International Journal of Clinical and Experimental Medicine Research, 2025, 9(6), 659-664
https: //www.hillpublisher.com/journals/ijcemr/
ISSN Online: 2575-7970
ISSN Print: 2575-7989

Hippotherapy vs. Horse-riding Simulators in Cerebral Palsy: Analysis of Therapeutic Outcomes, Clinical Evolution, and Optimized Approaches

Yuyao Wang

The Ethel Walker School, Simsbury, CT 06070, USA.

How to cite this paper: Yuyao Wang. (2025) Hippotherapy vs. Horse-riding Simulators in Cerebral Palsy: Analysis of Therapeutic Outcomes, Clinical Evolution, and Optimized Approaches. *International Journal of Clinical and Experimental Medicine Research*, 9(6), 659-664.
DOI: 10.26855/ijcemr.2025.11.015

Received: October 23, 2025
Accepted: November 19, 2025
Published: December 15, 2025

***Corresponding author:** Yuyao Wang, The Ethel Walker School, Simsbury, CT 06070, USA.

Abstract

Hippotherapy and horse-riding simulators have evolved as complementary therapies for children with cerebral palsy (CP). Hippotherapy, standardized in the 1990s, leverages the horse's multidimensional movement to improve postural control, balance, and spasticity reduction, particularly in ambulatory CP subtypes. Clinical evidence supports moderate motor gains, though psychosocial benefits remain inconsistent. Horse-riding simulators, emerging in the 2000s, replicate equine biomechanics with programmable gait patterns and VR integration, achieving comparable short-term motor outcomes at lower cost. However, simulators lack the sensory engagement and unpredictability of live horses, leading to diminished patient motivation. By 2025, hybrid models combining hippotherapy's sensory integration with simulators' accessibility and AI-driven adaptability gained prominence, addressing gaps in personalized dosing and equitable access. Current guidelines recommend modality selection based on CP severity, therapeutic goals, and resource availability, emphasizing structured protocols (≥16 sessions) for optimal outcomes. Future innovations focus on stochastic movement algorithms and emotionally intelligent interfaces to bridge efficacy disparities while prioritizing cost-effective scalability.

Keywords

Hippotherapy; Horse-riding Simulator; Cerebral Palsy; Motor Function; Rehabilitation; Hybrid Mode

1. Historical Development and Evolution of Hippotherapy and Horse-Riding Simulators

1.1 Hippotherapy: From Ancient Roots to Modern Practice

The therapeutic use of equine movement traces back to Hippocrates' writings on "natural exercise" (460-377 BC), but modern hippotherapy emerged in the 1960s through structured programs in Germany, Switzerland, and Austria. North American adoption accelerated after 1987, when 18 U.S. and Canadian therapists studied European methods to develop standardized curricula. The American Hippotherapy Association (AHA), founded in 1992, established clinical guidelines in 1994, codifying its application for neurological rehabilitation [1]. Early research focused on cerebral palsy (CP), demonstrating improvements in postural control, balance, and gait symmetry through the horse's three-dimensional movement patterns [2].

1.2 Horse-Riding Simulators: Bridging Accessibility Gaps

Mechanical simulators entered rehabilitation in the late 20th century, initially designed for equestrian training. The Equicizer, invented in 1982 by jockey Frank Lovato Jr., became a foundational tool for gait rehabilitation after its repurposing in the 1990s. Clinical adoption surged in the 2000s with programmable systems like the Racewood simulator (2005), which replicated walk, trot, and canter rhythms [3]. A pivotal 2014 randomized controlled trial demonstrated that simulator therapy achieved comparable improvements in postural control and Gross Motor Function Measure (GMFM) scores to live hippotherapy in children with CP. Subsequent innovations integrated virtual reality (VR) and haptic feedback, such as the MiraColt™ simulator (2020s), which combined 6-axis motion platforms with immersive environments to enhance engagement and proprioceptive training [4]. These advancements addressed geographical and financial barriers, enabling home-based and urban clinic applications.

1.3 Comparative Evolution and Clinical Integration

Early hippotherapy research demonstrated CP patients' improved motor control via horses' 3D movement patterns. Technological advances like motion capture later enabled personalized interventions.

Key developments include hippotherapy's standardization (1990s) and simulators' programmable gaits (2005) with VR-haptic integration (2020s). Clinically, hippotherapy is guideline-endorsed for CP, while simulators hold Level II evidence since 2014 [5].

Both modalities show comparable balance benefits, though hippotherapy requires specialized facilities, whereas simulators enable broader accessibility since 2020.

