Bi-Manual Therapy Results in in Improved Leisure Participation in Children with Cerebral Palsy Compared to Constrain Induced Movement Therapy.

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CLINICAL SCENARIO

There are well established clinical practice principles in the treatment of children with unilateral Cerebral Palsy (CP) (Sakzewaski, Ziviani & Boyd, 2011). With the exception of surgical intervention and Botulinum toxin A treatment two key therapies standout within the evidence base as most significantly improving functioning of the effected upper limb; modified CIMT (mCIMT) and intensive bimanual training (IBT) (Dong, Tung, Siu & Fong, 2013 and Hoare, Imms, Rawicki & Carey, 2010). The literature considers the efficacy of these therapies on a function and impairment level. This focus on function and impairment is somewhat problematic given that the literature also highlights the difficulty children with CP encounter participating in many leisure based activities (Wiklund & Uvebrant, 1991). As such, this sythesised literature review, will aim to determine whether mCIMT or bimanual therapy is more effective for increasing participation in leisure activities for primary school aged children with CP.

FOCUSSED CLINICAL QUESTION

Is constraint-induced movement therapy or bimanual therapy more effective for increasing participation in leisure activities for primary school aged children with CP?

SUMMARY

Medline, CINAHL, Embase, OT Seeker and the Cochrane Database of Systematic Reviews were searched from January 2004 to May 2014, using a PICO search strategy. The search was limited to English language articles that were peer reviewed and considered a population of primary school aged children. Studies were included if they compared CIMT with IBT or combinations thereof and contained a level 1b study design or better.

Of the 38 unique articles obtained 18 were deemed relevant based upon the inclusion and exclusion criteria. Of the 18 articles the most pertinent 5 were selected for review. A meta-analysis by Sakzewski, Ziviani and Boyd (2013) (n=1454) found a clinically meaningful treatment effect in the area of overall upper limb function for mCIMT, IBT and combination therapy. Correspondingly, Fedrizzi, et al (2013) (n=105) found that both mCIMT and IBT significantly improve overall hand function. Klingels, et al. (2013) (n=51) found that combination therapy (mCIMT and IBT) leads to greater improvement in bimanual task performance than mCIMT alone. Similarly, Deppe, et al (2013) (n=47) determined that there was a modest treatment effect in favour of combination therapy over IBT alone for overall motor function and spontaneous use of the effected upper limb. Sakzewski, et al (2012) (n=63) determined that both mCIMT and IBT achieved clinically meaningful and equal improvements in quality of life (QOL).

CLINICAL BOTTOM LINE

Overall, there is substantial evidence indicating both the statistical and clinical significance of

mCIMT, IBT and combination therapy in improving upper limb function and QOL in children with CP. Additionally, there is modest evidence to suggest that combination therapy is minimally more effective than either mCIMT of IBT. The literature further indicates that the efficacy of these upper limb therapies is significantly improved when they are intensive and high in dose, include a home-based therapy component and take a goal directed approach to intervention. While the current evidence base does not specifically outline the impact of mCIMT, IBT or combination therapy on participation in leisure tasks in primary school aged children, it can reasonably be inferred that meaningful improvements in hand and arm function, spontaneous use of the effected upper limb and perceived QOL, would correlate with clinically significant improvements in participation in leisure activities. Further research considering participation in leisure activities as the primary outcome, must be conducted to confirm this correlation.

Limitation of this Review: This evidence review has been peer-reviewed by one other independent person/lecturer. The last date of searches undertaken for this review occurred on May 2014.

SEARCH STRATEGY:

Databases and sites searched	**Obtained (some duplicates)**	**Search Terms**	**Limits used**
Medline CINAHL Embase OT Seeker Cochrane Library	11 4 7 27 0	**Population: Age** "Primary school aged child*", Child*, "Primary school", "Elementary school", Paediatric*, Pediatric*, "5 to 12 year*", "5 year old*", "6 year old*", "7 year old*", "8 year old*", "9 year old*", "10 year old*", "11 year old*", "12 year old*", "five to twelve year*", "five year old*", "six year old*", "seven year old*", "eight year old*", "nine year old*", "ten year old*", "eleven year old*", "twelve year old*", "school age* child*", Kid*, Student*, "pre teen", "pre-teen", Minor, Young* **Population: Diagnoses** "CP", CP "brain injury", "Neonatal stroke", "perinatal stroke", "Childhood stroke", "Early childhood stroke" **Intervention** "constraint induced movement	Year – 2004 to present English language Peer-reviewed Primary school aged children

		therap*", "Constraint induced therap*", "constrain therap*", CIMT, CI **Comparison** "bimanual therap*","bi-manual therap*", "bimanual train*", "bi-manual train*", "bimanual intervention*", "bi-manual intervention*", "bimanual program*", "bi-manual programme*", "bimanual programme*", "bi-manual program*", "bimanual treat*", "bi-manual treat*", "Bimanual upper limb therapy", "Bi-manual upper limb therapy", BULT **Outcome** Leisure, Play*, Hobb*, Sport*, Extracurricular activit*, "Extra-curricular activit*", Recreation, "After school activit*", Activit*, Meaningful activit*, Leisure goal*, Engage*, Participat*, Satisfaction*, Hour*, "quality of life", QOL, Sociali?ation	

INCLUSION and EXCLUSION CRITERIA:

Inclusion Criteria
● CP ● Children (5-12) ● Early childhood stroke (0-24 months) ● Studies comparing constraint-induced movement therapy (CIMT) with intensive bimanual therapy (IBM) (or combinations thereof) ● Level 1b evidence or better
Exclusion Criteria
● Brain injury and childhood stroke post infancy (24 months) ● Adults ● Studies considering only constraint-induced movement therapy, bimanual therapy or neither therapy ● Less than level 1b evidence

RESULTS OF SEARCH:

19 relevant studies were located and categorised as shown in Table 1(based on Levels of Evidence, Centre for Evidence Based Medicine, 2011)

Table 1: *Summary of Study Designs of Articles Retrieved*

Study Design	**Level**	**Located**	**Author (Year)**
Systematic review	1a	1	Dong (2013)
Meta-analysis of randomised control trials	1a	1	Sakzewski (2014)
RCT	1b	16	Boyd (2013) Deppe (2013) de Brito Brandao (2010) de Brito Brandao (2012) Fedrizzi (2013) Gordon (2011b) Hoare (2010) Hung (2011) Kingels (2013) Lin (2011) Sakzewski (2011a) Sakzewski (2011b) Sakzewski (2011c) Sakzewski (2011d) Sakzewski (2012) Sakzewski (2014)
Meta-analysis of randomised control trials (review of authors own previously published articles; no systematic search)	1d	1	Gordon (2011a)

BEST EVIDENCE:
Five key articles were considered "best evidence" and selected for review. Criteria for selecting these studies were;

- Highest level of evidence which addressed the specific research question.
- Following the initial selection of the meta-analysis by Sakzewski, Ziviani, & Boyd (2014), a new inclusion criterion was developed; articles must have been published post 2011 (when the collection of articles for the meta-analysis occurred) to prevent cross over.
- The final four studies were selected following consideration of factors including participant numbers, blinding of assessors, clear distinction between the control and treatment groups, outcome measures and generalisability.
- Studies were also prioritised if they specifically outlined leisure, participation or quality of life as an outcome

SUMMARY OF BEST EVIDENCE:
The critical appraisal tool chosen to appraise the meta-analysis was the LTU Summary Appraisal of a Systematic Review including the PRISMA .The critical appraisal tool chosen to appraise the RCTs was the LTU Summary Appraisal of a RCT including the ClearNPT.

