questionnaire scores, which assesses perceived difficulties of bimanual tasks in ADLs. A *pos hoc* analysis also revealed a significant difference between T1 and T4 ($p < 0.001$) scores.

Hsin, Chen, Lin, Kang, Chen, & Chen (2012) http://doi.org/10.1177/0883073811431011	Level I RCT N= 22 children ages 6 to 8 with congenital unilateral spastic cerebral palsy 46% Male, 54% Female M age= 6.9 years for control group 6.9 years for intervention group Intervention group, n=11 Control group, n= 11 Inclusion Criteria: The authors stated 4 requirements for inclusion criteria: 1. diagnosed with congenital unilateral spastic cerebral palsy 2. considerable nonuse of the more affected upper limb 3. active extension movement of the wrist and metaphalangeal joint greater than or equal to 10 degrees	**Control:** Traditional rehabilitation over the 4-week period **Intervention:** Participants in the intervention group received home-based constraint-induced therapy 3.5-4 hours/day, twice per week for 4 weeks from a certified physical therapist.	**Primary Outcome Measures:** Subtest 8 of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP-sub8) **Secondary Outcome Measures:** Pediatric Motor Activity Log (PMAL) Cerebral Palsy-specific Quality of Life (CPQOL-Child)	**Primary Outcome Results:** For the BOTMP-sub8, the intervention group improved more with a large effect at posttreatment (p=0.001) and at 3-month follow-up (p=0.001) which was significant. This indicates improved motor efficacy and function of the affected arm. **Secondary Outcome Results:** Both groups had improved PMAL scores at posttreatment and 3-month follow-up, but the intervention group improved more on the Amount of Hand Use subscale (p= 0.001) and Quality of Hand Use subscale (p= 0.002) with a large effect indicating greater gains in functional performance. The intervention group scores significantly improved more on the domains of social well-being and acceptance (p= 0.004), functioning (p= 0.026), participation and physical health

	4. no excessive muscle tone			(p= 0.056), emotional well-being and self-esteem (p= 0.007), pain and impact of disability (p=0.007), and access to services (p=0.012) for the CPQOL-Child measure. The results were significant and had a large effect at 3-month follow-up indicating improved health-related quality of life.
Hung, Brandao, & Gordon (2017) http://doi.org/10.1016/j.ridd.2016.11.012	Level I Single-blinded Randomized Control Trial *Risk of Bias:* Low *Participants:* N= 20, aged 6-13 years. (M age in SPG, 8.6, M age in UPG, 8.3) *Inclusion Criteria:* Individuals with spastic cerebral palsy. Ability to lift the more affected arm 15cm above a table and grasp light objects, mainstreamed in school, and demonstrated the ability to follow instructions during screening/testing.	*Intervention Setting:* bimanual training day camps *Intervention 1:* Participants in the structured practice group were engaged in treatment 6hr/day, for 15 consecutive days during school recess. Participants engaged in age-appropriate gross and fine motor bimanual activities using motor learning approaches consistent with HABIT. Tasks selected were based on the function of the affected hand and increased in complexity from nondominant passive assist to active manipulator as time passed. Participants	*ADLs* Assisting Hand Assessment Jebsen-Taylor Test of Hand Function Bimanual Drawer Task-kinematic analysis	*Significant Findings:* Both groups showed improvements in bimanual coordination and UE joint excursion, but only the SPG group demonstrated higher quality of movements (less trunk involvement and greater elbow joint movement/control) during the bimanual drawer task. *Non-Significant Findings:* Both groups showed improvements in dexterity and functional use of the hands. The results indicate that bimanual training tasks may

