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Interventions and Management

1. A systematic review of instrumented assessments for upper limb function in cerebral palsy: current limitations and future directions

Julie Rozaire, Clémence Paquin, Lauren Henry, Hovannes Agopyan, Rachel Bard-Pondarré, Alexandre Naaim, Sonia Duprey, Emmanuelle Chaleat-Valayer

Review J Neuroeng Rehabil. 2024 Apr 16;21(1):56. doi: 10.1186/s12984-024-01353-6.

Introduction: Recently, interest in quantifying upper limb function in cerebral palsy has grown. However, the lack of reference tasks and protocols, have hindered the development of quantified movement analysis in clinical practice. This study aimed to evaluate existing instrumented assessments of upper limb function in cerebral palsy, with a focus on their clinical applicability, to identify reasons for the lack of adoption and provide recommendations for improving clinical relevance and utility. **Methods:** A systematic review was conducted by a multidisciplinary team of researchers and clinicians (Prospero CRD42023402382). PubMed and Web of Science databases were searched using relevant keywords and inclusion/exclusion criteria. **Results:** A total of 657 articles were initially identified, and after the selection process, 76 records were included for analysis comprising a total of 1293 patients with cerebral palsy. The quality assessment of the reviewed studies revealed a moderate overall quality, with deficiencies in sample size justification and participant information. Optoelectronic motion capture systems were predominantly used in the studies ($N = 57/76$). The population mainly consisted of individuals with spastic cerebral palsy (834/1293) with unilateral impairment ($N = 1092/1293$). Patients with severe functional impairment (MACS IV and V) were underrepresented with 3.4% of the 754 patients for whom the information was provided. Thirty-nine tasks were used across the articles. Most articles focused on unimanual activities ($N = 66/76$) and reach or reach and grasp ($N = 51/76$). Bimanual cooperative tasks only represented 3 tasks present in 4 articles. A total of 140 different parameters were identified across articles. Task duration was the most frequently used parameter and 23% of the parameters were used in only one article. **Conclusion:** Further research is necessary before incorporating quantified motion analysis into clinical practice. Existing protocols focus on extensively studied populations and rely on costly equipment, limiting their practicality. Standardized unimanual tasks provide limited insights into everyday arm use. Balancing methodological requirements and performance evaluation flexibility is a challenge. Exploring the correlation between outcome parameters and therapeutic guidance could facilitate the integration of quantified movement assessment into treatment pathways.

PMID: [38622731](https://pubmed.ncbi.nlm.nih.gov/38622731/)

2. The relationship between manual ability, dystonia and choreoathetosis severity and upper limb movement patterns during reaching and grasping in children and young adults with dyskinetic cerebral palsy

Inti Vanmechelen, Helga Haberfehlner, Brian H M Martens, R Jeroen Vermeulen, Annemieke I Buizer, Kaat Desloovere, Jean-Marie Aerts, Hilde Feys, ELEGAST Monbaliu

Eur J Paediatr Neurol. 2024 Apr 9:50:41-50. doi: 10.1016/j.ejpn.2024.04.001. Online ahead of print.

Introduction: Impaired upper limb movements are a key feature in dyskinetic cerebral palsy (CP). However, information on how specific movement patterns relate to manual ability, performance and underlying movement disorders is lacking. Insight

in these associations may contribute to targeted upper limb management in dyskinetic CP. This study aimed to explore associations between deviant upper limb movement patterns and (1) manual ability, (2) severity of dystonia/choreoathetosis, and (3) movement time/trajectory deviation during reaching and grasping. Participants/methods: Participants underwent three-dimensional upper limb analysis during reaching forwards (RF), reaching sideways (RS) and reach-and-grasp vertical (RGV) as well as clinical assessment. Canonical correlation and regression analysis with statistical parametric mapping were used to explore associations between clinical/performance parameters and movement patterns (mean and variability). Results: Thirty individuals with dyskinetic CP participated (mean age 16±5 y; 20 girls). Lower manual ability was related to higher variability in wrist flexion/extension during RF and RS early in the reaching cycle ($p < 0.05$). Higher dystonia severity was associated with higher mean wrist flexion (40-82 % of the reaching cycle; $p = 0.004$) and higher variability in wrist flexion/extension (31-75 %; $p < 0.001$) and deviation (2-14 %; $p = 0.007/60-73$ %; $p = 0.006$) during RF. Choreoathetosis severity was associated with higher elbow pro/supination variability (12-19 %; $p = 0.009$) during RGV. Trajectory deviation was associated with wrist and elbow movement variability ($p < 0.05$). Conclusion: Current novel analysis of upper limb movement patterns and respective timings allows to detect joint angles and periods in the movement cycle wherein associations with clinical parameters occur. These associations are not present at each joint level, nor during the full movement cycle. This knowledge should be considered for individualized treatment strategies.

PMID: [38614013](#)

3. Effects of task-based mirror therapy on upper limb motor function in hemiplegia: study protocol for a randomized controlled clinical trial

Hongzhen Liu, Yangjie Xu, Wei Jiang, Fangchao Hu, Yi Zhou, Lu Pan, Feng Zhou, Ying Yin, Botao Tan

Trials. 2024 Apr 11;25(1):254. doi: 10.1186/s13063-024-08081-1.

Background and purpose: Research to date has lacked definitive evidence to determine whether mirror therapy promotes the recovery of upper extremity function after stroke. Considering that previous studies did not stratify patients based on structural retention, this may be one of the reasons for the negative results obtained in many trials. The goal evaluates the efficacy of TBMT (utilizing an innovatively designed mirror) versus standard occupational therapy for stroke patient's upper limb functionality. **Methods and analysis:** This single-center randomized controlled trial will involve 50 patients with stroke. All patients will be randomly assigned to either the task-based mirror therapy or the control group. The interventions will be performed 5 days per week for 4 weeks. The primary outcomes will be the mean change in scores on both the FMA-UE and modified Barthel Index (MBI) from baseline to 4 weeks intervention and at 12 weeks follow-up between the two groups and within groups. The other outcomes will include the Action Research Arm Test (ARAT), the Nine Hole Peg Test (9HPT), the Functional Independence Measure, and MRI. **Discussion:** This trial will not only to establish that task-based mirror therapy (TBMT) could improve the recovery of hand function after stroke but also to explore the underlying mechanisms. We expect that this finding will clarify the brain activation and brain network mechanisms underlying the improvement of hand function with task-oriented mirror therapy and lead to new ideas for stroke hand function rehabilitation. Trial registration: URL: <https://www.chictr.org.cn> ; Unique identifier: ChiCTR2300068855. Registered on March 1, 2023.

PMID: [38605413](#)

4. The Impact on Families of Children With Congenital Upper Extremity Differences

Sarah Ballatori, Andrea Bauer, Angela Wang, Julie Samora, Suzanne Steinman, Claire Manske, Apurva Shah, Lindley B Wall; CoULD Study Group

J Hand Surg Am. 2024 Apr 16:S0363-5023(24)00095-9. doi: 10.1016/j.jhsa.2024.02.011. Online ahead of print.

Purpose: To investigate the impact on caregivers of caring for a child with congenital upper extremity differences. **Methods:** In this cross-sectional study, caregivers of patients enrolled in the multi-institutional Congenital Upper Limb Difference (CoULD) registry were contacted. Demographic information and the Impact on Family Scale (IOFS), a validated measure of perceived caregiver strain, were collected. Patient-reported outcome measures from the CoULD registry, the Pediatric Outcomes Data Collection Instrument (PODCI), and Patient-Reported Outcomes Measurement Information System (PROMIS) were also analyzed for correlation with IOFS. **Results:** Two hundred ninety-nine caregivers participated. Factors with significantly stronger impact on family included public insurance; bilateral upper extremity involvement; household income of \$20,000-40,000; additional musculoskeletal diagnosis; and a single adult caregiver household. There was a significantly increased subcategory of IOFS-Finance score for distant travel to see the surgeon. Additionally, all categories of the PODCI (upper extremity, mobility, sports, pain, happiness, and global) demonstrated a negative correlation with IOFS. PROMIS upper extremity and peer relations also demonstrated an inverse relationship with IOFS, whereas PROMIS pain interference had a positive correlation with IOFS. The overall IOFS for children with CoULDs was greater than previously reported for children with brachial plexus birth injury, and less than cerebral palsy and congenital heart disease. **Conclusions:** Caregivers of children with congenital upper extremity differences report a significant impact on family life. Socioeconomic factors, such as economically disadvantaged or single-caregiver households, and clinical factors, such as bilateral upper extremity involvement, correlate with greater family impact. These findings represent opportunities to identify at-risk families and underscore the

importance of caring for the whole family through a multidisciplinary approach. Type of study/level of evidence: Prognostic II.