Table 2: *Efficacy of upper limb therapies for unilateral CP: a meta-analysis by Sakzewski, L., Ziviani, J., & Boyd, R. N. (2013)*

Aim/Objective: To determine the efficacy of non-surgical upper limb therapies for improving performance and achieving individualised outcomes for children with unilateral CP.

Study Design:

Study Type: Meta-analysis

Search Strategy: The authors searched five major databases (Medline, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Embase, Cochrane Central Register of Controlled Trails and PubMed) from inception to December 2011, for relevant materials using the same expansive and detailed search strategy. Experts in the field were not contacted for unpublished studies and the reference lists of included articles were not checked for further materials. While the search procedure for this meta-analysis was not as rigorous as it could have been it followed on directly from a systematic review completed by the same authors four years earlier which employed through search practices.

Selection Criteria: Results were limited to English language and only randomised controlled trials were considered for review; articles utilising a quasi-randomisation method were excluded.

Method: Inclusion and exclusion criteria were applied to selected articles independently by two of the authors. Articles were only included when there was 100% agreement between the two authors however processes used to resolve disagreements are not outlined.

Included Articles: 49 articles reporting upon 42 trials were included. These 42 studies comprised a total of 1454 participants and considered 13 upper limb therapy approaches; of note to the outlined clinical question were cCIMT (3 studies, n=56), mCIMT (15 studies, n=578), combination therapy (2 studies, n=68) and IBT (1 study, n=20). The results are generalisable to children (0-18) with unilateral CP; GMFCS levels were not outlined or considered within the meta-analysis.

Outcome Measures: Outcomes varied between studies but consistently measured either unimanual or bimanual capacity and performance of the upper limb, achievement of individualised goals or self-care skills. For studies utilising the same outcome measure, data was collated and standardised mean differences and 95% confidence intervals were calculated. Pooled treatment effects were calculated across trials by using a fixed effects model when trials used similar interventions and outcomes on similar populations.

Main Finding: See appendix A.

Original Authors' Conclusions: The authors concluded that mCIMT had a modest to large effect in improving efficiency and quality of movement of the impaired upper limb when compared with usual care. They established that 40 hours of mCIMT or bimanual therapy is adequate to yield meaningful clinical changes in upper limb and individualised outcomes. The exact critical threshold dose of intervention required to achieve meaningful changes in upper limb function is not clear.
The authors determined that home programs are an essential element of intervention and that mCIMT achieved between 50%-80% of the total desired dose through home programs while bimanual training achieved 85% of total desired dose. Furthermore their findings suggest the additional benefit of home over clinic based therapy in continued improvement in upper limb function three months post intervention as it increases meaningful, generalisable improvements in function.
They also identified a consistent trend highlighting the importance of activity-based, goal directed therapy as integral in upper limb rehabilitation. Children and care-givers also identified goal directed therapies as important.

Critical Appraisal:

Internal Validity: The authors conducted a well-considered and well-structured meta-analysis, which could be considered to be of high quality. When considering only the interventions relevant to our research question two key limitations of the study are evident. Firstly the qualities of included studies were assessed utilising the PEDro Scale however studies of poor quality were not excluded from analysis. Generally included studies were considered of moderate or poor quality secondary to their low power and as such the discussed studies may have suffered from a type two error.
Secondly, there was a significant imbalance in the content of included studies; considering the therapies relevant to the outlined search question, five articles considered cCIMT, 20 focused on mCIMT, two researched combination therapy and only one study of poor quality considered bimanual therapy. This is problematic as the meta-analysis does not reflect a wide range of research and evidence for all therapies but equally weights the evidence presented for each.

Summary: The results of this meta-analysis can be generalised to children (0-18) with unilateral CP, encompassing all levels of the GMFCS. While the results pertaining to specific therapeutic interventions may not be of high quality the meta-analysis does outline three key principles of any

upper limb intervention which are well supported across the entire evidence base. Firstly therapy should be goal directed and meaningful. Secondly, therapy will be more effective and gains better retained if intervention includes a home based program. Finally, of most importance is the dose and intensity of intervention; mCIMT and bimanual therapy were found to be equally effective if a child received a minimum of 40 hours of intervention in a condensed period of time.

Table 3: *Unimanual and Bimanual Intensive Training in Children With Hemiplegic Cerebral Palsy and Persistence in Time of Hand Function Improvement 6-Month Follow-Up Results of a Multisite Clinical Trial by Fedrizzi, E., Rosa-Rizzotto, M., Turconi, A.C., Pagliano, E., Fazzi, E., Dalla Pozza, L.V., & Facchin, P. (2013).*

Aim: The aims of the study were to compare mCIMT and IBT with standard treatment (ST) in order to assess the effect of intensity level for improving hand function and spontaneous use of the affected hand.

Study Design:

Study Type: The study was a cluster randomized, controlled and evaluator-blinded trial. Treatment allocation was not concealed as this study contained comparison interventions. Participants and care providers were not blinded. Each rehabilitations centre was randomly allocated with a treatment of either mCIMT, IBT or ST.

Setting: 20 rehabilitation centers in Italy.

Participants:
Number: 105
Diagnosis: hemiplegic cerebral palsy according to the Hagberg Classification.
Eligibility Criteria: Children were excluded if they had previously undergone restraint therapy or if they had received upper extremity, anti-spasticity drugs in the past six months.
Recruitment: All children enrolled were recruited in a cluster randomisation from 20 rehabilitation centers in Italy between March 2006 and December 2008.
Type of Sample: purposive, convenience sample.
Key Demographics: Participants were aged between 2 and 8 years and consisted of 53 males and 52 females. At baseline there were no recorded significant differences across the study groups on demographics
Number of dropouts: Both IBT and ST groups had a 10% dropout rate prior to the commencement of the trial.

Intervention Investigated: Treatment was administered over 10 weeks OT's. Treatment intensity differed between the experimental and standard treatment (ST) group. Outcome measures were administered by assessors at baseline, immediately post intervention and at a three and six month follow-up.
Experimental Group – mCIMT: Children wore a restraining glove with a built in splint on the dominant hand and underwent unimanual intensive training. The intervention lasted for 10 weeks, children were expected to wear the glove for 3 consecutive hours at home four days a week and attend three hour sessions at the rehabilitation centre three days a week. Activities included a perceptual

motor task, posture and balance, holding and manipulative tasks and self-care and ADL tasks.
Experimental Group - IBT: Tasks and schedule were the same as above however children did not wear a glove and children were encouraged to use both hands throughout the therapy session.
Control Group– Standard Treatment (ST): Children underwent 1 hour of standard rehabilitation sessions once or twice a week; sessions differed based on the age of the child. Infants received physiotherapy and preschool and school-aged children received occupational therapy.

