Benefits of Dynamic Movement in Gait Training

Welcome

Webinar

Presenter: Lori Potts, PT

Course Content

1. Dynamics of human gait and dynamic gait training research
2. Pediatric gait training research
3. Case studies and case stories

Pacer Product Demonstration:
Positioning & Prompt Reduction

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Dynamics of Human Gait

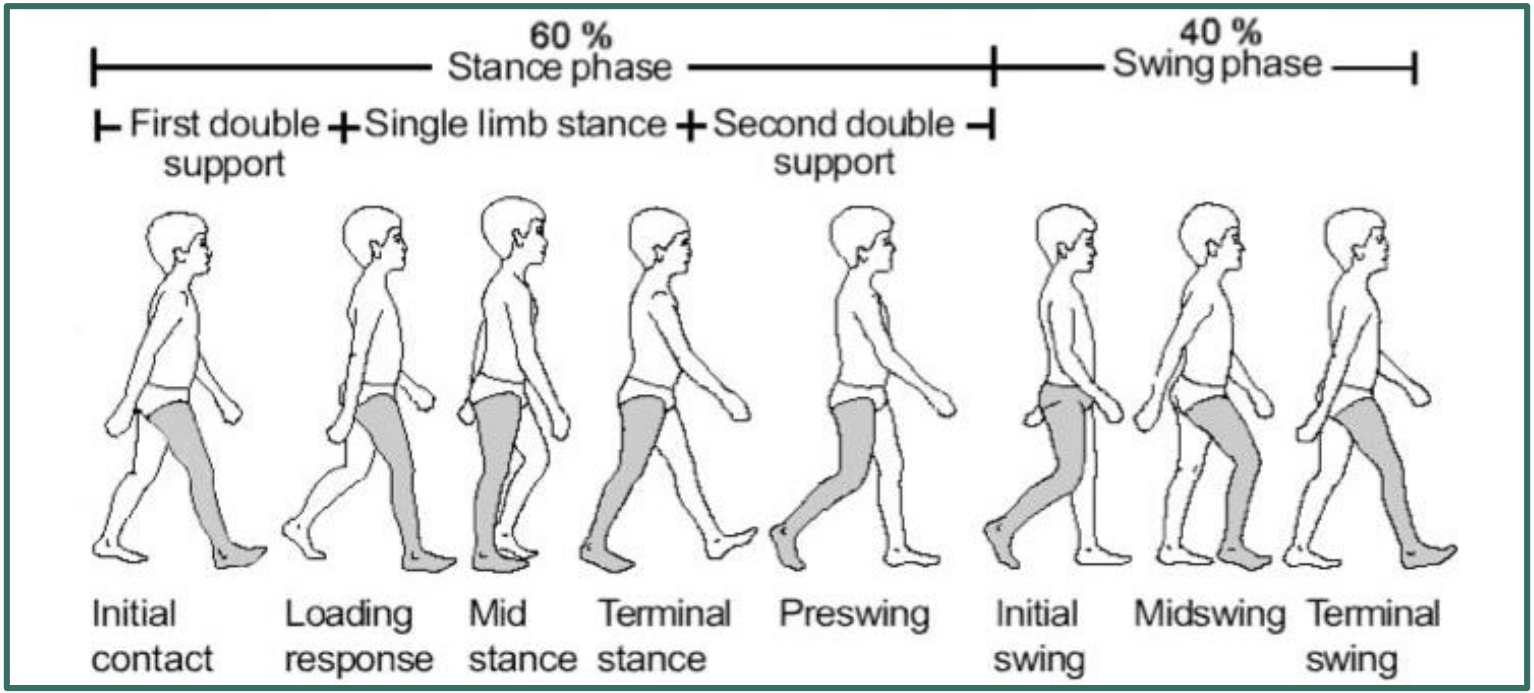

Illustration Source: https://www.semanticscholar.org/paper/Classification-of-autism-children-gait-patterns-and-Ilias-Tahir/acf6820f30b6b914aad30808cb7c5f0992049291/figure/2

Dynamics of Human Gait

Vertical movement “Body Weight Support”

- Height at stance allows contralateral leg swing
- The up-down motion stores and releases energy for gait efficiency

Lateral movement “Body Weight Shift”

- The center of gravity moves laterally towards the stance limb making it easier to swing the contralateral limb through to take a step.