PMID: [38639681](#)

5. Response to article "Effect of the Dynamic Orthotic Garment on Postural Control, and Endurance in Children with Spastic Diplegic Cerebral Palsy: A Randomized Controlled Trial" [Letter]

Payal Mehta, Sandeep Pattnaik, Sunanda Bhowmik

J Multidiscip Healthc. 2024 Apr 11;17:1585-1586. doi: 10.2147/JMDH.S471812. eCollection 2024.

No abstract available

PMID: [38623393](#)

6. Sagittal spinopelvic alignment in ambulatory persons with cerebral palsy

Stephen Plachta, Sonya B Levine, Kirsten Carlberg, Peter M Cirrincione, Michael Vitale, Lawrence G Lenke, Benjamin D Roye, Paulo R P Selber

Spine Deform. 2024 Apr 17. doi: 10.1007/s43390-024-00866-3. Online ahead of print.

Purpose: This study aimed to describe the spinopelvic alignment of a cohort of young ambulatory individuals with cerebral palsy (CP) and compare it to published spinopelvic alignment data for the typically developing adolescents. **Methods:** Thirty-seven adolescents (18 females) with CP at GMFCS I-III were included in this retrospective case series. Lumbar lordosis and pelvic incidence were measured, and their mismatch was calculated. A model that calculates predicted lumbar lordosis based on pelvic incidence in normative data was utilized to calculate a predicted lumbar lordosis in this cohort with cerebral palsy. **Results:** At imaging, ages were mean and standard deviation 13.5 ± 3.0 years. Pelvic incidence was $46.2^\circ \pm 12.9^\circ$, pelvic tilt was $2.8^\circ \pm 9.4^\circ$, sacral slope was $43.6^\circ \pm 10.8^\circ$, and measured lumbar lordosis was $59.4^\circ \pm 11.6^\circ$. There were no differences in pelvic incidence or lumbar lordosis among the GMFCS levels; however, pelvic incidence was higher in females. Pelvic incidence-lumbar lordosis mismatch greater than 10° was found in 67% of the cohort. Mean predicted lumbar lordosis based on the model was $54.7^\circ \pm 8.5^\circ$, averaging 8° less than measured lordosis. **Conclusion:** PI-LL mismatch was identified in 67% of this cohort of ambulatory adolescents with CP, in part due to greater lordosis than predicted by a model based on data from adolescents without CP. The implications of this finding, such as the correlation between sagittal spinopelvic alignment and quality of life in this population, should be assessed further in ambulatory patients with cerebral palsy. **Level of evidence:** Level IV-retrospective cohort study and literature comparison.

PMID: [38632183](#)

7. Effects of Pediatric Rehabilitation on Children With Spastic Quadriplegia Primary to Seizure Disorder and Global Developmental Delay: A Case Report

Neha M Chitlange, H V Sharath, Akshaya Saklecha, Sakshi Desai

Case Reports Cureus. 2024 Mar 14;16(3):e56189. doi: 10.7759/cureus.56189. eCollection 2024 Mar.

The most severe form of spastic cerebral palsy (CP), which affects the arms and legs and often the face, is known as spastic quadriplegia. In addition to other developmental disabilities such as intellectual disability and seizures, it can cause difficulty in walking. Children with CP often have seizures as a result of brain injury, and spastic quadriplegic CP is typically associated with global developmental delay. For the purpose of addressing the unique motor and functional challenges associated with spastic quadriplegia, neurophysiotherapy is essential. This treatment includes neurodevelopmental techniques, posture and balance training, and activities aimed at improving gait. The purpose of this case study is to demonstrate how early and continuous physical therapy interventions can maximize a child's functional abilities and prevent further complications. In this instance, a five-year-old boy with a documented history of spastic quadriplegia, seizure disorder, and global developmental delay reported experiencing challenges with sitting, walking, and speech. He had three episodes of fever, which led to his hospital admission. The child's medical history included acute hemorrhagic encephalitis, mild hydroreteronephrosis on the left side, and persistent convulsions that affected only one side of the body. Bilateral thalamic altered signal intensities were observed in the brain's MRI, and multiple calcifications were detected in the periventricular cortex, thalamus, and basal ganglia on the brain's CT scan. To enhance the independence, strength, and coordination of voluntary movement in individuals with CP, a variety of techniques are used in addition to physical therapy, such as occupational therapy, speech therapy, aquatic therapy, constraint-induced movement therapy, functional electrical stimulation, orthotic devices, injections of botulinum toxin, and hippotherapy.

PMID: [38618391](#)

8. Preliminary Results of Calcaneal Lengthening Osteotomy Combined With Extra-articular Subtalar Arthrodesis for Severe Pes Planovalgus Deformity in Children With Cerebral Palsy: A New Surgical Technique

Fuat Bilgili, Mehmet Demirel, Dağhan Koyuncu

J Pediatr Orthop. 2024 Apr 16. doi: 10.1097/BPO.0000000000002698. Online ahead of print.

Objective: Pes planovalgus is the most common foot deformity seen in patients with cerebral palsy (CP). There are several different treatment modalities to treat this condition. Single or double calcaneal osteotomies, extra-articular arthrodesis, calcaneo-cuboido-cuneiform osteotomy, intraarticular arthrodesis, and arthroereisis are some of these modalities. Currently, there is insufficient information to determine the most effective treatment approach for pes planovalgus in children with CP. The aim of this study is to show the short to mid-term results of the new technique which combines calcaneus lengthening osteotomy, extra-articular subtalar arthrodesis, and soft tissue reconstruction that aims to decrease recurrence and complication rates of pes planovalgus surgery for patients with ambulatory CP. **Methods:** Patients with CP who were treated with calcaneal lengthening surgery and extra-articular subtalar arthrodesis between 2018 and 2021 were investigated retrospectively. All patients were ambulatory and Gross Motor Function Classification System I-II-III. Functional levels of the patients were assessed with the American Orthopaedic Foot and Ankle Society, Ankle-Hindfoot Score, and the Foot and Ankle Ability Score (Foot and Ankle Ability Measure) in preoperative and postoperative periods. On anteroposterior x-rays, talus-first metatarsal, talocalcaneal, talonavicular coverage angle and on lateral x-rays talus-first metatarsal, talocalcaneal, calcaneal inclination angle and talar tilt angle were evaluated. **Results:** The mean follow-up was 46 (range: 36 to 60) months. The mean American Orthopaedic Foot and Ankle Society increased from 41 (20 to 79) to 74 (38 to 93; $P < 0.001$). The mean Foot and Ankle Ability Measure increased significantly from 35 (7 to 73) to 54 (29 to 96; $P < 0.001$). Clinical results were "satisfactory" for 32 feet, while they were "unsatisfactory" for 2 feet. Significant deformity correction was observed in all radiologic parameters. **Conclusion:** Our technique is found to be efficient for patients with Gross Motor Function Classification System I-II-III CP with pes planovalgus deformity. In short to mid-term follow-up, the technique achieved successful clinical and radiologic results with low complication rates. Superiority of this technique compared with the traditional ones can only be shown with randomized prospective studies. Level of evidence: Level III-retrospective cohort study.

PMID: [38623033](#)

9. Is dynamic motor control clinically important for identifying gait deviations in individuals with cerebral palsy?

Gilad Sorek, Marije Goudriaan, Itai Schurr, Simon-Henri Schless

Gait Posture. 2024 Apr 6:111:44-47. doi: 10.1016/j.gaitpost.2024.04.005. Online ahead of print.