Outcome Measures: Assessments were administered at baseline, immediately following treatment and at three and six month follow-ups. All assessments were scored by independent, blinded assessors. All measures employed in the study are considered valid and reliable.

Primary Outcome Measures:
Quality of upper extremity skills test (QUEST): The QUEST explores 4 main domains of upper extremity function (dissociated movements, grasp, protective extension and weight bearing). Each arm is scored separately and the assessment uses a dichotomous scale (does the task, doesn't do the task, not tested). Percentage scores are then calculated in accordance with a given formula.
Besta scale: The Besta scale assesses the quality of grasp and spontaneous hand use in relation to age and degree of impairment. Analysis is conducted by calculating 4 mean scores of 23 items (range 0-3), 1 global score for the mean for all 23 items and 3 subscale means (grasp, bimanual use, ADL's).

Main Findings: See appendix B.

Original Authors' Conclusions: It was concluded that "intensity of treatment improves the hand function in both groups of children treated either with unimanual or with bimanual training with respect to the control group.". The authors also found that "grasp is shown to improve significantly in the mCIMT group of children at the end of treatment, then remaining stable, while in the IBT group grasp improvement continues until assessment at 6 months." Finally "in both groups of intensively treated children, the spontaneous use of hand in play and life situations increases at the long-term assessment at 6 months, indicating that children have learned new strategies for bimanual coordination in accomplishing the tasks related to their developmental age." p172

Critical Appraisal:

Internal Validity: In order to assess internal validity a CLEAR-NTP scale was used. The paper received an overall score of 11/14 and had strong power. Due to an inability to conceal treatment allocation there is a risk of selection and allocation bias. A failure to blind participants and care providers also caused the possibility of performance or expectation bias. The parent's role as therapists was unable to be controlled and therefore all children would not have necessarily received the same treatment during their home based therapy.

Interpretation of Results: Results indicated that both mCIMT and IBT improve hand function in children with CP in comparison to ST. In the mean global scores of the Besta children in both the mCIMT and the IBT group showed a clinical significance at the 3 and 6 month follow up. The QUEST demonstrated clinical significance in the mean global score for mCIMT at baseline and for IBT at baseline, 3 and 6 month follow up.

Summary: This study indicates that improvement in hand function is dependent upon intensity of treatment of either mCIMT or IBT, irrespective of the control group. Specifically grasp is improved in mCIMT at the end of treatment and at 6 months with IBT. Spontaneous hand use is also improved in both mCIMT and IBT at 6 months. This study also highlighted the importance of the role of the parents and the value of parent training for assisting with home based therapy.

Table 4: *Description and appraisal of Randomized Trial of Modified Constraint-Induced Movement Therapy With and Without an Intensive Therapy Program in Children With Unilateral CP by Klingels, Feys, Molenaers, Verbeke, Van Daele, Hoskens, J., ... and De Cock (2013).*

Aim: This study investigated whether modified-CIMT (m-CIMT) alone or combined with an intensive therapy (IT) program (featuring bimanual training) improved hand functioning.

Study Design:

Study Type: A randomized, controlled and evaluator-blinded trial. Treatment allocation was not concealed as this study contained comparison interventions. Participants and care providers were not blinded.

Setting: University Hospital Leuven, Belgium.

Participants:
Sample size: 51
Diagnosis: Unilateral CP
Eligibility criteria: Children with unilateral CP, aged between 4 years and 6 months to 12 years of age, who have a minimal ability to grasp with their affected hand and are able to cooperate sufficiently in performing assessments and participate in intervention. All participants had a Manual Ability Classification System (MACS) level from 1 to 3.
Recruitment: recruitment from the CP program at the University Hospital Leuven, Belgium.
Type of sample: purposive, convenience sample.
Key demographics: mean age of individuals was 8 years and 9 months, with 28 males and 23 females. 28 children had left-sided unilateral CP.
Number of drop outs: 4 children, all in the m-CIMT group.
Number available for follow-up: 47

Intervention Investigated:
Treatment was administered over 10 weeks by parents at home and over seen by physios and OT's. Parents were instructed on how to administer intervention at home to their child and supervised by the key investigators.
Intervention Group - mCIMT Intervention: Participants wore a constraint on their unaffected hand and were provided structured skill practice focusing on unilateral capacity of the affected hand. Constraints were to be worn for 1 hour, 5 times a week for 10 weeks (total 50 hours).
Intervention Group - Combination Therapy: In addition to the same mCIMT treatment outlines above IBT used a unimanual and bimanual approach, focusing on distal muscle strength and hand functioning. IBT alone was for 1 hour, 5 times a week, for 10 weeks.

Outcome Measures: Assessments were administered at baseline, immediately post-intervention and at 10 week follow-up by a physiotherapist at the Clinical Motion Analysis Laboratory of the University Hospital Leuven. Measures used in the study are considered valid and reliable.

Primary Outcome Measures:
Assisting Hand Assessment (AHA): The AHA allows therapists to measure the degree of spontaneous use of the affected hand in executing bimanual activities. Scores range between 0-100 logit-based AHA units, converted from raw scores.

Secondary Outcome Measures:
Modified Ashworth Scale (MAS): The MAS was used to assess muscle tone in the shoulder, elbow, wrist and hand. Scores range from 0-36.
Manual muscle testing (MMT): MMT assesses muscle strength and total scores ranged from 0-36.
Grip Strength Test: To assess grip strength the mean of 3 contractions using a Jamar dynamometer was calculated.
The Melbourne Assessment of Unilateral Upper Limb Function (MA): The MA was used to measure unimanual capacity of the affected upper limb. Raw scale scores range from 0-122.
Jebsen-Taylor Hand Function Test (JTHF): The JTHF assesses the speed of movement in six unimanual tasks. Scores are established by timing children's task performance; these are then summed and raw scores then converted to a percentage with lower scores indicating greater function.
The ABILHAND-Kids Questionnaire: The questionnaire was utilized to assess performance in activities of daily living and bimanual tasks, through parents rating the difficulty their child encounters completing such tasks as impossible, difficult or easy.

Main Findings: See appendix C

Original Authors' Conclusions: Combined therapy, with a focus of IT on distal hand function and strength, improves m-CIMT alone for enhancing bimanual hand performance, as shown by improved bimanual performance in the combined therapy group. There were no differences between groups on measures at an activity or body function level (except on the Jebsen-Taylor test showing greater change in the combined therapy group). Researchers concluded that more specific training protocols are required.
Researchers concluded that if m-CIMT is implemented at home, close supervision and careful selection of families is required to ensure functional improvements are produced. Younger children benefited from both interventions however older children only benefited from the combined therapy. Researchers believe, due to developmental non-use phenomenon, that younger children are more capable to incorporate their affected arm spontaneously into bimanual activities than older children. Greater impairment equaled a higher response to treatment whereas individuals with a lower level of impairment only showed beneficial gains in the combined therapy intervention. Individuals with a poorer ability to use their affected hand spontaneously in bimanual activities benefited most across both interventions. Routine therapy did not impact on the reported treatment effects.