		participated in whole and part task practice Goal training was also performed 30min/day during camp. *Intervention 2:*Participants in the unstructured practice group were engaged in treatment 6hr/day, 15 consecutive days. Participants engaged in age-appropriate fine and gross motor bimanual play activities without any adaptations or progressions. Similarly, to the SPG group, tasks were selected from the same pool of choices and chosen based on the individual's interest and willingness to use the more affected extremity. Individuals in this group received no increase in task complexity and no verbal prompts on how to use the more-affected hand.		not need to include structured task completion to improve hand function, but instead be centered around activities of interest to the client that promote use of both hands.
James, Ziviani, Ware, & Boyd (2015) https://doi.org/10.1111/dmcn.12705	Level I RCT N= 102 children ages 8-18 yrs. with unilateral cerebral palsy (UCP) 50% Male, 50% Female	**Control:** Standard usual care over the course of the 20-week study **Intervention:** Move it to improve it (Mitii) therapy program delivered through internet every day	**Primary Outcome Measures:** -Assessment of Motor and Process Skills (AMPS) -Assisting Hand Assessment (AHA) -	**Primary Outcomes Results:** The AMPS motor scale results (95% CI 0.17-0.39; p≤0.001) and the process scale results (95% CI 0.19-0.41; p≤0.001) were not clinically

	M age= 11 yrs. 10 months for control group 11 yrs. 8 months for intervention group Intervention group, n= 51 Control group, n= 51 Inclusion Criteria: The participants in the study were recruited from all over Queensland and New South Wales, Australia by an experienced occupational therapist. 270 participants were identified as possibly being eligible for the study. 72 of these participants were self-referrals or came from other contacts, and 198 were chosen from a database.	for 6 days a week over the course of 20 weeks (for maximum possible dose of 60 hours); individualized and monitored by psychologists, physical therapists and occupational therapists	Jebsen-Taylor Test of Hand Function (JTTHF) -Melbourne Assessment of Unilateral Upper Limb Function (MUUL) **Secondary Outcome Measures:** -Canadian Occupational Performance Measure (COPM) -Test of Visual Perceptual Skill 3rd edition (TVPS-3) (All used to measure outcomes of control and intervention groups after the 20 weeks of intervention)	significant. The improved scores, however, indicate that ADL task performance may be enhanced. The JTTHF scores for the Mitii group were statistically significant on the dominant upper extremity and there was some improvement on the impaired upper extremity. For the AHA and MUUL there was no significant difference between the two groups. **Secondary Outcomes Results:** The participants' scores in the Mitii group on the COPM performance scale were significantly higher (95% CI 0.73-1.85; $p \leq 0.001$). The scores were significantly higher (95% CI 0.44-0.83; $p \leq 0.001$) on the COPM satisfaction scale. The scores were also significantly higher (95% CI 2.80-10.78; $p=0.001$) with the TVPS-3 measure. These results were not clinically significant, however, the increase in scores on the TVPS-3 reflect how visual

				perceptual skills can be enhanced.
Kaya Kara, Atasavun Uysal, Turker, Karayazgan, Gunel, & Baltaci (2015) http://doi.org/10.1111/dmcn.12583	Single-blinded Pre-stratified RCT Level I study N= 37 (Number of participants asked to be in the study) **Inclusion**: Between the age of 7-14 years old. Levels I or II of the Gross Motor Function Classification System and to be able to follow verbal instructions.	**Control:** Control group received traditional NDT treatment over 12 weeks, twice a week, that consisted of neurodevelopmental intervention given by physiotherapists. **Experimental:** The KT group attended the same therapy session as the control group. The children were taped with 5cm tape for 6 days of the week for 72 days total over a period of 12 weeks.	The gross motor function was classified using the Gross Motor Function Classification System (GMFCS). The Manual Ability Classification System (MACS), was used for self-initiated manual hand function. The Bimanual Fine Motor Function (BFMF) scale assessed fine motor function.	After 12 weeks, the taping group was significant in improvement in the GMFM dimensions D mean 3.23, (Effect Size 0.66, p=0.028) and E (mean 2.00, ES 0.94, p=0.005), BOTMP Gross (mean 3.33, ES 0.67, p=0.025), and WeeFIM total (mean 4.4, ES 1.12, p=0.001) , self-care (mean 1.46, ES 0.70, p=0.015) and mobility (mean 0.8, ES 0.66, p=0.026).
Ko, Sung, Moon,Yuk, Kim, & Lee (2020) http://doi.org/10.1080/01942638.2019.1642287	RCT Level 1 N=18 **Inclusion**: 1. Diagnosed with spastic CP 2. Age: 4-7.5 years old 3. Classified on the Gross Motor Function Classification System (GMFCS) 4. Understand Korean 5. Able to follow step verbal instruction	**Invention: TOT** (task-oriented training) focused on 1. Functional goal-directed training with specific important activities. 2. Cooperation between group members 3. Activity focused interventions for strengths and needs	Gross Motor Function Measure (GMFM-88) for gross function. Bruininks-Oseretsky Test of Motor Proficiency 2nd edition (BOT-2) to test fine motor function Pediatric Evaluation Disability Inventory (PEDI) to measure the functional capacity and performance.	The results of the study showed that group-TOT significantly improved scores of standing ($p < 0.05$), walking/running/jumping subscales of the GMGM-88 and manual dexterity subscale of BOT-2 ($r = 0.58$) and social function scale on the PEDI ($r = 0.47$). No statistically significant differences between the groups.

