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ASSESSING THE EFFECTS OF MULTIMODAL PSYCHOMOTOR REHABILITATION ON MOTOR FUNCTION AND FUNCTIONAL INDEPENDENCE IN CHILDREN WITH CEREBRAL PALSY: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Cerebral palsy (CP) is a leading cause of childhood motor disability and is frequently accompanied by limitations in balance, self-care, mobility, and participation. Objective: To compare the clinical outcomes of a six-month multimodal psychomotor rehabilitation program with standard rehabilitation and to provide a preliminary economic assessment. Materials and Methods: Forty children with CP aged 3–12 years were randomly allocated to an intervention group (n = 20) or a control group (n = 20). Outcomes included the Gross Motor Function Measure-88 (GMFM-88), Pediatric Balance Scale (PBS), Modified Ashworth Scale, Manual Ability Classification System, and Pediatric Evaluation of Disability Inventory. EEG and MRI outcomes and economic estimates were exploratory. Results: The intervention group demonstrated larger improvements than the control group in GMFM-88 scores (30.8% vs. 13.1%; between-group change $p < .01$) and PBS scores (46.5% vs. 17.6%; $p < .01$). Modified Ashworth Scale scores decreased significantly in the intervention group ($p < .001$), and functional independence improved across PEDI domains. Exploratory EEG and MRI findings suggested neurophysiological and structural change, but these outcomes require independent confirmation. The preliminary economic analysis estimated a 94.4% return on investment and a 6.2-month payback period. Conclusion: Multimodal psychomotor rehabilitation was associated with greater motor, balance, and functional gains than standard therapy. The small sample, incomplete blinding, and exploratory imaging and economic analyses limit definitive inference.

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Keywords: *cerebral palsy; psychomotor rehabilitation; motor function; GMFM-88; Pediatric Balance Scale; functional independence; randomized controlled trial.*

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Introduction.

Cerebral palsy (CP) comprises a group of permanent disorders of movement and posture caused by nonprogressive disturbances in the developing fetal or infant brain. Although motor impairment is the defining feature, CP is a lifelong, multisystem condition that may also involve cognition, communication, vision, hearing, epilepsy, behavior, pain, and participation restrictions (Graham et al., 2016; Gulati & Sondhi, 2018; Patel et al., 2020; Rosenbaum et al., 2007; Sadowska et al., 2020). Population-based estimates indicate that CP affects approximately 2 per 1,000 live births worldwide, with meaningful variation across regions, income settings, gestational age groups, and ascertainment methods (McIntyre et al., 2022; Vitrikas et al., 2020). European registry

data likewise demonstrate that associated impairments are common and should be considered when rehabilitation goals are formulated (Surveillance of Cerebral Palsy in Europe, 2000).

Contemporary rehabilitation emphasizes neuroplasticity, early identification, individualized goal setting, active practice, meaningful repetition, participation, and family involvement. International guidelines and systematic reviews support goal-directed, task-specific, activity-based, and sufficiently intensive interventions rather than reliance on any single named treatment approach (Hadders-Algra, 2021; Jackman et al., 2022; Morgan et al., 2021; Novak et al., 2020). Exercise and physical activity may improve fitness and selected functional outcomes, although intervention effects vary according to age, Gross Motor Function Classification System (GMFCS) level, treatment dose, and outcome measure (Ryan et al., 2017; Verschuren et al., 2016). Technology-assisted interventions are increasingly used; virtual reality, for example, has shown potential benefits for motor performance and balance, but the underlying evidence remains heterogeneous and is often based on small trials (Chen et al., 2018).

In Uzbekistan, strengthening access to coordinated, evidence-based pediatric rehabilitation and establishing locally relevant outcome and cost data remain important clinical and organizational priorities. A structured evaluation of multimodal psychomotor rehabilitation may therefore contribute to both clinical decision-making and service planning.

Aim of the Study. The primary objective was to compare changes in motor function, balance, muscle tone, manual ability, and functional independence between a multimodal psychomotor rehabilitation program and standard therapy. Secondary exploratory objectives were to describe EEG, MRI, parent-reported health-status, and preliminary economic outcomes.

Materials and Methods.