Critical Appraisal:

Internal Validity: The study received a Clear NPT score of 9/14. One key issue was identified with the study; the cohort group for mCIMT dropped below the participant number established to identify the smallest detectable difference (SDD) for the primary measure. Furthermore, the study mentioned further data analysis associated with the primary measure (AHA) measure that was explicitly not reported.
There is a possibility of a selection or allocation bias as treatment allocation was not concealed. However, as this study contained comparison interventions, researchers were required to know group allocation. A possibility of a performance or expectation bias is possible as participants and care providers were not blinded. Observed differences between groups do not seem to be explained by biases however, as researchers adequately explained their results and presented past research confirming these results.

Interpretation of Results: Results favoured the combined therapy group more so than the m-CIMT group. Mean difference between baseline and after intervention in both therapy groups accounted for a medium effect size. This may be due to each group not achieving a mean SDD for the AHA scores. In the combined therapy intervention, 10 children achieved higher than the SDD whereas 6 children achieved higher in the m-CIMT group. Mean difference between baseline and at follow up in both therapy groups accounted for a small effect size. This result was clinically important for some children however not for all children. Further investigation of the demographics and characteristics of these children is required.

Summary: Combination therapy improves functional outcomes more than mCIMT alone through enhancing bimanual hand performance.

Table 5: *Description and appraisal of Modified constraint-induced movement therapy versus intensive bimanual training for children with hemiplegia- a randomized control trial by Deppe, W., Thuemmler, K., Fleischer, J., Berger, C., Meyer, S., & Wiedemann, B. (2013)*

Aim: To clarify whether modified constraint-induced movement therapy provides greater improvement than intensive bimanual training both for motor functions and spontaneous use of the paretic arm and hand in everyday life activities.

Study Design:

Study Type: A randomised control trial; children were allocated to combination therapy or IBT by a computer-generated list of randomised numbers in concealed envelopes. Assessments were performed independently by experienced therapists that did not participate in treatment and were blinded to group assignment.

Setting: Neuropaediatric inpatient rehabilitation centre in Germany

Participants:
Number: 47

Diagnosis: Unilateral spastic CP, acquired non-progressive central hemiplegia with other etiologies (stroke, traumatic brain injury, non-traumatic intracranial hemorrhage) of more than two years' duration
Eligibility criteria: Children with unilateral spastic CP or acquired brain injury or acquired non-progressive hemiplegia with other etiologies, aged 3-12 years with active movement of the wrist and metacarpophalangeal joints with extension from full flexion of at least 20 degrees
Recruitment: Children were recruited from a German neuropediatric rehabilitation center between 2007 and 2010.
Type of sample: purposive, convenience sample.
Key demographics: mean age 6 years and 4 months with 15 males and 32 females
Number of dropouts: Five total; two from the combination therapy group and three from the IBT cohort.

Intervention Investigated:
Children in both groups received intensive therapy over a period of four weeks with a frequency of four sessions daily, each lasting 60 minutes, on five days a week. The interventions were performed by experienced physiotherapists, occupational therapists, and music therapists.
Intervention Group - Combination Therapy: Combination therapy consisted of three major elements; sensation with tactile stimulation of the hand and fingers several times a day for 10 minutes; mobilisation of restricted and shortened joint and muscular structures for 5-10 minutes twice daily; and activity. The activity program is the core component of combination therapy and addresses essential elements of arm function. The unaffected arm was restricted by fixing the arm, to the trunk with elastic bandages. Restriction was performed during all treatment sessions and during one meal. After 60 hours of CIMT (over three weeks), the program was terminated with 20 hours of bimanual training (over one week).
Comparison Group - IBT: The IBT program incorporated sensation, mobilisation and activity. The activity program involved activities of daily living, such as dressing, preparing a meal and eating with a knife and fork; other activities included collecting objects into a basket, throwing and catching a ball and building with bricks.

Outcome Measures
Assessments were administered at baseline and one week post-intervention. Primary assessments were administered by independent, blinded therapists; secondary assessments were scored by parents. All measures employed in the study are considered valid and reliable.

Primary Measures:
Melbourne Assessment- (refer to table 4).
Assisting Hand Assessment- (refer to table 4).

Secondary Measure:
Pediatric Evaluation of Disability Inventory: Self-care scale- Parents provide PEDI scores of children's performance of self-care tasks as capable of doing or unable to do each of the items, which are listed in order of mastery. Caregiver assistance is measured on a 6-point rating scale from total assistance to complete independence.

Main Findings: See appendix D.

Original Authors' Conclusions: "mCIMT and IBT are basically equally effective for improving the use of the paretic hand in everyday life activities. (Combination therapy) showed clinical importance in both primary outcomes for all aetiologies, and in only the Melbourne Assessment for CP. More severely impaired children show greater improvements compared to those less impaired and might profit more from constraint-induced treatment." pg 918

Critical Appraisal:

Internal Validity: The CLEAR-NPT scale was used to assess internal validity. The paper received an overall score of 9/14. The generation of allocation sequences was adequate, and the treatment allocation was concealed. The details of the interventions were made available and participant's adherence was measured quantitatively. Participants and therapists were not blinded, as this was not possible in this study; however outcome measure assessors were blinded.

Interpretation of Results*:* The results indicate clinical importance for combination therapy on the Melbourne Assessment for participants with CP. A mean percent post treatment gain score of 6.4 (3.4-9.5) (mean percent score of 5.7 needed for clinical importance)

Summary: Combination therapy is more effective than IBT alone, in improving motor functions in the arm and hand of children with CP. These results are generalisable to children with unilateral CP of MACS levels 1-3 without intellectual impairment.

Table 6: *Description and appraisal of Impact of intensive upper limb rehabilitation on quality of life: a randomized trial in children with unilateral CP by Sakzewski, L., Carlon, S., Shields, N., Ziviani, J., Ware, R.S., & Boyd, R.N. (2012)*

Aim: to determine whether mCIMT is more effective than IBT in improving the quality of life of children with unilateral CP.

Study Design:

Study Type: A randomised controlled trial. Children were paired based on age, sex, side of hemiplegia and upper limb function. Then they were randomised in pairs using a computer generated list of numbers and concealed envelopes.

Setting: 6 day camps, of a duration of ten days each, at sporting facilities in Melbourne and Brisbane, Australia.