Introduction: Individuals with cerebral palsy (CP) often present with altered motor control. This can be assessed selectively during sitting/lying with the Selective Control Assessment of the Lower Extremity (SCALE), or dynamically with the dynamic motor control index during walking (walk-DMC). Both approaches suggest that altered selective motor control relate to larger gait deviations. **Research question:** Does the walk-DMC provide valuable information in addition to the SCALE for estimating gait deviations in individuals with CP. **Methods:** Retrospective, treadmill-based gait analysis data of 157 children with spastic CP (mean 11.4 ± 3.5 years) and Gross Motor Function Classification System levels I ($n=45$), II ($n=88$) or III ($n=24$) were extracted. Gait kinematic deviations were evaluated using the Gait Profile Score (GPS). The SCALE, walk-DMC and GPS were extracted for the more clinically involved leg (unilateral-analysis), and for both legs together (bilateral-analysis). **Results:** GPS moderately correlated with both SCALE and walk-DMC scores, unilaterally and bilaterally ($r \geq 0.4$; $p < 0.001$). Multivariate linear regression analyses were conducted, taking into account potential confounding factors. In the unilateral analysis, 54% of the GPS variance was explained ($p < 0.001$), with both walk-DMC and SCALE significantly contributing to the GPS variance ($p=0.006$ and $p=0.008$, respectively). In the bilateral analysis, 61% of the GPS variance was explained ($p < 0.001$), with both walk-DMC and SCALE significantly contributing to the GPS variance ($p=0.006$ and $p < 0.001$, respectively). Dimensionless walking speed and use of assistive devices were the only confounding factors included in each analysis. **Significance:** Both SCALE and walk-DMC significantly contribute to GPS variance, suggesting that they likely measure different components of motor control, and both may be useful in understanding the underlying relationship between motor control and deviations in gait kinematics.

PMID: [38626568](#)

10. Baby Observational Selective Control AppRaisal (BabyOSCAR): Construct validity and test performance

Vanessa Maziero Barbosa, Colleen Peyton, Theresa Sukal-Moulton

Dev Med Child Neurol. 2024 Apr 16. doi: 10.1111/dmcn.15926. Online ahead of print.

Aim: To investigate the construct validity of the Baby Observational Selective Control AppRaisal (BabyOSCAR), an assessment of independent joint motion in infants with cerebral palsy (CP). **Method:** BabyOSCAR was scored for 75 infants (45 with CP and 30 without CP). Rasch analysis was used in combination with classical test theory to assess areas of strength

or improvement. Overall fit and precision, unidimensionality, local independence, reliability indices, Wright's child-item map, and differential item functioning were examined as part of Rasch analysis to investigate the item properties, internal construct validity, and reliability of BabyOSCAR. Cronbach's α was used to evaluate items' internal consistency. Results: Analysis demonstrated good fit to the Rasch model, with only one erratic item. Unidimensionality results suggest two dimensions, split between arm and leg items. Item calibration reliability was between 0.84 and 0.86, with three distinct item difficulty levels. Infant measure reliability was between 0.82 and 0.91, separating infants into three ability levels. Together, the two subscales covered the full range of skills, with redundancy mostly between the same motion on both sides of the body. Cronbach's α was between 0.90 and 0.95. Interpretation: BabyOSCAR's construct validity was supported. Arm and leg subscales can be translated to a logit scale.

PMID: [38627997](#)

11. Baby Observational Selective Control AppRaisal (BabyOSCAR): Scores at 3 months predict functional ability, spastic cerebral palsy distribution, and diagnosis at 2 years

Colleen Peyton, David Aaby, Vanessa Maziero Barbosa, Lynn Boswell, Raye-Ann de Regnier, Arend F Bos, Theresa Sukal Moulton

Dev Med Child Neurol. 2024 Apr 17. doi: 10.1111/dmcn.15925. Online ahead of print.

Aim: To assess the predictive capabilities of the Baby Observational Selective Control AppRaisal (BabyOSCAR) tool, administered at 3 months corrected age, in determining spastic cerebral palsy (CP) outcome, functional abilities, and body topography at 2 years of age or later. **Method:** Independent joint motions were measured at age 10 to 16 weeks from video recordings of spontaneous movement using BabyOSCAR in a sample of 75 infants. All included infants had known 2-year outcomes (45 with spastic CP and 30 without CP) including Gross Motor Functional Classification System (GMFCS) levels and CP body distribution. Receiver operating characteristic curves and cut points indicating greatest sensitivity and specificity were generated for predictive performance. **Results:** Total BabyOSCAR score was a strong predictor of future outcome of spastic CP (cut score of 22.5, sensitivity = 98%, specificity = 100%, area under the curve = 0.99), and was able to distinguish children classified in GMFCS levels I and II from those in III to V (cut score of 13.5, sensitivity = 92%, specificity = 89%, area under the curve = 0.94). Having an (absolute) asymmetry score on the BabyOSCAR of more than 5 was a predictor of having unilateral CP at age 2 years (sensitivity = 56%, specificity = 100%, area under the curve = 0.86). **Interpretation:** BabyOSCAR scores are predictors of diagnosis, body distribution, and future gross motor function in infants with spastic CP at 2 years of age or later.

PMID: [38629475](#)

12. Baby Observational Selective Control AppRaisal (BabyOSCAR): Convergent and discriminant validity and reliability in infants with and without spastic cerebral palsy

Theresa Sukal-Moulton, Vanessa Maziero Barbosa, Barbara Sargent, Lynn Boswell, Raye-Ann de Regnier, Arend F Bos, Colleen Peyton

Dev Med Child Neurol. 2024 Apr 15. doi: 10.1111/dmcn.15924. Online ahead of print.

Aim: To describe the development of an observational measure of spontaneous independent joint motion in infants with spastic cerebral palsy (CP), the Baby Observational Selective Control AppRaisal (BabyOSCAR), and to test its convergent validity and reliability. **Method:** A retrospective sample of 75 infants (45 with spastic CP and 30 without CP) at 3 months of age were scored with the BabyOSCAR and compared with diagnosis of spastic CP, limbs affected, and Gross Motor Function Classification level at 2 years of age or later for convergent validity using t-tests, Kruskal-Wallis tests, and Spearman's rank correlation coefficients. BabyOSCAR interrater and test-retest reliability was also evaluated using intraclass correlation coefficients. **Results:** Infants with spastic CP had significantly lower BabyOSCAR scores than children without CP ($p < 0.001$) and scores were significantly correlated with Gross Motor Function Classification System levels ($p < 0.001$). Children with unilateral CP had significantly higher asymmetry scores than children with bilateral CP or no CP ($p < 0.01$). Interrater and test-retest reliabilities were good to excellent. **Interpretation:** Reductions in independent joint control measured in infancy are a hallmark of eventual diagnosis of spastic CP, and influence gross motor function later in childhood (with or without a diagnosis of CP).

PMID: [38616771](#)

13. Dental caries and developmental defects of enamel in cerebral palsy: A meta-analysis

Thaynara Nascimento de Oliveira, Victor Zanetti Drumond, José Alcides Almeida de Arruda, Sharat Chandra Pani, Fabiana Vargas-Ferreira, Ricardo Rabelo Eustachio, Ricardo Alves Mesquita, Lucas Guimarães Abreu

Review Oral Dis. 2024 Apr 16. doi: 10.1111/odi.14957. Online ahead of print.

Objective: This systematic review and meta-analysis aimed to compare the occurrence of dental caries and developmental defects of enamel (DDE) in individuals with and without cerebral palsy (CP). **Materials and methods:** We conducted searches across five databases and the grey literature. Data were organized using EndNote 20. Reporting followed the MOOSE checklist. A random-effects model meta-analysis was conducted using RStudio, presenting results as mean difference (MD), odds ratio (OR), and 95% confidence interval (CI). The risk of bias of studies was analyzed using the Newcastle-Ottawa Scale, and the certainty of evidence was assessed using GRADE. **Results:** Among 1336 identified records, 25 studies involving 59,997 participants (mean age: 11.1 years) were included. Data of 12 were pooled into meta-analyses. No significant differences were found between CP and non-CP individuals across indices: DMFT ($k = 7$) (MD = 0.31; 95% CI [-0.42-1.05]), dmft ($k = 4$) (MD = 0.31; 95% CI [-0.50-1.14]), DMFS ($k = 2$) (MD = -0.61; 95% CI [-20.56-19.33]), dmfs ($k = 3$) (MD = 0.54; 95% CI [-1.09-2.17]), and DDE ($k = 3$) (OR = 0.80, 95% CI [0.09-7.31]). The certainty of evidence was very low. **Conclusion:** Individuals with CP do not appear to differ significantly from those without CP in terms of dental caries experience and DDE.