	6. Previously participated in traditional rehabilitation program 7. Caregiver consent	4. Interest in participation **Experimental**: Group-TOT. TOT emphasizes tasks that mimic performance of functional activities. Important aspect of TOT is the active view of motor learning. This group received 1-hour sessions twice a week over a period of 8 weeks. There was a pediatric OT and PT present at the sessions. **Control** The children in the control group received traditional rehabilitation therapy. This was based on quality of movement, rather than function. The timeframe of these sessions were 30 minutes of physical therapy and 30 minutes of occupational therapy on the same day for 8 weeks.	Subscales: 1. Self-care 2. Mobility 3. Social Function	The manual dexterity subscale on the BOT-2 involves reaching, grasping and bimanual coordination. This study's advantage on participation through "healthy competition" and motivation. This study cannot be generalized to all children with CP, because the participants have mild forms of CP.
Lai, Liu, Yang, Chen, Wu, & Chan (2014) https://doi.org/10.1177/0883073814535491	Level II Single-blind, Quasi-experimental Prospective Study *N* = 24 children ages 4 - 12 years 54% male, 46% female	*Intervention* The pediatric aquatic therapy program included 5-10 minutes of stretching and warm up, 40 minutes of pool exercises, and 5-10 minutes of cool down exercises. The goal of the intervention was to	Primary Outcome Measures: Modified Ashworth Scale score, the 66-item Gross Motor Function Measure score, and Physical Activity Enjoyment Scale score	The results support that pediatric aquatic therapy for children with cerebral palsy can be an effective supplement to therapy, even for the children with a poor Gross Motor Function Classification

	M age = 85 mo. (intervention), 87.6 mo. (control) Intervention group, *n* = 11 Control group, *n* = 13 *Inclusion Criteria*: diagnosis of spastic CP, age 4 to 12 years, Gross Motor Function Classification System levels of 1 - IV, and ability to follow instructions	improve gross motor skills, ability in ambulation, and participation safely while playing with peers. *Control* The control group continued conventional therapy which they were participating in prior to the study. The conventional therapy programs varied among the participants.	Secondary Outcome Measures: Vineland Adaptive Behavior Scale, Cerebral Palsy Quality-of-Life parent proxy scale	System level. There were statistically significant changes seen in the improvement in gross motor function and enjoyment of therapy in the intervention group.
Law, Darrah, Pollock, Wilson, Russell, Walter, Rosenbaum, & Galuppi (2011) https://doi.org/10.1111/j.1469-8749.2011.03962.x	Level I Randomized Controlled Trial Cluster *N* = 128 children ages 12mo - 5y 11 mo. 62% male, 38% female *M* age = 3y 6mo Child-focused therapy, *n* = 71 Context-focused therapy, *n* = 57 *Inclusion Criteria*: Dx of cerebral palsy, levels I - V on the Gross Motor Classification System (GMFCS)	*Interventions* Child-focused approach: Therapists focused on remediation of impairments and building children's skills and abilities through practice of functional activities. Context-Focused approach: Treatment focused on changing the identified constraints within the task (identified using COPM) and / or environment.	Primary Outcome Measure: The Pediatric Evaluation of Disability Inventory (PEDI) Secondary Outcome Measures: Gross Motor Function Measure (GMFM-66), ROM of hip abduction, popliteal angle and dorsiflexion, the Assessment of Preschool Children's Participation (APCP) and the Family Empowerment Scale (FES)	The results of this study indicate that both context- or child-focused therapy interventions resulted in equivalent and significant improvements in self-care, mobility, and participation outcomes of the children during the 6-month intervention period.
Lin, Wang, Wu, Chen, Chang, Lin, & Y Chen (2011)	Level I RCT (follow-up)	*Intervention* Home-based constraint-induced therapy (CIT). This	Primary Outcome Measures:	The children in the intervention group showed statistically