Participants:
Sample size: 63
Diagnosis: CP (spastic motor type or with spasticity and dystonia)
Eligibility criteria: Unilateral CP, between 5 and 16 years old, can follow instructions, Modified Ashworth Scale score of no greater than three for the distal upper limb. Children were not eligible if they had predominant dystonia or contractures or had intramuscular botulinum toxin A injections, upper limb surgery or serial casting in the last 6 months.
Recruitment: Through public and private therapy and medical specialists in Victoria and Queensland,

and through the population register in Queensland.
Type of sample: Purposive sample.
Key demographics: The mean age of participants was 10 years and 2 months, with 33 males and 30 females. There were no significant differences between groups on key demographics at baseline
Number of dropouts: 1 child dropped out prior to baseline, so was not included in the sample. 1 child dropped out from the IBM group during intervention.
Number available for follow-up: 62 children received the full intervention, 62 children were available at the 3 week follow up, and 58 children were available at 26 and 52 week follow ups.

Intervention Investigated:
Both groups received that same dosage and overall content of intervention in the same environment. Children received 6 hours of therapy per day for 10 days over 2 weeks (60 hours in total) using a circus themed day camp, with between 9 and 13 children in each camp. The circus theme was used to enhance motivation. The interventions used goal-directed activity-based frameworks, using principles of motor learning. The focus was on completing the activity in its entirety. A core team of four experienced OTs and physiotherapists conducted the camps and trained the therapist volunteers, therapy students, circus trainers and community youth workers. There was a ratio of 1 staff member to 2 children
Intervention Group - mCIMT: Participants in the CIMT group wore a tailor made glove on the unimpaired hand for the duration of the day camp, removing it for no more than 15 minutes per day.
Intervention Group - IBT: Used both hands to complete camp activities following the principles outlined by Gordon, et al., (2007).

Outcome Measures:
Assessments were administered at baseline, 3 weeks post intervention, 26 weeks post intervention, and 52 weeks post intervention. All measures employed in the study are considered valid and reliable.

Primary Outcome Measures:
CP Quality of Life Assessment for Children (CPQOL-Child): The CPQOL-Child was completed by children 9 or over and a proxy version by all parents. The CPQOL-Child covers 7 domains; social well-being and acceptance, functioning, participation and physical health, emotional well-being, access to services, pain and impact of disability, and family health. All items are rated on a continuous likert scale of 1-9 with 1 being very unhappy and 9 being very happy. These scores are then transformed into scale scores for each domain (range 0-100).
KIDSCREEN-52: The KIDSCREEN-52 was completed by children 8 or over and a proxy version by all parents. It is a generalised measure of health related QOL. All items are rated on a reverse item, continuous likert scale of between 1 (not at all/never) and 5(always/extremely).

Main Findings: See appendix E.

Original Authors' Conclusions*:* The authors concluded that the findings of the study suggest "that intensive goal-directed upper limb training using either a unimanual or bimanual approach can impact more broadly on children's perception of well-being in areas relating to feelings about functioning and participation and physical health." (Sakzewksi et. al., 2012, p.422).

Critical Appraisal:

Internal Validity: The CLEAR-NPT scale was used to assess internal validity. The paper received an overall score of 11/13 on the scale indicating good internal validity. The generation of sequences was adequate and treatment allocation was concealed. Details of the intervention administered to each group were made available to readers. Treatment providers who administered the treatment had sufficient knowledge and training. Participant's adherence was assessed quantitatively. Participants, treatment providers and assessors were not blinded, as this was not feasible. All treatment and care was the same across groups and withdrawal and loss to follow-up were comparable. There was not information in the paper about what methods were used to avoid ascertainment bias.

Interpretation of Results: The results indicate that following both mCIMT and IBT there are clinically significant improvements in children's feelings about functioning, participation and physical health, which are maintained for one year.

Summary: This study indicated that both mCIMT and IBT have positive impacts on quality of life for children with CP, specifically regarding their feelings about functioning, participation and physical health. The study also highlights the importance of using goal directed, meaningful, age appropriate and enjoyable activities in therapy. The generalisability of this study is questionable, due to the day camp model of treatment which may be difficult to replicate and not financially sustainable.

Table 7: *Characteristics of included studies*

	Study 1 (Sakzewski, et al., 2014)	**Study 2** (Fedrizzi, et al., 2013)	**Study 3** (Deppe, et al., 2013)	**Study 4** (Klingels, et al., 2013)	**Study 5** (Sakzewski, et al., 2012)
Intervention investigated	Meta-analysis (CIMT, IBT and combination therapy)	mCIMT and IBT	IBT	mCIMT	mCIMT
Comparison intervention	Not applicable	Standard treatment	Combination therapy	Combination therapy	IBT
Outcomes used	All included studies used a wide variety of measures	QUEST Besta Scale	Melbourne Assessment AHA PEDI Self-care Scale	AHA MAS MMT Grip Strength Melbourne Assessment Jebsen-Taylor Test ABILHAND-Kids questionnaire	CPQOL-Child KIDSCREEN-52
Findings	mCIMT had modest clinical effects in improving hand function. Significant contributors to the efficacy of any intervention were identified as dose and intensity, the inclusion of a home based program and a goal-directed approach.	Intensive mCIMT and IBT improve hand function, specifically grasp and spontaneous hand use, by six month follow-up.	Combination therapy is more effective than IBT alone, in improving motor functions in the arm and hand of children with CP.	Combination therapy improves functional outcomes more than mCIMT alone through enhancing bimanual hand performance.	Both mCIMT and IBT achieved changes in the QOL domains of feelings about functioning, participation and physical health.

IMPLICATIONS:

Implications for practice
From this research base there are several implications for practice which need to be considered. Key findings suggest that intensive goal directed upper limb training has been proven to be effective using either a mCIMT, IBT or a combination therapy approach. While all three therapies are considered to be of green light standard for improving function they can only be considered orange for use in increasing participation in leisure activities due to the lack of specific research in this area. These therapies have shown to improve areas of well-being including upper extremity function, physical health, feelings about participation and quality of life. Improved outcomes are typically related to a greater intensity of treatment, parental training, home programs and goal directed forms of therapy. Some studies demonstrated an age dependent difference in the combined interventions of mCIMT and IBT which could potentially be due to the developmental non-use phenomenon where younger children are more capable to incorporate the arm spontaneously into bimanual activities than older children. More severely impaired children demonstrated a significant improvement in combination therapy compared to those children who were less impaired; this could be expected as children with a more significant impairment have more functional gains to make. From the investigated research, there does not appear to be specific Australian practice guidelines for working with children who have CP. There are however hospital guidelines and information about specific CP therapy used in practice, such as those created by The Royal Children's Hospital (Royal Children's Hospital, 2008; Royal Children's Hospital, 2014). The development of specific CP practice guidelines would help to ensure high quality service provision for children and their families in Australia.