PMID: [38623066](#)

14. Outcome measures applied to robotic assistive technology for people with cerebral palsy: a pilot study

Manuel Lagos, Thais Pousada, Aroa Fernández, Rubén Carneiro, Alba Martínez, Betania Groba, Laura Nieto-Riveiro, Javier Pereira

Disabil Rehabil Assist Technol. 2024 Apr 15:1-8. doi: 10.1080/17483107.2024.2339425. Online ahead of print.

The application of robotic devices is being used as Assistive Technology (AT) for improving rehabilitation interventions. The purposes of this research were to (1) test a novel low-cost robotic AT to support interventions for people with Cerebral Palsy (CP); (2) determine its usability; and (3) analyze its impact. It was a pilot study with prospective, longitudinal and analytical cohorts was done. Intervention was developed in one association (NGO) of people with CP. Participants were 6 women and 3 men with CP, with a mean age of 51.67. Intervention with LOLA2 (a robotic platform, not wearable, equipped with artificial intelligence) was implemented for training some activities of daily life (ADL) of participants. Functional Independence Measure (FIM), Psychosocial Impact of Assistive Technology Scale (PIADS), and Assistive Technology Device Predisposition Assessment (ATPA) were used for outcome measures. Level of participants' independence was high (FIM = 98). Psychosocial impact of the robotic platform in terms of competence ($M = 0.25$), adaptability ($M = 0.33$), and self-esteem ($M = 0.25$), was positive, but low. The mean in ATDPA ($M = 3$) reflects a moderate match. No significant variations concerning the changes in functional independence were detected. The robotic platform is applicable and complementary AT for rehabilitation. This study leads to implementing some improvements in its design, proposed activities, human-robot interaction, and system for registering information.

PMID: [38618937](#)

15. A six degrees-of-freedom cable-driven robotic platform for head-neck movement

Ian Bales, Haohan Zhang

Sci Rep. 2024 Apr 16;14(1):8750. doi: 10.1038/s41598-024-59349-0.

This paper introduces a novel cable-driven robotic platform that enables six degrees-of-freedom (DoF) natural head-neck movements. Poor postural control of the head-neck can be a debilitating symptom of neurological disorders such as amyotrophic lateral sclerosis and cerebral palsy. Current treatments using static neck collars are inadequate, and there is a need to develop new devices to empower movements and facilitate physical rehabilitation of the head-neck. State-of-the-art neck exoskeletons using lower DoF mechanisms with rigid linkages are limited by their hard motion constraints imposed on head-neck movements. By contrast, the cable-driven robot presented in this paper does not constrain motion and enables wide-range, 6-DoF control of the head-neck. We present the mechatronic design, validation, and control implementations of this robot, as well as a human experiment to demonstrate a potential use case of this versatile robot for rehabilitation. Participants were engaged in a target reaching task while the robot applied both assistive and resistive moments on the head during the task. Our results show that neck muscle activation increased by 19% when moving the head against resistance and decreased by 28-43% when assisted by the robot. Overall, these results provide a scientific justification for further research in enabling movement and identifying personalized rehabilitation for motor training. Beyond rehabilitation, other applications such as applying force perturbations on the head to study sensory integration and applying traction to achieve pain relief may benefit from the innovation of this robotic platform which is capable of applying controlled 6-DoF forces/moments on the head.

PMID: [38627418](#)

16. Long-term outcomes of very low birth weight infants with intraventricular hemorrhage: a nationwide population study from 2011 to 2019

Joonsik Park, Sook-Hyun Park, Yu-Ra Kwon, So Jin Yoon, Joo Hee Lim, Jung Ho Han, Jeong Eun Shin, Ho Seon Eun, Min Soo Park, Soon Min Lee

World J Pediatr. 2024 Apr 13. doi: 10.1007/s12519-024-00799-x. Online ahead of print.

Background: Advancements in neonatal care have increased preterm infant survival but paradoxically raised intraventricular hemorrhage (IVH) rates. This study explores IVH prevalence and long-term outcomes of very low birth weight (VLBW) infants in Korea over a decade. **Methods:** Using Korean National Health Insurance data (NHIS, 2010-2019), we identified 3372 VLBW infants with IVH among 4,129,808 live births. Health-related claims data, encompassing diagnostic codes, diagnostic test costs, and administered procedures were sourced from the NHIS database. The results of the developmental assessments are categorized into four groups based on standard deviation (SD) scores. Neonatal characteristics and complications were compared among the groups. Logistic regression models were employed to identify significant changes in the incidence of complications and to calculate odds ratios with corresponding 95% confidence intervals for each risk factor associated with mortality and morbidity in IVH. Long-term growth and development were compared between the two groups (years 2010-2013 and 2014-2017). **Results:** IVH prevalence was 12% in VLBW and 16% in extremely low birth weight (ELBW) infants. Over the past decade, IVH rates increased significantly in ELBW infants ($P = 0.0113$), while mortality decreased ($P = 0.0225$). Major improvements in certain neurodevelopmental outcomes and reductions in early morbidities have been observed among VLBW infants with IVH. Ten percent of the population received surgical treatments such as external ventricular drainage (EVD) or a ventriculoperitoneal (VP) shunt, with the choice of treatment methods remaining consistent over time. The IVH with surgical intervention group exhibited higher incidences of delayed development, cerebral palsy, seizure disorder, and growth failure (height, weight, and head circumference) up to 72 months of age ($P < 0.0001$). Surgical treatments were also significantly associated with abnormal developmental screening test results. **Conclusions:** The neurodevelopmental outcomes of infants with IVH, especially those subjected to surgical treatments, continue to be a matter of concern. It is imperative to prioritize specialized care for patients receiving surgical treatments and closely monitor their growth and development after discharge to improve developmental prognosis. Supplementary file2 (MP4 77987 kb).

PMID: [38615088](#)

17. Estimating the prevalence of cerebral palsy in a semi-urban city in Benin: a door-to-door community-based study

Emmanuel Segnon Sogbossi, Adjoua Baba-Tadja, Emilienne Nouatin, Mendinatou Agbetou, Thierry Adoukonou, Oyéné Kossi

Neuroepidemiology. 2024 Apr 17. doi: 10.1159/000538799. Online ahead of print.

Introduction: Cerebral palsy (CP) is the most common cause of pediatric motor disability. While epidemiological data are widespread in high-income countries, corresponding data in low-income countries in Sub-Saharan Africa are still rare. This study aimed to estimate the prevalence of CP in Northern Benin, a French-speaking low-income country in Sub-Saharan Africa. **Methods:** This study was a community-based door-to-door study involving children younger than 18 years old, in Parakou, a semi-urban city in Benin. We used a two-stage procedure. The first one consisted on children screening to identify potential cases of CP. During the second stage, suspected children were examined by neurologists with high experience with CP. **Results:** In total, 2630 children were screened with 10 confirmed cases of CP, resulting in a crude prevalence (95% confidence interval) of 3.8(1.4, 6.15) per 1000 children. Of the ten confirmed cases, six were younger than 5 years old, and five were male. Eight children over ten were spastic with six bilateral spastic subtype according to the SCPE classification system. Seven children had a Gross Motor Function Classification System level III-V, and six were classified level III to V of the Manual Ability Classification System. **Conclusion:** Cerebral palsy is highly prevalent in Semi-Urban area in Northern Benin. Large studies on potential risk factors are needed for the development of effective preventive strategies.

PMID: [38631310](#)

18. Profile of paediatric occupational therapy practice in Eastern Mediterranean countries

Zainab A Jasem

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Background: Paediatric occupational therapy (OT) is considered the largest practice area in OT in several regions, including the Eastern Mediterranean (EM) countries. **Aims/objectives:** This study aimed to establish a profile of paediatric occupational therapists in EM countries to identify theoretical models, assessments and interventions employed. It also investigated the therapists' usage of evidence-based practice in their practice. **Material and methods:** We conducted a cross-sectional survey using a questionnaire which was distributed electronically to occupational therapists working with children. **Results:** The participants included 118 therapists. Majority of the participants were working at rehabilitation centres. The primary client groups were pre- and school-age children with autism spectrum disorder and cerebral palsy. The most frequently used

assessments were sensory-related tools. Activities of daily living and play were the most often targeted interventional area. Participants highlighted some of the challenges faced in implementing evidence in their practice. Conclusion: Paediatric occupational therapists are usually exposed to specific age groups and conditions. However, a lack of knowledge practice in some areas and challenges in others exist. Significance: Within the EM region, knowledge regarding therapists' practices is lacking. Actions should be taken to improve current practice and meet the current needs of clients, and utilise evidence-based practices.