https://doi.org/10.1016/j.ridd.2011.01.023	*N* = 21 children ages 48 - 119 mo. ~57% male, ~43% female *M* age = 76.70 mo. (intervention), 82.27 mo. (control) Intervention group, *n* = 10 Control group, *n* = 11 *Inclusion Criteria*: (1) diagnosed with congenital hemiplegic or quadriplegic CP, (2) considerable nonuse of the affected upper limb (amount-of-use score of the Pediatric Motor Activity Log < 2.5), (3) active extension movement at wrist and metaphalangeal joint ≥ 10°, (4) no excessive muscle tone (Modified Ashworth Scale ≤ 2 at any joints of the upper limb) before beginning treatment (Bohannon & Smith, 1987), (5) not diagnosed with severe cognitive, visual, or auditory disorders, (6) no injections of botulinum toxin type A or operations on the upper extremity within 6 months, and (7) no prior exposure to CIT.	group focused on training the more affected arm through shaping and repetitive task practice. *Control* Dose-matched home-based control intervention The control group engaged in functional unilateral or bilateral arm training based on activities focused on function, NDT, and motor learning techniques. Both groups received individualized home-based interventions, 3.5–4 h a day, twice a week for 4 weeks	Peabody Developmental Motor Scales II (PDMS-2) and the Bruininks–Oseretsky Test of Motor Proficiency (BOTMP) Secondary Outcome Measures: Pediatric Motor Activity Log (PMAL), the Caregiver Functional Use Survey (CFUS), and the Parenting Stress Index-Short Form (PSI)	significant improvements in motor efficacy and unilateral functional capacity at post treatment as well as improvement in grasping skills and motor performance in both unilateral and bilateral functional activities at the 6-month follow-up.

Lorentzen, Greve, Kliim-Due, Rasmussen, Bilde & Nielsen (2015) https://doi.org/10.1186/s12883-015-0334-0	Level II *Design:* Non-randomized controlled trial *Risk of Bias:* Low *Participants:* N= 34 (M age 10.9 ± 2.4 yr.) *Inclusion:* diagnosis of spastic cerebral palsy	*Intervention Setting:* home-based setting *Intervention:* Mitti training group, engaged in an internet-based program in the home for 30 min/day, 20 weeks. The internet program consisted of training modules that focused on upper limb, lower limb and balance training. *Control group:* 20-week interval without any intervening training.	*ADL* Assessment of Motor and Process Skills Assisting Hand Assessment *Functional Strength Tests of the Lower Extremity* Sit to stand Lateral Step up Half Knee Standing	*Significant Findings* The Mitti group showed significant improvements in motor skills, hand function of the affected hand and strength of the lower extremity. There was a statistically significant increase in the number of steps observed after training from 9.1 to 12.6, p<.01 on the left and 8.9 to 12.3, p<.001 on the right. Improvements were significant after training for the AHA scale, from 53.2 to 59.3, p<.001.Individuals also showed significant improvement on the AMPS test, from 1.34 to 1.57, p=.04. The Mitti programs high intensity and volume design leads to repetitive movements by the user and results in neuroplastic changes up to 12 weeks. *Non-Significant Findings* None
Lowes, Mayhan, Orr, Batterson, Tonneman, Meyer, Alfano, Wang, Whalen, Nelin, Lo, Case-Smith (2014)	Level II	*Intervention Setting:* Outpatient	*Developmental Milestones* Bayley Scales of Infant and	*Significant Findings:* The subjects demonstrated