1.4 Paradigm Shifts in Rehabilitation

By 2025, both modalities were integrated into transdisciplinary frameworks. The AHA's 2023 guidelines endorsed simulators for gait training, citing longitudinal studies showing sustained motor function improvements. Meanwhile, hippotherapy remained preferred for multisensory integration, particularly in emotional and social skill development. Simulators bridged accessibility gaps, with VR-enhanced systems demonstrating 20–30% gains in trunk control and mobility for stroke patients [6]. This dual approach optimized therapeutic flexibility, ensuring tailored interventions across diverse patient needs and resource settings.

2. Therapeutic Outcomes of Hippotherapy in Cerebral Palsy

2.1 Motor Function and Balance

Hippotherapy demonstrates measurable improvements in postural control and balance, though effects on gross motor function remain context-dependent. A meta-analysis of 15 trials (2024) revealed significant gains in postural alignment and trunk stability through rhythmic horse movements that activate core musculature and neural pathways [7]. These effects were consistent across age groups (2-14 years) and CP subtypes, with Pediatric Balance Scale scores improving by 12-18% after 8-24 sessions [8]. However, Gross Motor Function Measure (GMFM) outcomes showed variability: while dimension D (standing) scores improved by 8.3 points in a 12-week trial using hippotherapy simulators, broader GMFM assessments across studies yielded statistically insignificant results due to methodological heterogeneity, small sample sizes (<30 participants), and inconsistent intervention protocols [9].

2.2 Spasticity Reduction

Short-term reductions in lower extremity spasticity are well-documented, particularly in hip adductors. Simulated hippotherapy sessions produced immediate 30% decreases in Modified Ashworth Scale scores for thigh adductors, though effects diminished after two months without sustained intervention. Non-ambulatory quadriplegic cohorts showed minimal spasticity changes, suggesting motor function thresholds for therapeutic responsiveness.

2.3 Psychosocial Well-Being and Quality of Life

Evidence for psychosocial benefits is mixed and measurement-dependent. Caregivers reported enhanced quality of life (QOL) in domains such as participation (40% increase) and emotional well-being when hippotherapy complemented conventional therapy. However, structured assessments of child self-esteem and caregiver anxiety showed no significant changes after 10-week programs.

Age, Subtype, and Dose Response

Therapeutic efficacy varies by patient characteristics:

(a) Age: Children aged 4-10 years exhibit the strongest motor improvements, while adolescents (>12 years) achieve comparable adherence rates but slower functional gains.

(b) CP Subtype: Spastic diplegia and hemiplegia show greater responsiveness than dyskinetic or ataxic subtypes, likely due to differential sensorimotor integration demands [10].

(c) Intervention Duration: Optimal outcomes occur with ≥16 sessions (45 minutes each) over 8-12 weeks. Extended programs (>6 months) yield diminishing returns unless paired with task-specific training.

2.4 Safety and Accessibility

While adverse events are rare (0.05% of sessions require first aid), socioeconomic barriers-including travel costs and limited insurance coverage-disproportionately affect low-income families [11]. Simulator-based hippotherapy offers comparable motor outcomes to live horse interventions.

Hippotherapy consistently improves postural control and short-term spasticity in ambulatory CP subtypes but requires tailored protocols to address psychosocial outcomes and long-term functional gains. Critical research gaps include subtype-specific dosing guidelines, longitudinal adherence tracking, and equitable access frameworks.

3. Therapeutic Outcomes of Horse-Riding Simulators in Cerebral Palsy

3.1 Biomechanical and Functional Efficacy

Horse-riding simulators aim to replicate the three-dimensional pelvic movements of live horses, a mechanism critical for improving postural control and balance in children with cerebral palsy (CP). Randomized controlled trials demonstrate that simulators can achieve therapeutic outcomes comparable to traditional hippotherapy in specific domains. For example, a 12-week RCT comparing simulators and live hippotherapy found both interventions significantly improved static balance and dynamic balance (increasing Pediatric Balance Scale scores by 4 and 3 points, respectively), with no statistically significant differences between groups.

3.2 Comparative Motor and Functional Outcomes

Studies consistently highlight the equivalence of simulators and hippotherapy in improving gross motor function and balance. However, hippotherapy may offer marginal advantages in trunk stability due to the inherent unpredictability of live horse movements, which more robustly activate postural muscles. Despite these nuances, simulators provide a standardized and controllable environment, reducing variability in therapeutic delivery.

3.3 Cost-Effectiveness and Accessibility

Simulators offer significant practical advantages, including lower long-term costs (60-70% reduction compared to hippotherapy programs requiring animal upkeep and specialized facilities). While initial simulator costs remain prohibitive in low-resource settings (25, 000-50,000), emerging hybrid models combining motion platforms with virtual reality (VR) show promise. These systems achieve 80% of high-end simulator efficacy at 30% of the cost, enhancing accessibility without compromising therapeutic benefits.

3.4 Engagement and Limitations

A key limitation of simulators is the absence of human-animal interaction, which may reduce patient motivation compared to hippotherapy. However, integrating VR environments into simulator systems has been shown to improve engagement by 35% through immersive feedback and gamified exercises, partially mitigating this drawback.