PMID: [38631391](#)

19. Partnering Early to Provide for Infants At Risk of Cerebral Palsy (PĒPI ARC): protocol for a feasibility study of a regional hub for early detection of cerebral palsy in Aotearoa New Zealand

Angelica Allermo Fletcher, Gaela Kilgour, Meghan Sandle, Sally Kidd, Alison Sheppard, Stephanie Swallow, Ngaire Susan Stott, Malcolm Battin, Wyllis Korent, Sian A Williams

Front Pediatr. 2024 Apr 4;12:1344579. doi: 10.3389/fped.2024.1344579. eCollection 2024.

Introduction: Cerebral palsy (CP) can now be diagnosed in infants with identified CP risk factors as early as three months of age; however, many barriers prevent equitable access to early detection pathways. The "Partnering Early to Provide for Infants At Risk of Cerebral Palsy" feasibility study (PĒPI ARC) seeks to trial a new approach to decrease inequitable health service in Aotearoa New Zealand for high-risk infants and their families. PĒPI ARC incorporates face-to-face clinics, an in-person and virtual Hub, and the use of telehealth to enable flexible access to CP assessments and support for health professionals in early CP detection. Methods and analysis: A non-randomised feasibility study was conducted from a tertiary Neonatal Intensive Care Unit (NICU) in Wellington and included seven regional referral centres, servicing nearly 30% of the total population in New Zealand (NZ). The families of infants with a high risk of neurodevelopmental impairment and health professionals interacting with the Hub were invited to participate. Mixed methods were used to evaluate the (i) equitable implementation of an early detection pathway, (ii) acceptability, (iii) demand among families and health professionals, (iv) efficacy in relation to reducing the age of receipt of CP diagnosis, and (v) the experiences around communication and information sharing. Ethics and dissemination: The NZ Health and Disability Ethics Committee approved this study (HDEC: 2022 FULL 13434). The findings will be disseminated in peer-reviewed journals, in conference presentations, and via professional networks. Clinical trial registration: Australian New Zealand Clinical Trials Registry: ACTRN12623000600640.

PMID: [38638587](#)

20. Validation and reliability of Arabic version of Children's Hand-use Experience Questionnaire (CHEQ) for children with hemiparetic cerebral palsy

Ibrahim Q Alyami

Appl Neuropsychol Child. 2024 Apr 18:1-8. doi: 10.1080/21622965.2024.2336027. Online ahead of print.

The aim was to assess validation and reliability of Arabic version of Children's Hand-use Experience Questionnaire (CHEQ) for children with hemiparetic cerebral palsy (HCP). Ninety-nine children aged 6-18 years diagnosed with HCP participated in the study. The CHEQ was used to evaluate the hand-use experiences of children with cerebral palsy (CP). In the expert opinion questionnaire, the average percentage score of agreement on grasp efficacy was 91.5%. The highest percentage (93.3%) was for time taken. Agreement on CHEQ ranged from 91.5 to 93.3% indicating that the content validity of the prototype is supported by the expert ratings. Fitting indices showed that the one-factor structure of the CHEQ has a good and acceptable fit in children with HCP aged 6-18 years. All factor loads of the CHEQ items were greater than 0.7 and significant. Cronbach's alpha coefficient in this study was 0.921, thus showing that the questionnaire had high internal consistency.

PMID: [38636449](#)

21. Relationship between early infant motor repertoire and neurodevelopment on the hammersmith infant neurological examination in a developmentally vulnerable First Nations cohort

Carly Luke, Leeann Mick-Ramsamy, Arend F Bos, Katherine A Benfer, Margot Bosanquet, Anya Gordon, Hailey Williams, Chloe Taifalos, Maria Smith, Shaneen Leishman, Ellena Oakes, Megan Kentish, Lynda McNamara, Robert S Ware, Roslyn N Boyd

Early Hum Dev. 2024 Apr 8;192:106004. doi: 10.1016/j.earlhumdev.2024.106004. Online ahead of print.

Aim: To implement a culturally-adapted screening program aimed to determine the ability of infant motor repertoire to predict early neurodevelopment on the Hammersmith Infant Neurological Examination (HINE) and improve Australian First Nations families' engagement with neonatal screening. Methods: A prospective cohort of 156 infants (55 % male, mean (standard

deviation [SD]) gestational age 33.8 (4.6) weeks) with early life risk factors for adverse neurodevelopmental outcomes (ad-NDO) participated in a culturally-adapted screening program. Infant motor repertoire was assessed using Motor Optimality Score-revised (MOS-R), captured over two videos, 11-13+6 weeks (V1; <14 weeks) and 14-18 weeks (V2; ≥14 weeks) corrected age (CA). At 4-9 months CA neurodevelopment was assessed on the HINE and classified according to age-specific cut-off and optimality scores as; developmentally 'on track' or high chance of either adverse neurodevelopmental outcome (ad-NDO) or cerebral palsy (CP). Results: Families were highly engaged, 139/148 (94 %) eligible infants completing MOS-R, 136/150 (91 %), HINE and 123 (83 %) both. Lower MOS-R at V2 was associated with reduced HINE scores ($\beta = 1.73$, 95 % confidence interval [CI] = 1.03-2.42) and high chance of CP (OR = 2.63, 95%CI = 1.21-5.69) or ad-NDO (OR = 1.38, 95%CI = 1.10-1.74). The MOS-R sub-category 'observed movement patterns' best predicted HINE, infants who score '4' had mean HINE 19.4 points higher than score '1' (95%CI = 12.0-26.9). Receiver-operator curve analyses determined a MOS-R cut-off of <23 was best for identifying mild to severely reduced HINE scores, with diagnostic accuracy 0.69 (sensitivity 0.86, 95%CI 0.76-0.94 and specificity 0.40, 95 % CI 0.25-0.57). A trajectory of improvement on MOS-R (≥2 point increase in MOS-R from 1st to 2nd video) significantly increased odds of scoring optimally on HINE (OR = 5.91, 95%CI 1.16-29.89) and may be a key biomarker of 'on track' development. Interpretation: Implementation of a culturally-adapted program using evidence-based assessments demonstrates high retention. Infant motor repertoire is associated with HINE scores and the early neurodevelopmental status of developmentally vulnerable First Nations infants.

PMID: [38636257](#)

22. Prevalence and Types of Strabismus in Cerebral Palsy: A Global and Historical Perspective Based on a Systematic Review and Meta-Analysis

Michael S Herron, Lingchen Wang, Christopher S von Bartheld

Review Ophthalmic Epidemiol. 2024 Apr 18:1-18. doi: 10.1080/09286586.2024.2331537. Online ahead of print.

Purpose: Strabismus is more frequent in cerebral palsy (CP) than in the normal population, but reports differ how much it is increased. We here examined the global prevalence and types of strabismus in CP, whether esotropia or exotropia is more frequent, and whether the prevalence differs between ethnicities and/or country income levels, and between generations. Methods: We compiled in a systematic review and meta-analysis the results of 147 CP studies that report the prevalence of strabismus or the ratio of esotropia to exotropia, and we conducted subgroup analyses for region (income level) and ethnicity. We performed a pooled analysis for the CP strabismus prevalence, and estimated the global number of CP cases with strabismus. Results: The pooled prevalence of strabismus in CP is 49.8% in high-income countries and 39.8% in lower-income countries. We estimate the global number of strabismus cases in CP as 12.2 million, with 7.6 million males and 4.6 million females, based on current estimates of 29.6 million global CP cases. Esotropia is more frequent than exotropia in Caucasians, while exotropia is more frequent than esotropia in Hispanic and in some Asian and African populations. The strabismus prevalence in CP increases with increasing country income levels. Conclusion: Generational changes in strabismus prevalence appear to reflect a transition of CP types and an increase in prevalence as countries attain higher income and more effective maternal health care. The distribution of esotropia and exotropia in CP patients largely reflects the horizontal strabismus type that is predominant in the subject's ethnicity.