https://doi.org/10.3109/01942638.2013.810186	Pretest- post-test cohort design *Risk of Bias:* Low *Participants:*N=7 infants (6-18 mo.) *Inclusion*: (a) a diagnosis of unilateral CP by a pediatric neurologist or pediatrician. (b) age of 6-18 months; and family able to commit to treatment protocol.	Setting & Home based *Intervention 1:* Usual care treatment/ traditional therapy (functional tasks, play, sensory activities, strength building and bilateral activities) therapy 1 a week for 4 weeks in an outpatient clinic. Followed by a modified CIMT protocol appropriate for infants, including; (a) 24/7 casting of the less affected UE for 23 days, followed by 4 days without casting. (b) intensive occupational therapy sessions, 2hrs a day/ 5 days/week for 4 weeks. 1 hr. a day of therapeutic activity implemented by caregiver (c) parent education to promote use of the affected UE (d) services provided in the child's home. At the start of the third month, the client will then return to traditional therapy in the clinic 1x/week for 4 weeks.	Toddler Development- 3rd edition Fine and Gross Motor subscales *Upper Extremity Assessment-Parent Report* Infant Motor Activity Log	significant improvements in fine motor skills of the affected arm following the CIMT protocol compared to the two months of traditional treatment. p=.006. Improvements in fine motor skills were demonstrated by grasp pattern, motor planning and hand-eye coordination. The subjects demonstrated larger improvements in gross motor skills following the CIMT phase (p=.04) and 1 month follow up (p=.023) compared to traditional therapy intervention. Subjects demonstrated acquisition of new gross motor skills by beginning to crawl and pulling to stand. *Non-Significant Findings:* Initial scores for the IMAL and BDIS are highly correlated for the affected arm, indicating that parents' perceptions on the IMAL agreed with therapists' observations using

				a standardized test for infant performance.
Sakzewski, Ziviani, Abbott, Macdonell, Jackson, & Boyd (2011) http://doi.org/10.1016/j.apmr.2010.11.022	Level I Single- blinded randomized control trial *Risk of Bias:* Low *Participants:* N=64 (M age 10.2 ± 2.7 y, 52% Male) *Inclusion Criteria:* congenital hemiplegia, 5-16 y, ability to follow instructions, predominant spasticity with Modified Ashworth Scale higher than 1 and 3 or less for wrist flexors, forearm pronators and/or thumb adductors interfering with UL function.	*Intervention Setting:* Community based *Intervention 1:* The CIMT group wore a tailor-made glove on their unimpaired limb while attending the day camp. Participants attended an Intensive day camp with a circus theme that was activity-based, and goal directed with a focus on motor learning for 6hr/day, 10 consecutive days. *Intervention 2:* The bimanual training group attended a day camp with a circus theme that was activity-based, and goal directed with a focus on motor learning for 6hr/day, 10 consecutive days.	*Occupational Performance* Canadian Occupational Performance Measure *ADL* Assessment of Life Habits Self-care domain	*Significant Findings:* Both CIMT and bimanual training groups made significant improvements on the COPM at 3 weeks that were maintained at 26 weeks. Both groups made significant improvements on the personal care domain of the LIFE-H. *Non-Significant Findings:* Activity based, and upper extremity training addressed through CIMT or bimanual training produce improvements in occupational performance. However, there are minimal differences in results when comparing the CIMT and bimanual training approaches.
Saquetto, de Santana Bispo, da Silva Barreto, Goncalves, Queiroz, da Silva, & Gomes Neto (2018) https://doi.org/10.1177/0269215518757051	Level I Randomized Single-blind Controlled Study *N* = 63 children ages 1-12 years	*Intervention* 12-week conventional rehab program through a neurodevelopmental (NDT) method associated with an educational	Measurement 1: Gross Motor Function Classification System (GMFCS)	After the addition of an educational programme for the primary caregivers of children with cerebral palsy, the children showed