Source:
Noble, E. (2015, October 28). Why Dynamic Gait Training? A Closer Look at Improving Mobility and Gait Patterns.[Blog post]. Available at: https://www.rifton.com/adaptive-mobility-blog/blog-posts/2015/october/dynamic-gait-training

Noble, E. (2016, July 7). Gait Training and Dynamic Movement: What we think about when we think about good gait pattern. [Blog post]. Available at: https://www.rifton.com/adaptive-mobility-blog/blog-posts/2016/july/gait-training-dynamic-movement

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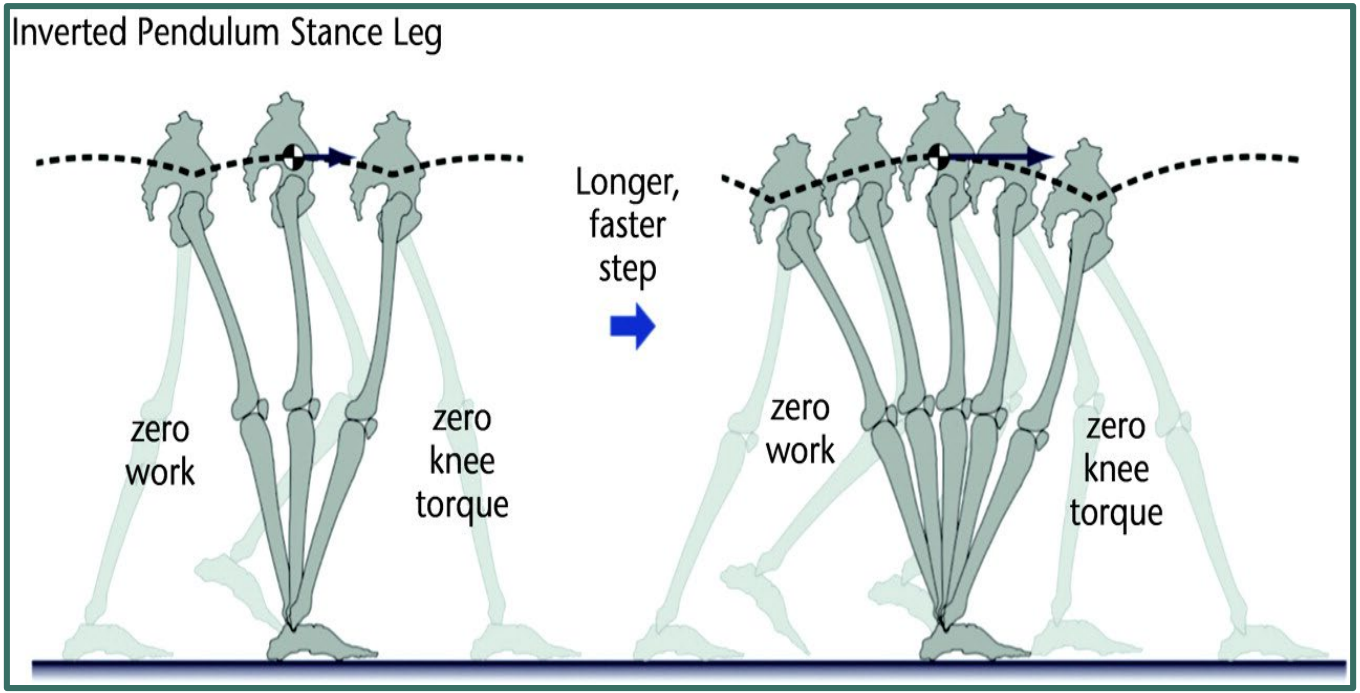
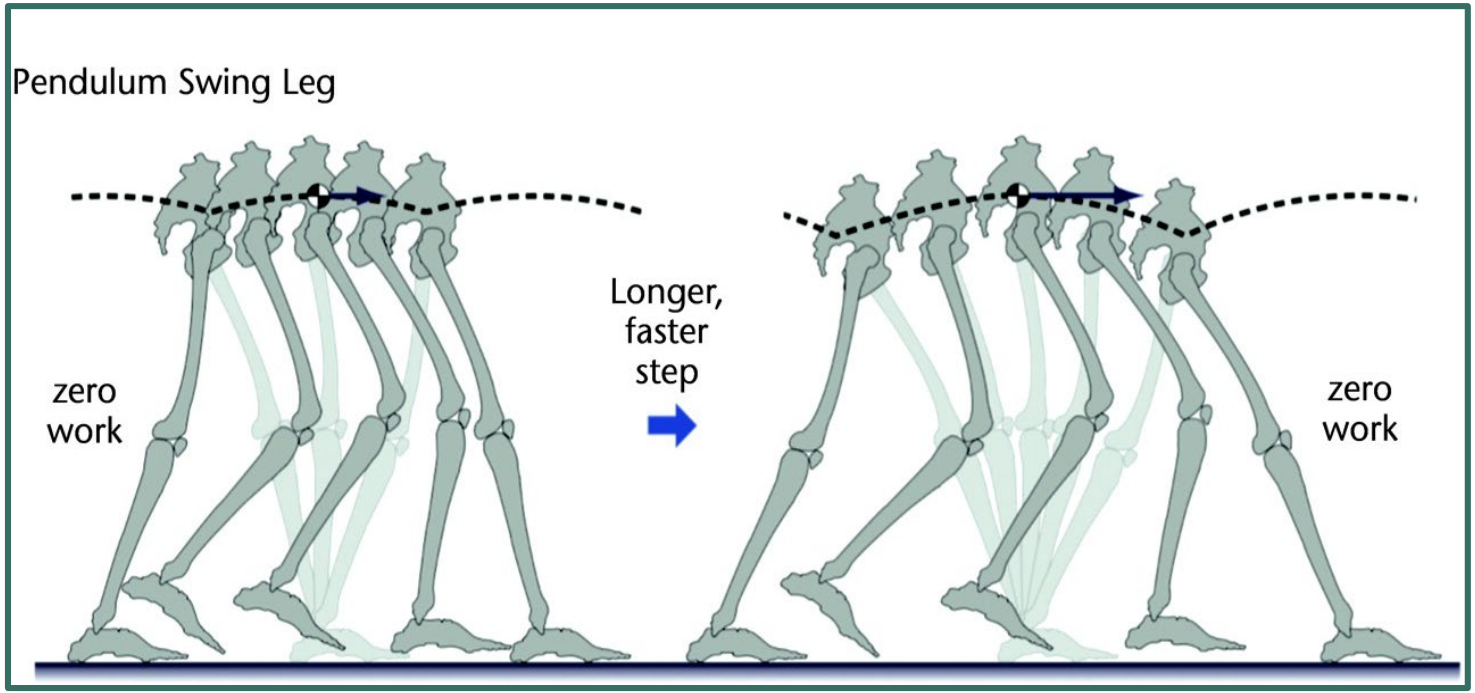
Dynamics of Human Gait