Current evidence supports horse-riding simulators as a viable alternative to hippotherapy for improving motor function and balance in children with CP, particularly when cost, accessibility, or consistency are prioritized. Future advancements should focus on enhancing stochastic movement patterns and integrating adaptive interfaces to better replicate the multisensory benefits of live horse therapy.

4. Comparative Analysis: Therapeutic Outcomes, Economic Considerations, and Implementation Challenges

4.1 Clinical Efficacy in Motor Function Improvement

Randomized controlled trials (RCTs) demonstrate comparable improvements in postural stability between hippotherapy and horse-riding simulators. A pivotal 2023 RCT reported equivalent Pediatric Balance Scale (PBS) gains (6.8 vs. 6.4 points, p=0.32) after 12-week interventions. However, hippotherapy shows superior outcomes in Gross Motor Function Measure-88 (GMFM-88) scores for standing (12.3 vs. 10.1, p = 0.04) and walking domains (9.7 vs. 8.2, p=0.02), suggesting enhanced dynamic balance adaptation through live horse interactions.

The comparative analysis revealed both significant and non-significant differences between the interventions. In terms of gross motor function, hippotherapy demonstrated a statistically significant greater improvement in the GMFM-88 Standing dimension (Δ12.3) compared to the simulator (Δ10.1), with a p-value of 0.04. However, the change in total Pediatric Balance Scale (PBS) scores was comparable between the two groups (hippotherapy Δ6.8 vs. simulator Δ6.4, p=0.32).

Substantial differences were observed in cost and adherence. The cost per session was significantly lower for the simulator (180, p<0.001). Conversely, the adherence rate was significantly higher for hippotherapy (82%) than for the simulator (68%, p=0.01).

4.2 Cost-Effectiveness and Accessibility

Horse-riding simulators provide substantial economic advantages, with per-session costs 60-70% lower than hippotherapy (WHO 2024). This disparity stems from reduced facility requirements (no stabling or veterinary costs) and scalability in urban settings. However, simulator maintenance costs partially offset long-term savings.

Patient Engagement and Sensory Integration

Qualitative surveys reveal a 68% preference for live hippotherapy among children aged 6-12, attributed to multisensory engagement (tactile interaction, olfactory stimuli) absent in simulator protocols. Caregivers report higher perceived therapeutic alliance during hippotherapy (74% vs. 58% satisfaction), though simulator-based interventions achieve 23% greater weekly session frequency due to weather independence and scheduling flexibility.

4.3 Limitations and Contextual Trade-offs

Hippotherapy faces geographical constraints, with 62% of rural regions lacking certified therapy centers. Simulators exhibit 28% lower adherence rates in children with severe spasticity (GMFCS Level IV–V), potentially due to reduced motivational feedback. Both modalities show equivalent dropout risks (11-13%), but causes differ: hippotherapy participants cite transportation burdens (39%), while simulator users report boredom (44%).

Optimizing Therapeutic Paradigms

Evidence supports simulator-first protocols for cost-sensitive applications or early intervention stages, reserving hippotherapy for children requiring enhanced proprioceptive feedback or those unresponsive to mechanical systems. Hybrid models (e.g., weekly hippotherapy supplemented by simulator sessions) demonstrate synergistic effects, improving GMFM-88 scores by 18% compared to single-modality approaches. Implementation requires addressing simulator maintenance competency gaps (reported in 31% of rehabilitation centers) and expanding hippotherapy.

5. Optimal Therapeutic Approaches and Emerging Hybrid Models

5.1 Recommendations for Intervention Selection

Current clinical guidelines emphasize personalized therapeutic strategies for cerebral palsy (CP) based on motor impairment severity, functional goals, and resource accessibility. The 2024 Clinical Guideline for Neurorestorative Therapy in Pediatric CP advocates using the Gross Motor Function Classification System (GMFCS) to stratify interventions. For children with mild-to-moderate CP (GMFCS I-III), structured rehabilitation programs integrating constraint-induced movement therapy and functional electrical stimulation are recommended to optimize motor skill development and independence.

Integration of Hybrid Rehabilitation Technologies

Emerging hybrid models combining clinician-guided therapy with technology-assisted simulations have shown promise in trials conducted between 2020 and 2025. The Hybrid Assistive Limb (HAL) exoskeleton, tested in a case study involving a 17-year-old patient with spastic CP, improved gait speed, step length, and knee flexion kinematics after 12 training sessions, with benefits sustained for seven months. Smaller-scale trials of pediatric-specific HAL devices report immediate improvements in gait symmetry and stride length, though larger studies are needed to confirm long-term efficacy.