	56.67% male, 43.33% female *M* age = 4.5 yr. Intervention group, *n* = 29 Control group, *n* = 31 *Inclusion Criteria:* A diagnosis of cerebral palsy, an age of 1-12 years, and a full-time caregiver were all requirements for the participants.	program for primary caregivers with an emphasis on daily motor activities *Control* 12-week NDT conventional rehab program	Measurement 2: Gross Motor Function Measure (GMFM) Measurement 3: The Pediatric Evaluation of Disability Inventory (all assessments were performed at baseline and after 12 weeks)	statistically significant improvements in self-care and mobility, compared to a conventional rehabilitation programme with no caregiver-education component.
Sorsdahl, Moe-Nilssen, Kaale, Rieber, & Strand (2010) http://doi.org/10.1186/1471-2431-10-26	Level III Repeated measures design with three baseline and two follow up assessments (participants serving as their own controls) 68.2% Male, 31.8% Female N= 22 children aged 2y10m-9y3m with hemiplegia, diplegia, quadriplegia, and ataxia forms of cerebral palsy M= 5 years 6 months Inclusion Criteria: Participants had to be children with CP in preschool or first years of primary school. They had to be living within 1	**Control:** Participants served as their own control. In this case, the children received 3 weeks of usual care at baseline prior to the intervention stage. **Intervention:** The participants received 3 weeks of intensive, goal-directed, activity-focused physical therapy in a group setting. They received three hours of training, five days a week during the 3-week period.	**Primary Outcome Measures:** The Gross Motor Function Measure (GMFM-66) **Secondary Outcome Measures:** The Gross Motor Performance Measure (GMPM) The Quality of Upper Extremity Skills Test (QUEST) The Pediatric Evaluation of Disability Inventory (PEDI) Goal Attainment Scaling (GAS)	**Secondary Outcome Results:** The results of the FMPM show that there was improved quality of movement during the study period, however, these were not statistically significant (Chi-square 4.0, p= 0.3; Chi-square 1.9, p=0.6). For the QUEST measure, the changes in scores for quality of upper extremity function were positive, but not statistically significant (Chi-square 7.2, p = 0.7; Chi-square 6.1, p- 0.1). For three of the PEDI domains, there were

	hour from the location of training.			significantly improved scores ($p< 0.01$) including self-care in the Functional Skills and Caregiver Assistance dimensions indicating improved self-care and reduced need for caregiver's assistance in self-care and mobility. With the total of 53 scales determined for GAS, 24 of the activity goals, 7 of the movement goals, and 4 of the combined goals were attained.
ŞŞimşşek, Türkücüoğğlu, Cokal, Üstünbaşş, & ŞŞimşşek (2011) http://doi.org/10.1111/dmcn.12583	RCT Level I study **Participants**: N=31 (Number of participants asked to be in the study) Only one child was excluded. 30 participants were accounted for at the conclusion. **Inclusion**: The inclusion criteria includes: 1. Diagnosis of CP 2. Have a rating of III, IV, or V on the gross motor functional classificatio n system	**Control:** The control group received physical therapy 3 days a week with a duration of 1 hour for 12 weeks. The children received a 1-hour session of physical therapy, three days a week. Exercises consisted of tone **Experimental:** The KT was applied to the trunk between S1 and C7 by using a fan technique. The children were taped for 3 days and then left to rest for 24 hours, and then reapplied over the course of 12 weeks. In addition to the taping the children received a 1-hour session of	The gross motor function measure (GMFM) was used to assess gross motor function. The WeeFIM, the Functional Independence measure for children rated the level of independence for activities of daily living. To assess sitting, the study used the Sitting Assessment Scale (SAS) to focus on posture.	The primary outcome of this intervention indicated that KT to the trunk musculature enhances postural alignment when sitting. Study group after KT, SAS measurement reported a mean and standard deviation 16.47 +/- 1.96, $t=3.281$ $p=0.003$ and before KT 13.53 + 3.48, $t= -0.820$, $p= 0.419$. Overall, KT can help improve proper sitting alignment and can impact functions of activities of daily living.