Study Design and Participants

This randomized controlled trial included 40 children aged 3–12 years (mean age, 6.8 ± 2.4 years) with a confirmed diagnosis of CP. Participants were allocated to an intervention group (n = 20), which received a comprehensive multimodal psychomotor rehabilitation program, or a control group (n = 20), which received standard rehabilitation therapy. The intervention period was six months. At baseline, the groups did not differ significantly in age, sex distribution, or GMFCS level ($p = .87$). Details of random-sequence generation, allocation concealment, prospective trial registration, and an a priori sample-size calculation were not available in the study records and are therefore acknowledged as reporting limitations.

Assessment Instruments

Gross motor function was classified using the five-level GMFCS, which describes self-initiated movement and mobility and has established reliability and content validity (Palisano et al., 1997, 2008). Quantitative gross motor performance was assessed using the Gross Motor Function Measure-88 (GMFM-88), which evaluates lying and rolling, sitting, crawling and kneeling, standing, and walking, running, and jumping (Russell et al., 2002).

Balance and postural control were evaluated with the Pediatric Balance Scale (PBS), a child-adapted modification of the Berg Balance Scale developed for school-age children with mild to moderate motor impairment (Franjoine et al., 2003). Spasticity was assessed using the Modified Ashworth Scale (Bohannon & Smith, 1987), and manual ability was classified using the Manual Ability Classification System (MACS; Eliasson et al., 2006). Because the Modified Ashworth Scale primarily measures resistance to passive movement, its scores were interpreted as an indirect clinical indicator of hypertonia rather than a complete physiological measure of spasticity (Pandyan et al., 1999).

Cognitive screening was performed with a study-specific age-adapted version of the Mini-Mental State Examination (MMSE). Because the original MMSE was developed for adults and the study-specific adaptation was not independently validated, cognitive scores were treated as exploratory and were not used as a primary efficacy endpoint (Folstein et al., 1975). Functional independence in activities of daily living was assessed using the Pediatric Evaluation of Disability Inventory (PEDI; Haley et al., 1992). For participants older than the PEDI's original normative age range, raw functional-domain scores were used descriptively rather than interpreted as age-normed values. Parent-reported health status was evaluated with the SF-36. Because the original SF-36 was developed for respondents aged 14 years and older, parent-proxy findings in this sample were treated as exploratory and not as validated pediatric quality-of-life outcomes (Ware & Sherbourne, 1992).

Neurophysiological and Neuroimaging Assessment

EEG was recorded according to the international 10–20 electrode placement system (Jasper, 1958). Recordings used a low-frequency filter of 0.5–1 Hz, a high-frequency filter of 35–70 Hz, a sampling rate of 256–

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512 Hz, and a minimum duration of 20–30 minutes. Activation procedures included photic stimulation and hyperventilation. Background rhythm frequency and amplitude, epileptiform activity, and interhemispheric asymmetry were evaluated. Brain structure was assessed using MRI. T1-weighted, T2-weighted, fluid-attenuated inversion recovery, and diffusion-weighted sequences were used to evaluate cortical thickness, white matter integrity through fractional anisotropy, ventricular volume, corpus callosum thickness, and hippocampal volume.

Rehabilitation Program

The rehabilitation process was structured within the International Classification of Functioning, Disability and Health framework (World Health Organization, 2001). Following a multidimensional baseline assessment, individualized short-term goals (2–4 weeks) and long-term goals (3–12 months) were formulated using SMART principles (Bovend'Eerdt et al., 2009).

The multimodal program combined neuromotor treatment elements associated with the Bobath and Vojta approaches; exercises targeting attention, memory, and executive functioning; computer-based cognitive training; sensorimotor integration; and functional practice through play, sports, music, and art activities in home and school contexts. Consistent with contemporary evidence, the program emphasized active, goal-directed, task-specific, and participation-oriented practice rather than exclusive use of a single treatment concept (Anaby et al., 2013; Imms et al., 2017; Jackman et al., 2022; Novak et al., 2020). Progress was monitored monthly with standardized outcome measures. The intervention logic and assessment pathway are summarized in Figure 1.