Implications for public health
The reviewed studies found positive impacts for mCIMT, IBT and combination therapy on upper limb function and QOL in children with CP. Given this all three therapies should be offered in the public health settings. Overall, the reviewed studies consistently highlighted the importance of therapeutic intervention taking a goal directed and engaging approach. Six independent studies within the meta-analysis identified activity-based therapy focusing on goals identified by the children and their parents as being an integral part of upper limb intervention. This concept is perhaps best highlighted by the Sakzewaski et al. (2012) randomised control trial, which engaged children with a circus themed day camp which employed goal-directed activity-based frameworks. Of all the considered studies and the majority of the 42 included in the meta-analysis, Sakzewaski et al. (2012) had the lowest dropout rate of children. This highlights the increased compliance and engagement seen in therapies which are meaningful, promote ability not impairment and absorb participants in age appropriate, fun activities which help them work toward important goals, ultimately leading to improved outcomes for intervention. When considering the implications of this finding for public health it is important to evaluate the viability a day camp model. Potentially, this intensive structure is not financially viable for the public health system, particularly for children living in more remote and rural areas. This is of particular concern for the Australian public health system given the low population density outside urban areas. It is important to weigh the financial costs of such interventions against the benefit demonstrated for children and the potential to reduce future public medical and social services costs as a result of children's improved upper limb function.

Implications for education
Evidence demonstrates that mCIMT, IBT and combination therapy are all effective for improving upper limb function in children with CP and as such are established as green light interventions. In order to provide the most effective and suitable therapy available it is essential that OT's prioritise the use of green light interventions in practice. Literature indicates that when using these forms of therapies both dose and intensity are key contributing characteristics to better outcomes in children (Sakzewaski, 2012; Fedrizzi, 2013). A critical cut-off point has yet to be established for these therapies however evidence suggests that at least 40 hours of these therapies over a condensed period of time has led to both clinically and statistically significant improvements in upper limb function (Sakzewaski, 2012; Fedrizzi, 2013). The need for home-based therapy programs has been highlighted throughout the research in order to provide intensive and cost-effective therapy. Additionally, the literature also indicates that interventions that are embedded in familiar and natural environments tend to provide a more meaningful, generalisable and sustainable improvement in functioning. This leads to the notion that in order to provide consistent and effective home therapy, appropriate parent education and training must be provided. Five key principles for developing home-based programs have been proposed including; building collaborative partnerships between therapists and parents; developing mutually agreed upon goals; selecting activities which directly reflect goal attainment; providing parent support; and frequently evaluating outcomes and sharing the results with parents.

Implications for future research
The current research base demonstrates that CIMT, IBT and combination therapy are all effective for improving upper limb function in children with CP. However a purely functional outlook is limiting and future research needs to be conducted to determine the efficacy of these therapy types on the outcome of participation in leisure tasks. Much of the available research focus on motor function as an outcome, and perhaps this is because there is a lack of valid and reliable measures for participation in leisure tasks for children with CP. Future research should focus on developing or determining the most legitimate tool to measure engagement in leisure. Additionally, many of the studies reviewed differed in the dosage of therapy, making a clinically significant intervention dose for these therapies unclear. A defined dose should be established to ensure efficacy, cost effectiveness and improved outcomes. Klingels et al (2013) and Deppe et al (2013) drew different conclusions on the correlation between intervention dose and age, therefore, it should be determined if there is an association between age and dose, as this may guide practice for early intervention programs. Finally, from the research, it was unclear which children achieve the most clinically meaningful outcomes; future research should also aim to establish the characteristic of children who experience the most significant and functional gains from these interventions.

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APPENDIX A:

Efficacy of upper limb therapies for unilateral CP: a meta-analysis by Sakzewski, L., Ziviani, J., & Boyd, R. N. (2013) – Relevant Results

Comparison	**Outcome Measure**	**Statistical Results**	**Significance**
mCIMT v. Control	QUEST- Grasp Domain	0.30(-0.04-0.64) p=.08	Non-significant
mCIMT v. Alternative therapy	QUEST – Grasp Domain	0.11(-0.26-0.47) p=.57	Non-significant
mCIMT v. Control	Bruininks-Osteretsky – Movement Efficiency	1.95(-1.01-4.95) p=.20	Non-significant
mCIMT v. Alternative therapy	Bruininks-Osteretsky – Movement Efficiency	0.82(0.12-1.52) p=.02	Clinically and statistically significant
mCIMT v. Bimanual	Assisting Hand Assessment	-0.04(-0.42-0.35) p=.86	Non-significant
mCIMT v. Control	Assisting Hand Assessment	0.13(-0.39-0.66) p=.62	Non-significant
Bimanual v. mCIMT	COPM – Performance & Satisfaction	-0.13(-0.58-0.31) p=.29	Non-significant
mCIMT v. Control	COPM – Performance	0.05(-0.38-0.48) p=.83	Non-significant

APPENDIX B:

Unimanual and Bimanual Intensive Training in Children With Hemiplegic Cerebral Palsy and Persistence in Time of Hand Function Improvement 6-Month Follow-Up Results of a Multisite Clinical Trial by Fedrizzi, E., Rosa-Rizzotto, M., Turconi, A.C., Pagliano, E., Fazzi, E., Dalla Pozza, L.V., & Facchin, P. (2013) – Relevant Results

Table 2. Mean Global and Subscores per Treatment Group on the Beats and Quality of Upper Extremity Skills Test Scales Before (t_0) and After (t_1) Treatment and in the 2 Follow-up Sessions (t_2 and t_3).[a]

		Beats Scale												Quality of Upper Extremity Skills Test									
		Global Score			Group, Affected Side			Bimanual Use			ADL Use			Global Score			Group[b]			Group, Affected Side			Group, Unaffected Side		
	Time	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
mCIMT	t_0	2.41	0.80		2.85	0.77		2.54	0.88		2.14	0.92		69.4	15.8		65.1	16.8		5.2	3.8		11.5	1.9	
	t_1 (p t_1-t_0)[c]	2.62	0.75	<.001	3.15	0.66	.002	2.76	0.00	.010	2.28	0.06	.200	76.3	14.9	<.001	72.1	16.0	<.001	6.9	3.9	<.001	11.1	1.8	.157
	t_2 (p t_2-t_1)[c]	2.66	0.84	.099	3.13	0.70	.938	2.74	0.86	.851	2.40	0.95	.015	73.8	16.7	.111	70.8	18.7	.761	6.5	3.8	.208	11.6	1.8	.040
	t_3 (p t_3-t_2)[c]	2.66	0.83	.913	3.12	0.71	.496	2.77	0.84	.688	2.39	0.93	.809	74.1	15.2	.739	69.2	18.7	.358	6.3	3.9	.231	11.9	1.6	.060
IBT	t_0	2.54	0.88		2.80	0.91		2.67	0.87		2.40	1.00		66.3	20.3		64.2	21.3		5.7	4.0		11.2	2.2	
	t_1 (p t_1-t_0)[c]	2.74	0.87	<.001	2.88	0.86	.263	2.94	0.81	.001	2.59	0.99	.001	70.0	20.3	.002	66.9	22.1	.040	5.9	3.7	.107	11.4	2.2	.044
	t_2 (p t_2-t_1)[c]	2.80	0.92	.278	2.95	0.91	.200	2.93	0.86	.915	2.70	1.03	.122	71.4	19.1	.123	67.6	20.7	.427	6.0	3.6	.377	11.0	2.2	.988
	t_3 (p t_3-t_2)[c]	2.86	0.90	.883	3.01	0.91	.672	3.05	0.86	.560	2.73	0.97	.910	74.6	18.3	.294	68.9	24.0	.742	7.3	4.1	.023	11.7	2.3	.109
ST	t_0	2.63	0.84		2.96	0.87		2.89	0.85		2.35	0.91		72.2	17.2		64.9	21.5		6.1	3.9		11.8	1.3	
	t_1 (p t_1-t_0)[c]	2.71	0.79	.127	3.01	0.78	.650	3.02	0.68	.107	2.48	0.93	.098	72.6	17.7	.601	66.1	20.8	.474	6.1	3.8	1.000	11.6	1.7	.332
	t_2 (p t_2-t_1)[c]	2.68	0.71	.212	3.05	0.73	.383	2.97	0.68	.502	2.38	0.83	.378	68.0	15.9	.776	62.4	16.5	.738	5.3	3.5	.522	11.3	1.6	.998
	t_3 (p t_3-t_2)[c]	2.70	0.67	.615	3.05	0.73	1.000	2.93	0.69	.554	2.44	0.78	.636	71.3	15.7	.681	66.5	19.9	.820	6.0	3.6	.408	11.9	1.1	.328