PMID: [38635869](#)

23. Comparison of the efficiency of transcutaneous electrical nerve stimulation and manual therapy in children with cerebral palsy with lower urinary system dysfunction- a randomized prospective trial

Betul Unal, Pelin Pisirici, Aygul Koseoglu Kurt, Halil Tugtepe

J Pediatr Urol. 2024 Mar 30:S1477-5131(24)00181-5. doi: 10.1016/j.jpuro.2024.03.027. Online ahead of print.

Introduction: Neurological defects in children with cerebral palsy (CP) not only affect their motor skills but also lead to bladder and bowel problems. Although most children with CP have achieved urinary control, more than 50% of cases experience lower urinary tract symptoms (LUTS). Common LUTS complaints observed in CP include delayed toilet training, urinary incontinence, increased frequency of urination, urgency, urinary hesitancy, and recurrent urinary tract infections. Objective: This study aimed to prospectively evaluate and compare the effectiveness of two different physiotherapy approaches, sacral Transcutaneous Electrical Nerve Stimulation (TENS) and massage, on lower urinary tract dysfunction in children with CP. Method: A total of 54 children with CP who had the Dysfunctional Voiding Scoring System (DVISS) of 8.5 or higher were included in the study. Children were randomized to the TENS (TG; n = 27) and Manual Therapy (MG; n = 27) groups. TENS application was performed 2 sessions in a week for 20 min for a total of 12 weeks. The electrodes used during the application were adhered bilaterally to the parasacral region (S2-S4). 4 electrodes of 5 × 5 cm were used. Classical bowel massage was applied to the MG with the friction massage technique twice a week for 12 weeks. Manual therapy applications were performed in the form of abdominal, colon, and friction massage, twice a week for 20 min by the physiotherapist. Massage was applied to the abdominal region between the lower subcostal border and the anterior superior iliac spine. Questionnaires were applied before and after treatment interventions: DVISS, functional bladder capacity (FBC), frequency of voiding, and urinary incontinence episodes evaluated by bladder diary, Bristol Gaita Scale, and Pediatric Incontinence Quality of Life Scale (PIN-Q)

used. Results: The decrease in the episodes of incontinence was higher in the TG ($p = 0.037$; $p < 0.05$). FBC increased after treatment in both groups, but there was no statistically significant difference between the groups ($p = 0.683$; $p > 0.05$). Manual therapy was more effective in improving constipation symptoms. In both groups, DVISS and PIN-Q values decreased after treatment, but the decrease in TG was statistically significant in the evaluation made between groups ($p = 0.001$; $p < 0.01$). Conclusion: Both parasacral TENS and massage provided a significant improvement in LUTS, constipation, and quality of life but TENS showed a bigger improvement. We suggest adding these interventions to the treatment of bladder and bowel problems in CP children.

PMID: [38641452](#)

24. Prevalence and Risk Factors for Cerebral Palsy in Children With Congenital Heart Disease Based on Risk of Surgical Mortality

Suman Ghosh, Ing Grace Lien, Kerstin Martinez, Tracy Lin, Mark S Bleiweis, Joseph Philip, Lori C Jordan, Steven G Pavlakis

Pediatr Neurol. 2024 Mar 1;155:133-140. doi: 10.1016/j.pediatrneurol.2024.02.011. Online ahead of print.

Background: Children with congenital heart disease (CHD) have a higher prevalence of motor impairment secondary to brain injury, resulting in cerebral palsy (CP). The purpose of this study is to determine the prevalence of CP in CHD in a single-center cohort, stratify risk based on surgical mortality using Society of Thoracic Surgeons-European Association for Cardio-Thoracic Surgery (STAT) categories and identify risk factors. Methods: Retrospective cohort study of pediatric patients registered in the University of Florida (UF) Society of Thoracic Surgeons Congenital Heart Surgery database from 2006 to 2017 with a diagnosis of CHD who continued follow-up for more than two years at UF. Results: A total of 701 children with CHD met inclusion criteria. Children identified to have CP were 54 (7.7%). Most common presentation was spastic hemiplegic CP with a Gross Motor Function Classification System of level 2. Analysis of surgical and intensive care factors between the two groups showed that children with CHD and CP had longer time from admission to surgery ($P = 0.003$), higher STAT categories 4 and 5 ($P = 0.038$), and higher frequency of brain injury and seizures ($P < 0.001$). Developmental disabilities and rehabilitation needs were significantly greater for children with CHD and CP when compared with those with CHD alone ($P < 0.001$). Conclusions: In our cohort, 7.7% children with CHD develop CP; this is significantly higher than the 2010 US population estimate of 0.3%. Our study suggests higher STAT categories, brain injury, and seizures are associated with developing CP in children with CHD.

PMID: [38640862](#)

25. Bioinformatics-based discovery of biomarkers and immunoinflammatory targets in children with cerebral palsy: An observational study

Bo Chen, Ling Wang, Dongke Xie, Yuanhui Wang

Observational Study Medicine (Baltimore). 2024 Apr 19;103(16):e37828. doi: 10.1097/MD.00000000000037828.

Cerebral palsy (CP) is the most common disabling disease in children, and motor dysfunction is the core symptom of CP. Although relevant risk factors have been found to be closely associated with CP: congenital malformations, multiple gestation, prematurity, intrauterine inflammation and infection, birth asphyxia, thrombophilia, and perinatal stroke. Its important pathophysiological mechanism is amniotic fluid infection and intraamniotic inflammation leading to fetal developing brain damage, which may last for many years. However, the molecular mechanism of CP is still not well explained. This study aimed to use bioinformatics to identify key biomarker-related signaling pathways in CP. The expression profile of children with CP was selected from the Gene Expression Comprehensive Database, and the CP disease gene data set was obtained from GeneCards. A protein-protein interaction network was established and functional enrichment analysis was performed using Gene Ontology and Kyoto Encyclopedia of Genes and Genomes databases. A total of 144 differential key intersection genes and 10 hub genes were identified through molecular biology. Gene Ontology functional enrichment analysis results show that differentially expressed genes are mainly concentrated in biological processes, such as immune response and neurogenesis. The cellular components involved mainly include axons, postsynaptic membranes, etc, and their molecular functions mainly involve proteoglycan binding, collagen binding, etc. Kyoto Encyclopedia of Genes and Genomes analysis shows that the intersection genes are mainly in signaling pathways related to the immune system, inflammatory response, and nervous system, such as Th17 cell differentiation, Toll-like receptor signaling pathway, tumor necrosis factor signaling pathway, NF- κ B signaling pathway, axon guidance, PI3K-Akt signaling pathway, HIF-1 signaling pathway, gap junction, etc. Jak-STAT signaling pathway, mTOR signaling pathway, and related hub genes regulate immune cells and inflammatory factors and play an important role in the development and progression of CP.

PMID: [38640267](#)

26. Evidence for dystonia reduction in cerebral palsy remains limited

Daniel E Lumsden

Dev Med Child Neurol. 2024 Apr 19. doi: 10.1111/dmcn.15923. Online ahead of print.

No abstract available

PMID: [38640101](#)

27. Pharmacological and neurosurgical management of cerebral palsy and dystonia: Clinical practice guideline update

Darcy Fehlings, Brenda Agnew, Hortensia Gimeno, Adrienne Harvey, Kate Himmelmann, Jean-Pierre Lin, Jonathan W Mink, Elegast Monbaliu, James Rice, Emma Bohn, Yngve Falck-Ytter

Dev Med Child Neurol. 2024 Apr 19. doi: 10.1111/dmcn.15921. Online ahead of print.

Dystonia, typically characterized by slow repetitive involuntary movements, stiff abnormal postures, and hypertonia, is common among individuals with cerebral palsy (CP). Dystonia can interfere with activities and have considerable impact on motor function, pain/comfort, and ease of caregiving. Although pharmacological and neurosurgical approaches are used clinically in individuals with CP and dystonia that is causing interference, evidence to support these options is limited. This clinical practice guideline update comprises 10 evidence-based recommendations on the use of pharmacological and neurosurgical interventions for individuals with CP and dystonia causing interference, developed by an international expert panel following the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach. The recommendations are intended to help inform clinicians in their use of these management options for individuals with CP and dystonia, and to guide a shared decision-making process in selecting a management approach that is aligned with the individual's and the family's values and preferences.