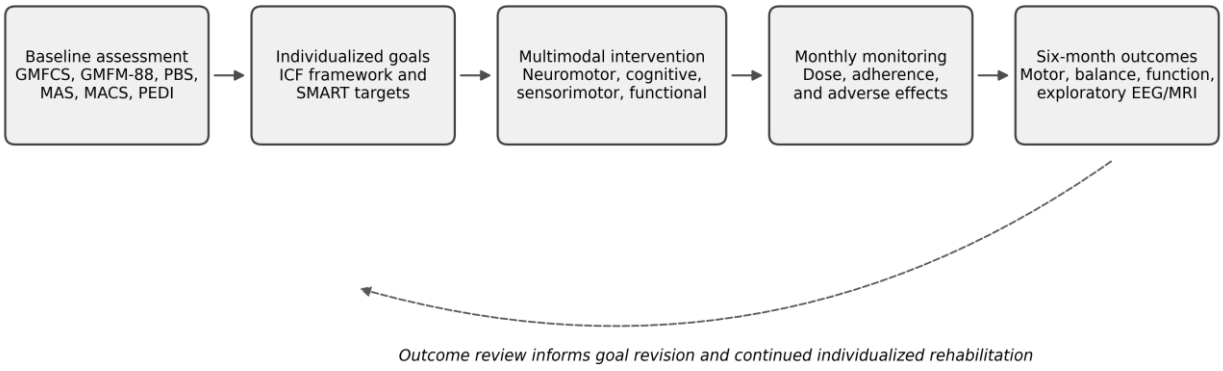


Figure 1. Multimodal psychomotor rehabilitation and outcome-assessment pathway.

Note. GMFCS = Gross Motor Function Classification System; GMFM-88 = Gross Motor Function Measure-88; PBS = Pediatric Balance Scale; MAS = Modified Ashworth Scale; MACS = Manual Ability Classification System; PEDI = Pediatric Evaluation of Disability Inventory; ICF = International Classification of Functioning, Disability and Health.

Statistical and Economic Analysis

Data were analyzed using SPSS version 25.0. Descriptive statistics included means, standard deviations, medians, and frequency distributions. Inferential analyses included paired- and independent-samples t tests as appropriate, the chi-square test, analysis of variance, correlation analysis, and regression analysis. Statistical significance was set at $p < .05$, and 95% confidence intervals were reported where available. Results are presented as mean ± standard deviation. Given the small sample and multiple exploratory outcomes, imaging, cognitive, parent-proxy health-status, and economic findings were interpreted cautiously. The economic analysis estimated incremental cost per additional GMFM-88 and PBS point, return on investment, and payback period. Because a full decision-analytic model and sensitivity analysis were not reported, the economic findings were treated as preliminary and interpreted against current reporting principles for health economic evaluation (Husereau et al., 2022).

Results

Baseline Characteristics

Baseline demographic and clinical characteristics were similar between the two groups. The intervention group included 12 boys (60%) and 8 girls (40%), whereas the control group included 11 boys (55%) and 9 girls (45%); the difference was not significant ($p > .05$). GMFCS levels were also balanced: levels I–II accounted for 40% of the intervention group and 45% of the control group, level III for 35% and 30%, respectively, and levels IV–V for 25% in each group ($p = .87$).

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Motor Function, Balance, Spasticity, and Manual Ability

After six months, GMFM-88 scores improved in both groups, with a greater increase in the intervention group. The mean score increased from 52.3 ± 18.7 to 68.4 ± 19.2 in the intervention group, corresponding to a 30.8% improvement ($p < .001$), and from 51.8 ± 17.9 to 58.6 ± 18.4 in the control group, corresponding to a 13.1% improvement ($p < .05$). The between-group difference in change was significant ($p < .01$), with a mean difference of 9.3 points (95% confidence interval, 4.7–14.9).

Analysis of individual GMFM-88 domains showed marked improvements in the intervention group. The sitting score increased from 65.3 ± 18.9 to 82.7 ± 14.2, and the crawling and kneeling score increased from 48.7 ± 22.4 to 71.3 ± 19.8 (both $p < .001$). Significant but smaller changes were observed in the standing and walking domains.

Independent sitting was achieved by 60% of children in the intervention group and 30% in the control group. Independent standing was achieved by 40% and 20%, respectively, and independent walking by 35% and 15%, respectively. PBS scores increased from 28.4 ± 12.7 to 41.6 ± 14.2 in the intervention group (46.5%, $p < .001$) and from 27.9 ± 13.1 to 32.8 ± 13.6 in the control group (17.6%, $p < .05$); the between-group difference was significant ($p < .01$). Modified Ashworth Scale scores decreased from 1.2 ± 0.8 to 0.7 ± 0.6 in the intervention group ($p < .001$) and from 1.3 ± 0.7 to 1.1 ± 0.7 in the control group ($p > .05$). MACS classification improved in 65% of children in the intervention group and 30% in the control group. Relative percentage improvements in GMFM-88 and PBS scores are shown in Chart 1.