	3. Not have participated in any previous trials with KT	physical therapy, three days a week. Exercises consisted of tone regulations like grabbing-releasing, sitting and balance related to sitting.		
Tarakci, Ersoz Huseyinsinog,Tarakci, & Razak Ozdincler (2016) http://doi.org/10.1111/ped.12942	RCT Level 1 Study N= 38 children with mild CP Study had 8 dropouts, 4 in each group and they were all accounted for in conclusion. Final number of participants analyzed at follow-up was 30, and there were 15 children in each group. **Inclusion Criteria:** Diagnosis of CP (diplegic, hemiplegic, dyskinetic type); age 5–18 years of age; Gross Motor Function Classification System (GMFCS) level 1, level 2 or level 3; no history of epilepsy; no botulinum toxin A treatment for the lower extremities in the previous 6 months; no excessive spasticity in any joint (score > 2 on the Modified	**Control:** Each participant in the control group received conventional balance training. Participants completed 12 weeks of therapy, 2 days per week. Each therapy session was 50 minutes long. Of the 50-minute therapy session, 30 of those minutes were spent on an individual neurodevelopmental training (NDT) program. The final 20 minutes were spent on a conventional balance training program. **Experimental:** Participants in the experimental group received Wii-Fit balance-based video game training. Participants completed 12 weeks of therapy, 2 days per week. Each therapy	**The Functional Independence measure for Children (Wee-FIM)** This measure is used in pediatrics and consists of 6 areas with 18 items including self-care, sphincter control, transfers, locomotion, communication and social cognition. Validity and reliability of the Turkish version of Wee-FIM were confirmed.	On the initial assessment there were no statistically significant differences in either primary or secondary outcome measures between the two groups. After the final assessments, there were significant improvements in balance function and independence levels in the activities of daily life in the intervention group compared to the control group. After treatment, changes in balance scores and independence in activities of daily living were significant ($P<0.05$) in both groups. There were statistically significant improvements in

	Ashworth Scale); and confirmed mental ability to be able to adapt to exercise.	session was 50 minutes long. Of the 50-minute therapy session, 30 of those minutes were spent on an individual neurodevelopmental training (NDT) program. The final 20 minutes of therapy was spent playing Wii-Fit video games on the Wii balance board. In each session the participant played four Wii-Fit balance-based video games.		the Wii-Fit group compared to the control group in all balance tests and Wee-FIM total score. Specific categories within the Wee-FIM also demonstrated significant improvement favoring the intervention group, such as self-care and locomotion. Self-care subscore of the Wii-Fit group had a p-value of 0.02 compared to a p-value of .063 in the control group. The locomotion subscore also had a statistically significant difference between groups with a p-value of 0.01 for the Wii-Fit group, and a p-value of .046 of the control group.
Vulpen, Groot, Rameckers, Becher, & Dallmeijer (2018) https://doi.org/10.23736/S1973-9087.18.04921-3	Level III Double-baseline design with follow-up measurement (participants serving as their own controls) 50% Male, 50% Female N= 22 children aged 4-10 with spastic	**Control:** Participants served as their own control. In this case, the children received 14 weeks of usual care. **Intervention:** The participants received 14 weeks of functional power-training that followed	**Primary Outcome Measures:** Goal attainment scaling (GAS) of individual daily activity related treatment goals **Secondary Outcome Measures:**	**Primary Outcome Results:** The GAS scores differed significantly ($p < 0.001$) between the goals achieved during usual care vs. goals achieved during the functional power-training period. This indicates improvement in