PMID: [38640091](#)

28. Cerebral Palsy Heterogeneity: Clinical Characteristics and Diagnostic Significance from a Large Sample Analysis

Junying Yuan, Mengli Cui, Qionqiong Liang, Dengna Zhu, Jie Liu, Jiefeng Hu, Shijie Ma, Dong Li, Jing Wang, Xuejie Wang, Deyou Ma, Kate Himmelmann, Xiaoyang Wang, Yiran Xu, Changlian Zhu

Neuroepidemiology. 2024 Apr 18. doi: 10.1159/000539002. Online ahead of print.

Introduction: Cerebral palsy (CP) is a nonprogressive movement disorder resulting from prenatal or perinatal brain injury that benefits from early diagnosis and intervention. The timing of early CP diagnosis remains controversial, necessitating analysis of clinical features in a substantial cohort. **Methods:** We retrospectively reviewed medical records from a university hospital, focusing on children aged >24 months or followed up for ≥24 months, and adhered to the International classification of diseases-10 for diagnosis and Subtyping. **Results:** Among the 2012 confirmed CP cases, 68.8% were male and 51.44% had spastic diplegia. Based on the Gross Motor Function Classification System (GMFCS), 62.38% were levels I and II, and 19.88% were levels IV and V. Hemiplegic and diplegic subtypes predominantly fell into levels I and II, while quadriplegic and mixed types were mainly levels IV and V. White matter injuries appeared in 46.58% of cranial MRI findings, while maldevelopment was rare (7.05%). Intellectual disability co-occurred in 43.44% of the CP cases, with hemiplegia having the lowest (20.28%, 58/286) and mixed types (73.85%, 48/65). Additionally, 51.67% (697/1349) of the children with CP aged ≥48 months had comorbidities. **Conclusions:** This study underscores white matter injury as the primary CP pathology and identifies intellectual disability as a common comorbidity. Although CP can be identified in infants under one year old, precision in diagnosis improves with development. These insights inform early detection and tailored interventions, emphasizing their crucial role in CP management.

PMID: [38636464](#)

29. Prechtl's method to assess general movements: Inter-rater reliability during the preterm period

Angélica Valencia, Carlos Viñals, Elsa Alvarado, Marcela Balderas, Joëlle Provasi

PLoS One. 2024 Apr 18;19(4):e0301934. doi: 10.1371/journal.pone.0301934. eCollection 2024.

Introduction: Prechtl's method (GMA) is a test for the functional assessment of the young nervous system. It involves a global and a detailed assessment of the general movements (GMs) and has demonstrated validity. Data on the reliability of both assessments in the preterm period are scarce. This study aimed to evaluate the inter-rater reliability for the global and detailed assessments of the preterm writhing GMA. **Materials and methods:** The study participants were 69 infants born at <37

gestational weeks and admitted to the neonatal intensive care unit. They were randomly assigned to five pairs of raters. Raters assessed infants' GMs using preterm videos. Outcome variables were (a) the GMs classification (normal versus abnormal; normal versus abnormal subcategories) and (b) the general movements optimality score (GMOS), obtained through the global and detailed assessments. The Gwet's AC1 and the intraclass correlation coefficient (ICC) were calculated for the GMs classification and the GMOS, respectively. Results: The global assessment presented an AC1 = 0.84 [95% CI = 0.54,1] for the GMs binary classification and an AC1 = 0.67 [95% CI = 0.38,0.89] for the GMs classification with abnormal subcategories. The detailed assessment presented an ICC = 0.72 [95% CI = 0.39,0.90] for the GMOS. Conclusions: Inter-rater reliability was high and substantial for the global assessment and good for the detailed assessment. However, the small sample size limited the precision of these estimates. Future research should involve larger samples of preterm infants to improve estimate precision. Challenging items such as assessing the neck and trunk, poor repertoire GMs, and tremulous movements may impact the preterm writhing GMA's inter-rater reliability. Therefore, ongoing training and calibration among raters is necessary. Further investigation in clinical settings can enhance our understanding of the preterm writhing GMA's reliability.

PMID: [38635854](#)

30. Development and evaluation of a BCI-neurofeedback system with real-time EEG detection and electrical stimulation assistance during motor attempt for neurorehabilitation of children with cerebral palsy

Ahad Behboodi, Julia Kline, Andrew Gravunder, Connor Phillips, Sheridan M Parker, Diane L Damiano

Front Hum Neurosci. 2024 Apr 3;18:1346050. doi: 10.3389/fnhum.2024.1346050. eCollection 2024.

In the realm of motor rehabilitation, Brain-Computer Interface Neurofeedback Training (BCI-NFT) emerges as a promising strategy. This aims to utilize an individual's brain activity to stimulate or assist movement, thereby strengthening sensorimotor pathways and promoting motor recovery. Employing various methodologies, BCI-NFT has been shown to be effective for enhancing motor function primarily of the upper limb in stroke, with very few studies reported in cerebral palsy (CP). Our main objective was to develop an electroencephalography (EEG)-based BCI-NFT system, employing an associative learning paradigm, to improve selective control of ankle dorsiflexion in CP and potentially other neurological populations. First, in a cohort of eight healthy volunteers, we successfully implemented a BCI-NFT system based on detection of slow movement-related cortical potentials (MRCP) from EEG generated by attempted dorsiflexion to simultaneously activate Neuromuscular Electrical Stimulation which assisted movement and served to enhance sensory feedback to the sensorimotor cortex. Participants also viewed a computer display that provided real-time visual feedback of ankle range of motion with an individualized target region displayed to encourage maximal effort. After evaluating several potential strategies, we employed a Long short-term memory (LSTM) neural network, a deep learning algorithm, to detect the motor intent prior to movement onset. We then evaluated the system in a 10-session ankle dorsiflexion training protocol on a child with CP. By employing transfer learning across sessions, we could significantly reduce the number of calibration trials from 50 to 20 without compromising detection accuracy, which was 80.8% on average. The participant was able to complete the required calibration trials and the 100 training trials per session for all 10 sessions and post-training demonstrated increased ankle dorsiflexion velocity, walking speed and step length. Based on exceptional system performance, feasibility and preliminary effectiveness in a child with CP, we are now pursuing a clinical trial in a larger cohort of children with CP.

PMID: [38633751](#)

31. Reoperation Rates According to Surgical Approach After Operation for Degenerative Cervical Pathology in Patients With Athetoid Cerebral Palsy: A Nationwide Cohort Study

Jae Jun Yang, Jun Young Choi, Dong-Ho Lee, Chang Ju Hwang, Jae Hwan Cho, Sehan Park

Global Spine J. 2024 Apr 17;21925682241247486. doi: 10.1177/21925682241247486. Online ahead of print.

Study design: National population-based cohort study. Objective: The overall complication rate for patients with athetoid cerebral palsy (CP) undergoing cervical surgery is significantly higher than that of patients without CP. The study was conducted to compare the reoperation and complication rates of anterior fusion, posterior fusion, combined fusion, and laminoplasty for degenerative cervical myelopathy/radiculopathy in patients with athetoid cerebral palsy. Methods: The Korean Health Insurance Review and Assessment Service national database was used for analysis. Data from patients diagnosed with athetoid CP who underwent cervical spine operations for degenerative causes between 2002 and 2020 were reviewed. Patients were categorized into four groups for comparison: anterior fusion, posterior fusion, combined fusion, and laminoplasty. Results: A total of 672 patients were included in the study. The overall revision rate was 21.0% (141/672). The revision rate was highest in the anterior fusion group (42.7%). The revision rates of combined fusion (11.1%; hazard ratio [HR], .335; P = .002), posterior fusion (13.8%; HR, .533; P = .030) were significantly lower than that of anterior fusion. Revision rate of laminoplasty (13.1%; HR, .541; P = .240) was also lower than anterior fusion although the result did not demonstrate statistical significance. Conclusion: Anterior fusion presented the highest reoperation risk after cervical spine surgery reaching 42.7% in patients with athetoid CP. Therefore, anterior-only fusion in patients with athetoid CP should be avoided or reserved for strictly selected patients. Combined fusion, with the lowest revision risk at 11.1%, could be safely applied to patients with athetoid CP.

PMID: [38631333](#)

32. Utilizing an Environmental Framework to Explore the Acceptability of a Health Promotion Program for Youth with Disabilities

Meaghan Walker, Gillian A King, Toni Lui, Nivatha Moothathamby, Amy C McPherson

Dev Neurorehabil. 2024 Apr 17:1-7. doi: 10.1080/17518423.2024.2340454. Online ahead of print.