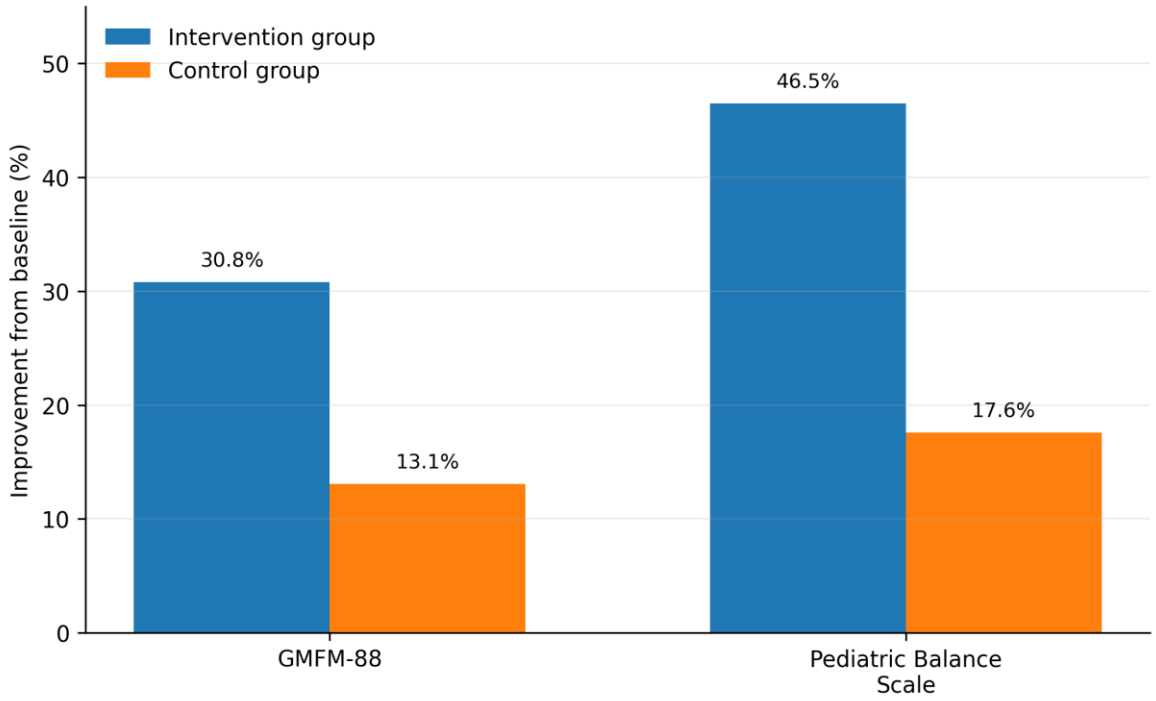


Chart 1. Percentage improvement in GMFM-88 and Pediatric Balance Scale scores after six months.

Note. Percentages were calculated from the baseline and six-month means reported for each group. GMFM-88 = Gross Motor Function Measure-88.

Table 1. Comparison of Key Clinical Outcomes Between Intervention and Control Groups

Outcome measure	Intervention group, baseline	Intervention group, 6 months	Control group, baseline	Control group, 6 months
GMFM-88, points	52.3 ± 18.7	68.4 ± 19.2*	51.8 ± 17.9	58.6 ± 18.4**
Pediatric Balance Scale (PBS), points	28.4 ± 12.7	41.6 ± 14.2*	27.9 ± 13.1	32.8 ± 13.6**
Modified Ashworth Scale, grade	1.2 ± 0.8	0.7 ± 0.6*	1.3 ± 0.7	1.1 ± 0.7
PEDI self-care domain, points	45.7 ± 16.8	62.3 ± 18.4*	—	—

*Note. Values are mean ± SD. *p < .001 versus baseline; **p < .05 versus baseline. Between-group changes were significant for GMFM-88 and PBS (both p < .01). Dashes indicate values not reported.*

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Functional Independence and Parent-Reported Health Status

PEDI scores improved significantly in all measured domains in the intervention group. Self-care increased from 45.7 ± 16.8 to 62.3 ± 18.4, mobility from 38.2 ± 19.6 to 56.8 ± 21.2, and social functioning from 52.4 ± 14.7 to 68.9 ± 16.3 (all $p < .001$). Improvements in each domain were reported as greater than those observed in the control group. Parent-proxy SF-36 physical-functioning scores increased from 34.2 ± 8.1 to 42.8 ± 7.6, and social-functioning scores increased from 28.6 ± 6.4 to 35.1 ± 6.9. Because the SF-36 proxy administration was not validated for this pediatric sample, these results are reported as exploratory parent-rated health-status findings rather than definitive quality-of-life outcomes.