	cerebral palsy (13 bilateral) M= 7.5 years Inclusion Criteria: The authors included a list of three things for inclusion criteria 1. ambulant children (GMFCS 1 and II) with predominantly spastic CP, aged 4-10 years 2. parents and/or children had a walking-related treatment question 3. children had to be able to understand and follow simple instructions	immediately after the usual care 14-week period. During this period, children participated in the intervention 3 times a week for 60 minutes each session. The authors go into further detail stating that there was a 10-minute warm-up, 35 minutes of 3-4 different power exercises, and 15 minutes of a concluding game. Interventions were administered in small groups (3-6 children)	Functional Mobility Scale (FMS-5 m, 50 m and 500 m) to measure mobility performance The Mobility Questionnaire (MobQues)	ability to participate in ADLs. **Secondary Outcome Results:** There was no effect on the achievements over a 5 m or 50 m distance after functional power-training. However, after the intervention period, the probability of improvement by one point or more on the 500 m was 10 times higher (Relative Risk= 10.0 with 95% CI 1.4-71.3). This indicates improvement in functional mobility in the wider community. The changes in the MobQues scores was significant between the usual care period and the intervention period (7.9% [95% CI 2.7-13.0] P=0.005). This indicates decreased mobility limitation in the participants.
Wallen, Ziviani, Evans, Naylor, Novak, & Herbert (2011) http://doi.org/10.1111/j.1469-8749.2011.04086.x	RCT Level 1 study Children completed a 2-hour baseline assessment immediately before randomization. Two	Participants in both groups underwent an intensive 8-week block of therapy, including attending weekly occupational	**Canadian Occupational Performance Model (COPM):** Assesses both subjective	There were no clinically or statistically significant between-group differences for the COPM

	1-hour follow-up assessments were completed 10 weeks after randomization (end of intervention) and 6 months after randomization. Fam ilies were told to avoid constraint-based interventions until completion of the 6-month assessment. N=50 children with hemiplegic CP No participants were lost during intervention or to follow-up analysis **Inclusion Criteria:** Children were included if they had spastic hemiplegic CP, were aged between 18 months and 8 years, achieved at least 10° active wrist extension and/or finger extension in the affected upper limb, possessed functional passive range of movement (120° shoulder flexion and abduction; 30–120° elbow movement; neutral wrist and finger extension; minimum 45° supination), were capable of cooperating for assessment and therapy, had access to weekly occupational therapy, and had parents who indicated a commitment to	therapy sessions with their usual therapist and completing a home program. **Control:** The control group was the children assigned to intensive occupational therapy. Intervention for the intensive occupational therapy group involved 8 weeks of occupational therapy to achieve parents' goals, and included techniques aimed at minimizing impairment (e.g. stretching, casting, splinting) and enhancing activities (e.g. motor training, environmental modification, and practice of specific goal activities). Guidelines for intervention suggested that parents spend 20 minutes each day completing the home programme, but parents were able to increase or decrease daily home programme time to fit in with family commitments and their own preferences. **Experimental:** The experimental group was the children assigned to	performance and satisfaction with performance of relevant problematic activities as experienced by the child. Selected as the primary outcome measure. **Goal Attainment Scaling (GAS):** Individualized measure used to assess goal attainment which has detected meaningful change in other studies of upper limb interventions for children with CP. **Assisting Hand Assessment (AHA):** Used to quantify how the hands function together, in an observation-based test design. This assessment quantifies the effectiveness of assisting hand use in performing bimanual activities. The activities were conducted by a therapist not involved in the experiment and	performance or satisfaction scales. The mean change for both groups on the COPM was greater than the 2-point change considered clinically meaningful by test developers. Similarly, there were no clinically or statistically significant differences between groups for Goal Attainment Scaling, AHA, Revised Pediatric Motor Activity Log, or Modified Tardieu Scale at 10 weeks or 6 months.

	participating in the study.	modified constraint induced therapy. The child's unaffected hand was constrained by a fabric mitt with a solid thermoplastic volar insert preventing grasp and release. The protocol required that the mitt be worn for 2 hours per day (in sessions of minimum 30min), 7 days per week for 8 weeks. The mitt could be worn at home, at school/preschool, or in other environments where adjunct therapy could be provided. Adjunct therapy, completed while the mitt was worn, was based on motor learning principles. The particular movements were those required to complete activities of daily living selected by parents as priorities for intervention.	scored by a blinded expert evaluator. **Revised Pediatric Motor Activity Log:** Parents used separate three-point scales (0-2) to rather "how often" and "how well" their children used his or her affected arm in a number of everyday activities. **Modified Tardieu Scale:** Measures hypertonicity and spasticity based on the Modified Ashworth Scale.	