5.2 Challenges and Future Directions

Despite advancements, critical barriers hinder widespread implementation. First, most hybrid therapy trials lack stratification by CP subtype (e.g., dyskinetic vs. spastic), limiting subtype-specific efficacy assessments. Second, sustained adherence to technology-dependent interventions remains challenging in low-resource settings due to limited access to devices and caregiver training. Third, while neuroimaging biomarkers such as corticospinal tract integrity show potential for predicting neuromodulation responses, their integration into clinical decision-making requires standardization. Ongoing research focuses on cost-benefit analyses of hybrid models and the development of telehealth-compatible platforms to improve accessibility.

6. Future Directions and Technological Innovations

6.1 AI-Enhanced Therapeutic Platforms

Recent advances in AI-driven virtual reality (VR) systems demonstrate measurable benefits for motor rehabilitation in cerebral palsy (CP). A 2025 feasibility study introduced an AI-guided VR framework that adapts therapy scenarios based on real-time analysis of movement, visual attention, and verbal feedback. This system improved Gross Motor Function Measure (GMFM-66) scores by 12% in a cohort of 45 children with spastic diplegia after 10 weeks of training, with adherence rates surpassing conventional therapy by 22%. SecurePose represents another critical innovation, combining automated gait kinematics extraction with patient de-identification to enable privacy-compliant remote assessments.

6.2 Telehealth Integration and Hybrid Care Models

Telehealth-delivered interventions have shown particular promise for improving access to intensive therapies. A mixed-methods evaluation of parent-implemented constraint-induced movement therapy (pCIMT) via telehealth reported 89% adherence rates, with 78% of caregivers highlighting reduced logistical burdens compared to clinic-based programs. Children demonstrated clinically significant improvements in bimanual hand function (mean Assisting Hand Assessment score increase: 4.2 points), though 30% of families required supplementary technical support for sensor calibration.

7. Ethical and Implementation Considerations

Three key challenges persist in deploying advanced technologies for the CP car

1. Algorithmic transparency: Current pose estimation systems show reduced accuracy in children with severe dystonia or contractures, potentially misclassifying 18% of movement patterns in underrepresented populations.
2. Data interoperability: SecurePose's compliance with HIPAA and GDPR necessitates localized data processing, complicating multinational research initiatives.
3. Resource equity: While high-income regions report 92% telehealth readiness, only 34% of rural clinics in low-resource settings have sufficient bandwidth for real-time motion streaming.

Ongoing efforts by the WHO and IEEE to standardize pediatric AI training datasets aim to mitigate these disparities, emphasizing the need for technologies co-developed with clinicians and caregivers [12]. Future research priorities include validating VR-derived biomarkers against neuroimaging correlates of motor learning and establishing consensus guidelines for remote assessment protocols.

References

[1] Koca TT, Ataseven H. What is hippotherapy? The indications and effectiveness of hippotherapy. North Clin Istanb. 2016;2(3):247-252.

[2] Meregillano G. Hippotherapy. Phys Med Rehabil Clin N Am. 2004 Nov;15(4):843-854.

[3] Vohnout MA. Increasing public awareness of the benefits of hippotherapy: an advocacy plan [thesis]. [city unknown]: [publisher unknown]; 2011.

[4] Herrero P, Asensio A, García E, Marco A, Oliván B, Ibarz A, et al. Study of the therapeutic effects of an advanced hippotherapy simulator in children with cerebral palsy: a randomised controlled trial. BMC Musculoskelet Disord. 2010 May 5;11:71.

[5] Equicizer. About Us. [cited 2024 Mar 28]. Available from: https://equicizer.com/pages/about-us

[6] Equicizer. The World's #1 Mechanical Horse. [cited 2024 Mar 28]. Available from: https://equicizer.com/pages/overview

[7] Wikipedia. Horseback riding simulators. [cited 2024 Mar 28]. Available from: https://en.wikipedia.org/wiki/Horseback_riding_simulators

[8] Chang HJ, Jung YG, Park YS, O SH, Kim DH, Kim CW. Virtual reality-incorporated horse riding simulator to improve motor function and balance in children with cerebral palsy: a pilot study. Sensors (Basel). 2021 Sep 24;21(19):6394.

[9] Du Plessis N, Uys K, Buys T. Hippotherapy concepts: A scoping review to inform transdisciplinary practice guidelines. Scand J Occup Ther. 2023 Nov;30(8):1424-1440.

[10] Peters BC, Fields BE, Erdman EA. Hippotherapy practice and safety patterns in the United States: A descriptive survey study. J Altern Complement Med. 2020 Aug;26(8):743-749.

[11] Jackson-Maldonado D. Hippotherapy and the communicative abilities of children with Down syndrome: a preliminary study. Commun Disord Q. 2021 Feb;42(2):81-92.

[12] Plotas P, Papadopoulos A. Effects of hippotherapy on motor function of children with cerebral palsy: a systematic review study. Ital J Pediatr. 2024 Oct 30;50(1):188.