EEG and MRI Outcomes

In the intervention group, the EEG alpha-rhythm index increased by 78.2%, from 23.4 ± 5.2% to 41.7 ± 6.8% ($p < .001$), and beta-rhythm activity increased by 52.2% ($p < .001$). Pathological delta/theta activity decreased by 45.3% ($p < .001$), and epileptiform activity decreased in 45% of the children. Corresponding changes in the control group were smaller and mostly nonsignificant.

MRI findings in the intervention group included an increase in cortical thickness of 0.23 ± 0.04 mm (8.7%, $p < .001$), an increase in fractional anisotropy and white matter integrity of 12.7 ± 3.2% ($p < .001$), a decrease in ventricular volume of 8.4 ± 2.1% ($p < .01$), and increases in corpus callosum thickness and hippocampal volume; hippocampal volume increased by 6.2 ± 1.8% ($p < .01$). These changes were greater than those recorded in the control group.

Adherence, Follow-Up, and Economic Outcomes

Mean attendance was 87.4 ± 6.8%, and parental satisfaction was 76.3 ± 8.4%. Mild fatigue was reported in 25% of the children, and 10% showed resistance to participation in some sessions. At six-month follow-up, 68.7 ± 9.2% of the gains achieved in the intervention group were maintained, compared with 52.4 ± 8.7% in the control group. Parent-reported activities of daily living improved by 15.7%–22.4% across the assessed domains.

The preliminary economic analysis estimated an incremental cost of approximately 7.7 million Uzbek soums per additional GMFM-88 point and 8.6 million Uzbek soums per additional Berg Balance Scale point. The estimated return on investment was 94.4%, with a payback period of approximately 6.2 months. The estimated savings were attributed mainly to a 40% reduction in hospitalization days and lower family out-of-pocket expenditure.

Discussion

The six-month multimodal psychomotor rehabilitation program was associated with greater improvement in gross motor function, balance, resistance to passive movement, functional independence, and selected quality-of-life domains than standard therapy alone. The direction of these findings is consistent with contemporary evidence favoring individualized, goal-directed, task-specific, activity-based, and adequately dosed interventions for children and young people with CP (Jackman et al., 2022; Novak et al., 2020). Exercise-based interventions can also support mobility, strength, fitness, and participation, although pooled effects are variable and depend on intervention content and participant characteristics (Ryan et al., 2017; Verschuren et al., 2016).

The improvement in balance is clinically relevant, but direct comparison with published percentage changes should be made cautiously because pediatric balance studies differ in age, CP subtype, GMFCS distribution, intervention dose, and scale administration. The PBS was developed as a child-adapted version of the Berg Balance Scale and provides an appropriate measurement framework for school-age children with motor impairment (Franjoine et al., 2003). The reduction in Modified Ashworth Scale scores suggests decreased resistance to passive movement; however, the scale has recognized limitations and does not isolate the neural component of spasticity from soft-tissue and biomechanical factors (Bohannon & Smith, 1987; Pandyan et al., 1999).

Improvements in PEDI domains are consistent with rehabilitation models that prioritize activity, participation, family goals, and performance in natural environments (Anaby et al., 2013; Imms et al., 2017). However, PEDI findings for participants beyond the original normative age range should be interpreted as descriptive raw functional scores rather than age-standardized estimates. Parent-proxy SF-36 findings also require caution because the instrument was not developed as a validated proxy measure for children aged 3–12 years. Future studies should use a validated pediatric and CP-specific quality-of-life instrument, such as the PedsQL Cerebral Palsy Module (Varni et al., 2006).

The EEG and MRI changes may be compatible with experience-dependent neuroplastic adaptation, a concept that underpins early and intensive rehabilitation (Hadders-Algra, 2021; Morgan et al., 2021). However, the present data do not demonstrate neurogenesis or establish that structural changes were caused by the intervention.