This study explored the acceptability of Children and Teens in Charge of their Health (CATCH), a program for children with spina bifida or cerebral palsy to enhance their physical activity and diet. Qualitative interviews were conducted with children (n = 6) and their parents (n = 6) who participated in CATCH. Analysis used an environmental systems framework. Microsystem factors impacting acceptability of the program were: Children's motivations for change, their age, and their physical health. Mesosystem factors were: Use of virtual coaching and the relationship between coach and child. Macrosystem factors (e.g. Covid-19), did not impact acceptability, but affected some goal attainment strategies. CATCH was broadly acceptable to children and parents and shows promise as a health promotion program tailored to children with disabilities. An environmental systems framework can potentially help other health promotion programs enhance their acceptability and success.

PMID: [38630613](#)

33. A bibliometric analysis of cerebral palsy from 2003 to 2022

Yue Hu, Yadan Zheng, Yue Yang, Wenfeng Fang, Maomao Huang, Dan Li, Zhangyu Xu, Fangyuan Xu, Jianxiong Wang

Front Neurol. 2024 Apr 2:15:1292587. doi: 10.3389/fneur.2024.1292587. eCollection 2024.

Purpose: This bibliometric study explores cerebral palsy (CP) research from 2003 to 2022 to reveal the topic hotspots and collaborations. **Methods:** We retrieved studies on CP from the Web of Science Core Collection from 2003 to 2022 and then used CiteSpace and Bibliometrix to perform a bibliometric analysis and attain knowledge mapping, including publication outputs, funding, journals, authors, institutions, countries/territories, keywords, collaborative relationships, and topic hotspots. **Results:** In total, 8,223 articles were published from 2003 to 2022. During this period, the number of publications increased continuously. Developmental Medicine and Child Neurology was the most productive and frequently co-cited journal. Boyd was the most productive and influential author, with 143 publications and 4,011 citations. The United States and Vrije Universiteit Amsterdam were the most productive countries and institutions, respectively. Researchers and institutions from the USA, Australia, and Canada constituted the core research forces, with extensive collaborations worldwide. The most common keywords were gait (553), rehabilitation (440), spasticity (325), botulinum toxin (174), therapy (148), upper extremity (141), quality of life (140), disability (115), pain (98), electromyography (97), kinematics (90), balance (88), participation (85), and walking (79). **Conclusion:** This study provides a systematic and comprehensive analysis of the CP-related literature. It reveals that Developmental Medicine and Child Neurology is the most active journal in this field. The USA, Vrije Universiteit Amsterdam, and Boyd are the top countries, institutions, and authors, respectively. Emerging treatment methods, complication management, and functional recovery comprise the future research directions and potential topic hotspots for CP.

PMID: [38628701](#)

34. Mimickers of hypoxic-ischaemic brain injury in term neonates: What the radiologist should know

Shalendra K Misser, Moherndran Archary

Review SA J Radiol. 2024 Feb 29;28(1):2810. doi: 10.4102/sajr.v28i1.2810. eCollection 2024.

Patterns of neonatal hypoxic-ischaemic brain injury (HIBI) are fairly well known. There are, however, other diagnoses with imaging patterns that may mimic HIBI. A review of MRI studies was conducted for children with suspected cerebral palsy, correlated with prior imaging, clinical details and laboratory tests where available. In the 63 identified cases, imaging features were, in many cases, very similar to the known patterns of HIBI. The alternative diagnoses can be classified as developmental, vascular, chromosomal, infections, metabolic disorders, and congenital syndromes. These findings are described in this pictorial essay. The potential mimickers of HIBI described in this essay can demonstrate similar imaging appearances to HIBI. **Contribution:** There are multiple possible causes of neonatal encephalopathy other than hypoxic-ischaemic encephalopathy. Many conditions may mimic HIBI, each of which can be associated with significant morbidity. It is prudent for the reporting radiologist to be aware of these alternate clinico-radiological diagnoses.

PMID: [38628264](#)

35. Consensus guidelines for the diagnosis and management of isolated sulfite oxidase deficiency and molybdenum cofactor deficiencies

Bernd C Schwahn, Francjan van Spronsen, Albert Misko, Julija Pavaine, Victoria Holmes, Ronen Spiegel, Guenter Schwarz, Flora Wong, Alistair Horman, James Pitt, Jörn Oliver Sass, Charlotte Lubout

Review J Inherit Metab Dis. 2024 Apr 16. doi: 10.1002/jimd.12730. Online ahead of print.

Sulfite intoxication is the hallmark of four ultrarare disorders that are caused by impaired sulfite oxidase activity due to genetic defects in the synthesis of the molybdenum cofactor or of the apoenzyme sulfite oxidase. Delays on the diagnosis of these disorders are common and have been caused by their unspecific presentation of acute neonatal encephalopathy with high early mortality, followed by the evolution of dystonic cerebral palsy and also by the lack of easily available and reliable diagnostic tests. There is significant variation in survival and in the quality of symptomatic management of affected children. One of the four disorders, molybdenum cofactor deficiency type A (MoCD-A) has recently become amenable to causal treatment with synthetic cPMP (fosdenopterin). The evidence base for the rational use of cPMP is very limited. This prompted the formulation of these clinical guidelines to facilitate diagnosis and support the management of patients. The guidelines were developed by experts in diagnosis and treatment of sulfite intoxication disorders. It reflects expert consensus opinion and evidence from a systematic literature search.

PMID: [38627985](#)

36. Barriers and facilitators to parent-delivered interventions for children with or infants at risk of cerebral palsy. An integrative review informed by behaviour change theory

Jill Massey, Phillip Harniess, Deborah Chinn, Glenn Robert

Review Disabil Rehabil. 2024 Apr 16:1-15. doi: 10.1080/09638288.2024.2338193. Online ahead of print.

Purpose: Empowering parents to deliver evidenced-based interventions improves outcomes for children with or infants at risk of cerebral palsy (CP), by integrating repetition and contextual learning into daily routines. We aimed to identify the barriers and facilitators to parent-delivered interventions and suggest practice improvements guided by behaviour change models. Methods: Eight electronic databases were searched to identify studies presenting parent and therapist perspectives on parent-delivered interventions in CP. Included studies were critically appraised using validated checklists. Barriers and facilitators to parent-delivered interventions were identified and categorised into subcomponents of The Capability Opportunity and Motivation Model of Behaviour (COM-B), the Theoretical Domains Framework (TDF) and the Behaviour Change Wheel to formulate appropriate practice recommendations. Results: Thirty-four studies were identified which mainly used qualitative or randomised control trial designs. Barriers to parent-delivery included insufficient parental knowledge, lack of confidence and time. Facilitators included staff continuity, empowering parents, efficient resource utilisation and flexible delivery. Practice recommendations emphasise realistic goal setting, tailored parental education and enhancing the coaching skills of therapists. Conclusions: Fostering parent-delivered interventions requires addressing knowledge gaps, skill and capacity of parents and therapists. Therapists forming strong alliances with parents and setting collaborative realistic goals are key to successful parent-delivered interventions.

PMID: [38627931](#)

37. Participation experiences of young people with cerebral palsy in key life situations: A qualitative study

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Aims: To explore the participation experiences of adolescents and young adults with cerebral palsy (CP) in key life situations of young adulthood and investigate the impact of a government-funded, disability insurance scheme on participation and health service access. Method: We conducted a qualitative descriptive study using semi-structured interviews. Sixteen young people with CP (aged 16-30 years; mean age = 24 years 4 months) participated. Interviews were audio-recorded and transcribed verbatim before thematic analysis. Results: An overarching theme of 'branching out into adulthood' was identified. Participants described early adulthood as a time of change, choice, and challenge. The sub-themes were: (1) making sense of my CP as an adult; (2) people's attitudes towards disability and the impacts on me; (3) roadblocks and workarounds; and (4) participation at the time of the COVID-19 pandemic. Participants reported complex views on the new disability insurance scheme. While access to services and support increased, participants experienced significant difficulty negotiating appropriate funding, resulting in frustration and reduced confidence in the scheme. Interpretation: Young people with CP experience complexity as they participate during young adulthood. Alongside exploring how their identity is intertwined with having CP, they face significant barriers to participation when navigating relationships, accessing services, and being involved in the community.

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