Abbreviations: ADL, activities of daily living; IBT, intensive bimanual training; mCIMT, modified constraint-induced movement therapy; ST, standard treatment.
[a] P values were calculated comparing each time with the previous, eg, p t_1-t_0, p t_2-t_1, p t_3-t_2, for each treatment group.
[b] Quality of Upper Extremity Skills Test Group score results from the combination of performance on request of both arms (affected and nonaffected).
[c] Wilcoxon signed rank test—nonparametric paired samples t test.

APPENDIX C:

Description and appraisal of Randomized Trial of Modified Constraint-Induced Movement Therapy With and Without an Intensive Therapy Program in Children With Unilateral CP by Klingels, Feys, Molenaers, Verbeke, Van Daele, Hoskens, J., ... and De Cock (2013)- Relevant Results

Table 2. Descriptive Statistics of Outcome Measures at Baseline, After Intervention, and at 10 Weeks Follow-Up and Statistical Comparison (*P* Values).

			Baseline	Postintervention	10-Week Follow-Up	Time	Time * Group
Body function level							
Modified Ashworth Scale	X (SD)	m-CIMT	6.83 (2.76)	5.02 (2.13)	5.55 (1.84)	.002	.40
		m-CIMT + IT	6.74 (2.92)	6.04 (2.33)	5.96 (2.76)		
Manual muscle testing	Me (IQR)	m-CIMT	19.8 (17.5-22.0)	21.8 (19.0-23.0)	21.0 (20.5-23.5)	<.0001	.91
		m-CIMT + IT	19.5 (18.0-21.5)	20.0 (19.0-23.5)	21.5 (19.5-22.5)		
Grip strength; JAMAR dynamometer absolute scores (kg)	X (SD)	m-CIMT	4.89 (2.98)	4.77 (3.33)	5.11 (3.43)	.02	.85
		m-CIMT + IT	5.32 (3.42)	5.37 (3.74)	5.97 (4.05)		
Activity level							
AHA (logits 0-100)	X (SD)	m-CIMT	63.6 (16.2)	65.6 (13.3)	65.5 (15.0)	.21	.04
		m-CIMT + IT	61.0 (14.6)	65.2 (14.5)	64.7 (14.8)	.002	
Melbourne Assessment (%)	Me (IQR)	m-CIMT	68.9 (55.7-87.7)	74.6 (59.0-90.2)	74.2 (56.0-88.5)	<.0001	.56
		m-CIMT + IT	68.9 (56.0-85.3)	74.6 (61.5-88.0)	75.4 (59.8-89.3)		
Jebsen–Taylor test (seconds)	Me (IQR)	m-CIMT	250 (93-457)	158 (75-418)	153 (83-409)	<.0001	.07
		m-CIMT + IT	295 (121-426)	218 (82-309)	201 (87-312)		
ABILHAND-Kids (logits)	X (SD)	m-CIMT	1.42 (1.38)	1.77 (1.46)	1.63 (1.60)	.14	.40
		m-CIMT + IT	1.36 (1.27)	1.79 (1.38)	1.75 (1.80)		

Abbreviations: X, mean; SD, standard deviation; Me, median; IQR, interquartile range; m-CIMT, modified constraint-induced movement therapy; IT, intensive therapy.

APPENDIX D:

Description and appraisal of Modified constraint-induced movement therapy versus intensive bimanual training for children with hemiplegia- a randomized control trial by Deppe, W., Thuemmler, K., Fleischer, J., Berger, C., Meyer, S., & Wiedemann, B. (2013) – Relevant Results

Table 2b. Comparison of treatment outcome for modified constraint-induced movement therapy and intensive bimanual training for patients with cerebral palsy only.

	Kid-CIMT (*N* = 16)			IBT (*N* = 13)			Group effect		
	Mean ± SD	95% CI	*P*-value	Mean ± SD	95% CI	*P*-value	*F*	df	*P*-value
Melbourne Assessment									
Posttreatment raw score	82.9 ± 21.4			83.7 ± 23.8					
Posttreatment gain	7.6 ± 5.8	4.5–10.7	<0.001	2.7 ± 5.7	–0.8–6.2	0.116	4.513	1	0.043*
Posttreatment percent score	68.4 ± 18.2			68.6 ± 19.5					
Posttreatment gain	6.4 ± 5.7	3.4–9.5	<0.001	2.2 ± 4.6	–0.6–5.0	0.116	4.186	1	0.051
Assisting Hand Assessment									
Posttreatment raw score	62.6 ± 7.2			64.4 ± 13.1					
Posttreatment gain	3.9 ± 3.3	2.1–5.6	<0.001	3.2 ± 2.5	1.7–4.8	0.001	0.120	1	0.732
Posttreatment percent score	61.5 ± 10.8			64.2 ± 19.8					
Posttreatment gain	5.8 ± 5.1	3.1–8.5	<0.001	4.8 ± 3.8	2.6–7.1	0.001	0.092	1	0.764
PEDI self-care									
Posttreatment raw score	62.1 ± 7.8			60.4 ± 8.9					
Posttreatment gain	1.8 ± 3.0	0.0–3.7	0.046	1.4 ± 5.1	–1.7–8.4	0.408	0.158	1	0.695

CI, confidence interval; df, degrees of freedom; kid-CIMT, child-friendly modified constraint-induced movement therapy; IBT, intensive bimanual training; MACS, Manual Ability Classification System; PEDI, Pediatric Evaluation of Disability Inventory; SD, standard deviation.