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These outcomes should be regarded as exploratory until replicated using prespecified imaging pipelines, blinded analysis, test–retest reliability procedures, and longer follow-up.

The high attendance rate suggests that the program was feasible for many families. Nevertheless, children at different GMFCS levels have distinct developmental trajectories, assistance needs, and opportunities for participation; therefore, the same intervention dose and content cannot be assumed to be equally appropriate across GMFCS levels I–V (Hanna et al., 2009; Imms et al., 2017). Stratified analyses by age, CP distribution, GMFCS level, cognitive status, epilepsy, and family support would strengthen interpretation.

The preliminary economic estimates are promising, but they require cautious interpretation. A robust economic evaluation should clearly state the analytical perspective, time horizon, intervention and comparator costs, valuation methods, missing-data handling, uncertainty analysis, and whether downstream health and family costs were included (Husereau et al., 2022). The reported return on investment and payback period should therefore be validated prospectively in a larger sample.

Several limitations should be acknowledged. The study had a small single-center sample, outcome assessors were not fully blinded, and the inclusion of children across GMFCS levels I–V produced substantial clinical heterogeneity. The available records did not provide sufficient detail on random-sequence generation, allocation concealment, trial registration, or an a priori sample-size calculation. The intervention combined multiple components, so the contribution of each component could not be determined. Cognitive efficacy cannot be concluded because the study-specific MMSE adaptation was not independently validated and cognitive results were not presented as a primary outcome. PEDI scores for older participants and parent-proxy SF-36 results were descriptive rather than fully validated pediatric measures. EEG and MRI analyses lacked sufficient information on blinded processing, reproducibility, and correction for multiple comparisons. The economic evaluation did not include a fully specified perspective, uncertainty analysis, or sensitivity analysis. Larger multicenter trials with blinded assessment, validated pediatric cognitive and quality-of-life measures, prespecified imaging methods, and longer follow-up are needed.

Conclusion

This randomized controlled study suggests that a six-month multimodal psychomotor rehabilitation program may produce greater improvements than standard therapy alone in gross motor function, balance, resistance to passive movement, and functional independence in children with cerebral palsy. Exploratory EEG and MRI changes may reflect neuroplastic adaptation but require independent confirmation. Parent-proxy health-status and economic estimates should also be interpreted cautiously. The small sample and incomplete reporting of randomization procedures limit definitive inference. Structured, individualized, multidisciplinary rehabilitation with regular monitoring warrants evaluation in larger, prospectively registered multicenter trials.

REFERENCES

1. Anaby, D., Hand, C., Bradley, L., DiRezze, B., Forhan, M., DiGiacomo, A., & Law, M. (2013). The effect of the environment on participation of children and youth with disabilities: A scoping review. *Disability and Rehabilitation, 35*(19), 1589–1598. https://doi.org/10.3109/09638288.2012.748840
2. Bohannon, R. W., & Smith, M. B. (1987). Interrater reliability of a modified Ashworth scale of muscle spasticity. *Physical Therapy, 67*(2), 206–207. https://doi.org/10.1093/ptj/67.2.206
3. Bovend'Eerdt, T. J. H., Botell, R. E., & Wade, D. T. (2009). Writing SMART rehabilitation goals and achieving goal attainment scaling: A practical guide. *Clinical Rehabilitation, 23*(4), 352–361. https://doi.org/10.1177/0269215508101741
4. Chen, Y., Fanchiang, H. D., & Howard, A. (2018). Effectiveness of virtual reality in children with cerebral palsy: A systematic review and meta-analysis of randomized controlled trials. *Physical Therapy, 98*(1), 63–77. https://doi.org/10.1093/ptj/pzx107
5. Eliasson, A.-C., Krumlinde-Sundholm, L., Rösblad, B., Beckung, E., Arner, M., Öhrvall, A.-M., & Rosenbaum, P. (2006). The Manual Ability Classification System (MACS) for children with cerebral palsy: Scale development and evidence of validity and reliability. *Developmental Medicine & Child Neurology, 48*(7), 549–554. https://doi.org/10.1017/S0012162206001162

6. Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-mental state”: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6
7. Franjoine, M. R., Gunther, J. S., & Taylor, M. J. (2003). Pediatric Balance Scale: A modified version of the Berg Balance Scale for the school-age child with mild to moderate motor impairment. *Pediatric Physical Therapy, 15*(2), 114–128. https://doi.org/10.1097/01.PEP.0000068117.48023.18
8. Graham, H. K., Rosenbaum, P., Paneth, N., Dan, B., Lin, J.-P., Damiano, D. L., Becher, J. G., Gaebler-Spira, D., Colver, A., Reddihough, D. S., Crompton, K. E., & Lieber, R. L. (2016). Cerebral palsy. *Nature Reviews Disease Primers, 2*, Article 15082. https://doi.org/10.1038/nrdp.2015.82
9. Gulati, S., & Sondhi, V. (2018). Cerebral palsy: An overview. *Indian Journal of Pediatrics, 85*(11), 1006–1016. https://doi.org/10.1007/s12098-017-2475-1
10. Hadders-Algra, M. (2021). Early diagnostics and early intervention in neurodevelopmental disorders—Age-dependent challenges and opportunities. *Journal of Clinical Medicine, 10*(4), Article 861. https://doi.org/10.3390/jcm10040861
11. Haley, S. M., Coster, W. J., Ludlow, L. H., Haltiwanger, J. T., & Andrellos, P. J. (1992). Pediatric Evaluation of Disability Inventory (PEDI), version 1.0: Development, standardization, and administration manual. New England Medical Center Hospitals and PEDI Research Group.
12. Hanna, S. E., Rosenbaum, P. L., Bartlett, D. J., Palisano, R. J., Walter, S. D., Avery, L., & Russell, D. J. (2009). Stability and decline in gross motor function among children and youth with cerebral palsy aged 2 to 21 years. *Developmental Medicine & Child Neurology, 51*(4), 295–302. https://doi.org/10.1111/j.1469-8749.2008.03196.x
13. Husereau, D., Drummond, M., Augustovski, F., de Bekker-Grob, E., Briggs, A. H., Carswell, C., Caulley, L., Chaiyakunapruk, N., Greenberg, D., Loder, E., Mauskopf, J., Mullins, C. D., Petrou, S., Pwu, R.-F., & Staniszewska, S. (2022). Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement: Updated reporting guidance for health economic evaluations. *BMJ, 376*, e067975. https://doi.org/10.1136/bmj-2021-067975
14. Imms, C., Granlund, M., Wilson, P. H., Steenbergen, B., Rosenbaum, P. L., & Gordon, A. M. (2017). Participation, both a means and an end: A conceptual analysis of processes and outcomes in childhood disability. *Developmental Medicine & Child Neurology, 59*(1), 16–25. https://doi.org/10.1111/dmcn.13237
15. Jackman, M., Sakzewski, L., Morgan, C., Boyd, R. N., Brennan, S. E., Langdon, K., Toovey, R. A. M., Greaves, S., Thorley, M., & Novak, I. (2022). Interventions to improve physical function for children and young people with cerebral palsy: International clinical practice guideline. *Developmental Medicine & Child Neurology, 64*(5), 536–549. https://doi.org/10.1111/dmcn.15055
16. Jasper, H. H. (1958). The ten-twenty electrode system of the International Federation. *Electroencephalography and Clinical Neurophysiology, 10*, 371–375.
17. McIntyre, S., Goldsmith, S., Webb, A., Ehlinger, V., Hollung, S. J., McConnell, K., Arnaud, C., Smithers-Sheedy, H., Oskoui, M., Khandaker, G., Himmelmann, K., & Global Cerebral Palsy Prevalence Group. (2022). Global prevalence of cerebral palsy: A systematic analysis. *Developmental Medicine & Child Neurology, 64*(12), 1494–1506. https://doi.org/10.1111/dmcn.15346
18. Morgan, C., Fetters, L., Adde, L., Badawi, N., Bancale, A., Boyd, R. N., Chorna, O., Cioni, G., Damiano, D. L., Darrah, J., de Vries, L. S., Dusing, S., Einspieler, C., Eliasson, A.-C., Ferriero, D., Fehlings, D., Forssberg, H., Gordon, A. M., Greaves, S., … Novak, I. (2021). Early intervention for children aged 0 to 2 years with or at high risk of cerebral palsy: International clinical practice guideline based on systematic reviews. *JAMA Pediatrics, 175*(8), 846–858. https://doi.org/10.1001/jamapediatrics.2021.0878
19. Novak, I., Morgan, C., Fahey, M., Finch-Edmondson, M., Galea, C., Hines, A., Langdon, K., McNamara, M., Paton, M. C. B., Popat, H., Shore, B., Khamis, A., Stanton, E., Finemore, O. P., Tricks, A., te Velde, A., Dark, L., Morton, N., & Badawi, N. (2020). State of the Evidence Traffic Lights 2019: Systematic review of interventions for preventing and treating children with cerebral palsy.