APPENDIX E:

Description and appraisal of Impact of intensive upper limb rehabilitation on quality of life: a randomized trial in children with unilateral CP by Sakzewski, L., Carlon, S., Shields, N., Ziviani, J., Ware, R.S., & Boyd, R.N. (2012) – Relevant Results

Table II: Estimated mean difference (EMD) over time in quality of life domains between groups receiving constraint-induced movement therapy (CIMT) or bimanual training (BIM) according to CPQOL-Child, parent proxy and self-reports

	EMD, parent proxy report			EMD, child self-report		
	Baseline to 3 weeks (99% CI); *p*	Baseline to 26 weeks (95% CI); *p*	Baseline to 52 weeks (95% CI); *p*	Baseline to 3 weeks (99% CI); *p*	Baseline to 26 weeks (95% CI); *p*	Baseline to 52 weeks (95% CI); *p*
Social well-being						
CIMT[a]	6.1 (3.9 to 8.2); <0.001	5.7 (1.9 to 9.5); 0.003	5.6 (1.6 to 9.6); 0.006	4.6 (−0.4 to 9.6); 0.07	4.3 (−2.3 to 10.9); 0.2	5.4 (−1.3 to 12.2); 0.1
BIM[a]	2.4 (0.3 to 4.5); 0.02	3.4 (−0.5 to 7.2); 0.09	2.3 (−1.8 to 6.4); 0.3	−0.2 (−6.4 to 5.1); 0.9	−1.8 (−8.7 to 5.2); 0.6	3.4 (−3.7 to 10.5); 0.4
Difference between groups	3.6 (0.8 to 6.6); 0.02	2.3 (−3.1 to 7.8); 0.4	3.3 (−2.5 to 9.0); 0.3	4.8 (−2.5 to 12.0); 0.2	6.1 (−3.5 to 15.6); 0.2	2.0 (−7.8 to 11.8); 0.7
Feelings about functioning						
CIMT	4.9 (1.7 to 8.0); 0.002	6.4 (2.7 to 11.1); <0.001	3.5 (−0.1 to 7.1); 0.06	8.4 (5.5 to 11.3); <0.001	9.3 (3.7 to 15.0); 0.001	9.4 (3.0 to 15.9); 0.004
BIM	7.8 (4.7 to 10.8); <0.001	7.4 (3.7 to 11.1); <0.001	8.1 (4.4 to 11.7); <0.001	3.8 (0.8 to 6.8); 0.01	2.4 (−3.8 to 8.4); 0.4	8.6 (1.8 to 15.4); 0.01
Difference between groups	−2.9 (−7.3 to 1.4); 0.2	−0.9 (−6.2 to 4.3); 0.7	−4.6 (−9.7 to 0.5); 0.08	4.6 (0.4 to 8.7); 0.03	6.9 (−1.4 to 15.1); 0.1	0.8 (−8.5 to 10.2); 0.9
Participation and physical health						
CIMT	5.2 (3.3 to 7.1); <0.001	6.2 (1.7 to 10.8); 0.008	5.1 (0.8 to 9.4); 0.03	4.8 (1.3 to 8.4); 0.007	10.0 (3.5 to 16.5); 0.003	9.1 (1.5 to 16.7); 0.02
BIM	7.8 (5.9 to 9.7); <0.001	9.6 (5.0 to 14.3); <0.001	9.2 (4.5 to 13.9); <0.001	3.7 (0.1 to 7.3); 0.05	6.1 (−0.8 to 13.0); 0.08	11.8 (3.7 to 19.8); 0.004
Difference between groups	−2.6 (−6.3 to 0.1); 0.06	−3.4 (−9.9 to 3.1); 0.3	−4.1 (−10.6 to 2.4); 0.2	1.2 (−3.9 to 6.2); 0.7	3.9 (−5.8 to 13.3); 0.4	−2.6 (−13.7 to 8.4); 0.6
Emotional well-being						
CIMT	3.4 (0.5 to 6.3); 0.02	3.4 (−1.0 to 7.8); 0.1	2.3 (−1.8 to 6.3); 0.3	3.8 (0.2 to 7.4); 0.04	3.7 (−2.6 to 10.0); 0.2	1.8 (−4.7 to 8.2); 0.6
BIM	5.4 (2.6 to 8.2); <0.001	4.2 (−0.3 to 8.6); 0.07	4.0 (−0.2 to 8.2); 0.06	−1.8 (−6.6 to 1.9); 0.3	1.1 (−5.6 to 7.7); 0.8	5.7 (−1.1 to 12.5); 0.1
Difference between groups	−2.0 (−6.0 to 2.0); 0.3	−0.8 (−7.1 to 5.5); 0.8	−1.7 (−7.6 to 4.1); 0.6	5.7 (0.5 to 10.9); 0.03	2.8 (−6.5 to 11.7); 0.6	−3.9 (−13.2 to 5.5); 0.4
Pain						
CIMT	2.8 (−1.7 to 7.3); 0.2	−2.4 (−6.8 to 4.1); 0.5	−0.6 (−6.7 to 5.6); 0.9	−4.7 (−12.4 to 3.0); 0.2	−6.9 (−17.1 to 3.2); 0.2	−7.8 (−18.3 to 2.8); 0.1
BIM	−2.2 (−6.7 to 2.3); 0.3	−2.3 (−6.6 to 4.2); 0.5	−4.0 (−10.3 to 2.4); 0.2	−10.6 (−18.5 to −2.6); 0.009	−6.4 (−17.2 to 4.4); 0.2	−12.1 (−23.0 to −0.9); 0.03
Difference between groups	5.0 (−1.4 to 11.3); 0.1	−0.1 (−6.2 to 9.1); 0.9	3.4 (−5.4 to 12.2); 0.8	5.9 (−5.2 to 16.9); 0.3	−0.5 (−15.3 to 14.3); 0.9	4.3 (−11.0 to 19.7); 0.6
Access[b]						
CIMT	2.4 (−1.0 to 10.9); 0.1	4.9 (−1.0 to 11.0); 0.1	2.7 (−3.2 to 8.7); 0.4	–	–	–
BIM	3.2 (−2.2 to 8.6); 0.5	2.3 (−3.7 to 8.3); 0.5	3.7 (−2.3 to 9.7); 0.2	–	–	–
Difference between groups	−0.7 (−8.4 to 7.0); 0.9	2.7 (−5.8 to 11.2); 0.5	−0.9 (−9.3 to 7.5); 0.8	–	–	–
Family[b]						
CIMT	3.6 (0.5 to 6.7); 0.02	3.3 (−1.3 to 7.9); 0.2	2.5 (−2.6 to 7.7); 0.2	–	–	–
BIM	4.4 (1.4 to 7.5); 0.004	8.6 (3.9 to 13.3); <0.001	10.5 (5.3 to 15.7); <0.001	–	–	–
Difference between groups	−0.8 (−5.1 to 3.5); 0.7	−5.4 (−11.9 to 1.2); 0.1	−7.9 (−15.3 to 0.6); <0.001	–	–	–

[a]Child self-report, *n*=18; parent proxy report, *n*=32. [b]Child self-report, *n*=17; parent proxy report, *n*=31. [c]Domains not assessed in child self-report. EMD generated from generalized estimating equations. CPQOL-Child, Cerebral Palsy Quality of Life Questionnaire for Children; CI, confidence interval.