ISSN: 2181-3337 | SCIENTISTS.UZ

Current Neurology and Neuroscience Reports, 20(2), Article 3. https://doi.org/10.1007/s11910-020-1022-z

20. Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine & Child Neurology, 39*(4), 214–223. https://doi.org/10.1111/j.1469-8749.1997.tb07414.x
21. Palisano, R. J., Rosenbaum, P., Bartlett, D., & Livingston, M. H. (2008). Content validity of the expanded and revised Gross Motor Function Classification System. *Developmental Medicine & Child Neurology, 50*(10), 744–750. https://doi.org/10.1111/j.1469-8749.2008.03089.x
22. Pandyan, A. D., Johnson, G. R., Price, C. I. M., Curless, R. H., Barnes, M. P., & Rodgers, H. (1999). A review of the properties and limitations of the Ashworth and modified Ashworth scales as measures of spasticity. *Clinical Rehabilitation, 13*(5), 373–383. https://doi.org/10.1191/026921599677595404
23. Patel, D. R., Neelakantan, M., Pandher, K., & Merrick, J. (2020). Cerebral palsy in children: A clinical overview. *Translational Pediatrics, 9*(Suppl. 1), S125–S135. https://doi.org/10.21037/tp.2020.01.01
24. Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., Dan, B., & Jacobsson, B. (2007). A report: The definition and classification of cerebral palsy April 2006. Developmental Medicine & Child Neurology, 49(Suppl. 109), 8–14. https://doi.org/10.1111/j.1469-8749.2007.tb12610.x
25. Russell, D. J., Rosenbaum, P. L., Avery, L. M., & Lane, M. (2002). *Gross Motor Function Measure (GMFM-66 & GMFM-88) user's manual*. Mac Keith Press.
26. Ryan, J. M., Cassidy, E. E., Noorduyn, S. G., & O'Connell, N. E. (2017). Exercise interventions for cerebral palsy. *Cochrane Database of Systematic Reviews, 2017*(6), Article CD011660. https://doi.org/10.1002/14651858.CD011660.pub2
27. Sadowska, M., Sarecka-Hujar, B., & Kopyta, I. (2020). Cerebral palsy: Current opinions on definition, epidemiology, risk factors, classification and treatment options. *Neuropsychiatric Disease and Treatment, 16*, 1505–1518. https://doi.org/10.2147/NDT.S235165
28. Surveillance of Cerebral Palsy in Europe. (2000). Surveillance of cerebral palsy in Europe: A collaboration of cerebral palsy surveys and registers. *Developmental Medicine & Child Neurology, 42*(12), 816–824. https://doi.org/10.1111/j.1469-8749.2000.tb00695.x
29. Varni, J. W., Burwinkle, T. M., Berrin, S. J., Sherman, S. A., Artavia, K., Malcarne, V. L., & Chambers, H. G. (2006). The PedsQL in pediatric cerebral palsy: Reliability, validity, and sensitivity of the Generic Core Scales and Cerebral Palsy Module. *Developmental Medicine & Child Neurology, 48*(6), 442–449. https://doi.org/10.1017/S001216220600096X
30. Verschuren, O., Peterson, M. D., Balemans, A. C. J., & Hurvitz, E. A. (2016). Exercise and physical activity recommendations for people with cerebral palsy. *Developmental Medicine & Child Neurology, 58*(8), 798–808. https://doi.org/10.1111/dmcn.13053
31. Vitrikas, K., Dalton, H., & Breish, D. (2020). Cerebral palsy: An overview. *American Family Physician, 101*(4), 213–220.
32. Ware, J. E., Jr., & Sherbourne, C. D. (1992). The MOS 36-item Short-Form Health Survey (SF-36): I. Conceptual framework and item selection. *Medical Care, 30*(6), 473–483. https://doi.org/10.1097/00005650-199206000-00002
33. World Health Organization. (2001). International classification of functioning, disability and health: ICF.