Source: Kuo A, Donelan J. Dynamic principles of gait and their clinical implications. Physical Therapy. 2010; 90:157-74. Available at: https://academic.oup.com/ptj/article/90/2/157/2737752

Dynamics of Human Gait



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Dynamics of Human Gait

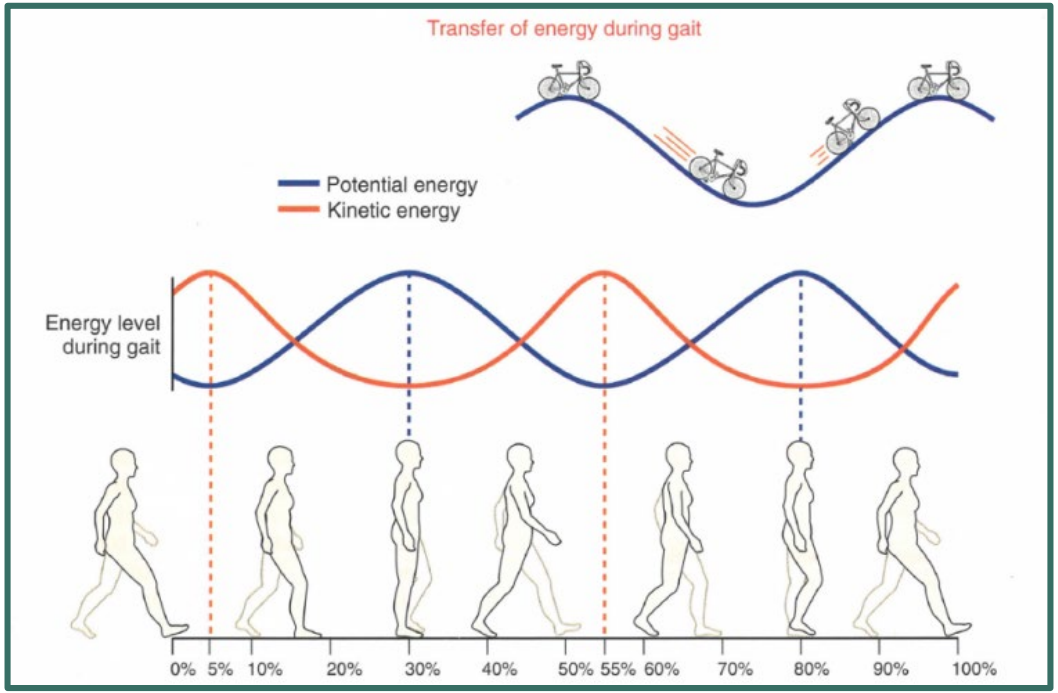

Illustration Source: https://slideplayer.com/slide/4188504/Kinesiology of Walking/Dr. Michael P. Gillespie (@ 18:02)

Dynamics of Human Gait

"No person walks completely straight. This is evident when looking at a person wearing a headlamp in the dark, walking towards you. The light will be seen to move up and down and from side to side.

This is even more evident when a person is walking slowly in order not to fall…this is very relevant for people with ambulation disorders."

Dr. Andrey Kalachev - Russia

Illustration Source: https://images.all-free-download.com/images/graphiclarge/walking_in_the_dark_with_light_in_helmet_clip_art_16891.jpg

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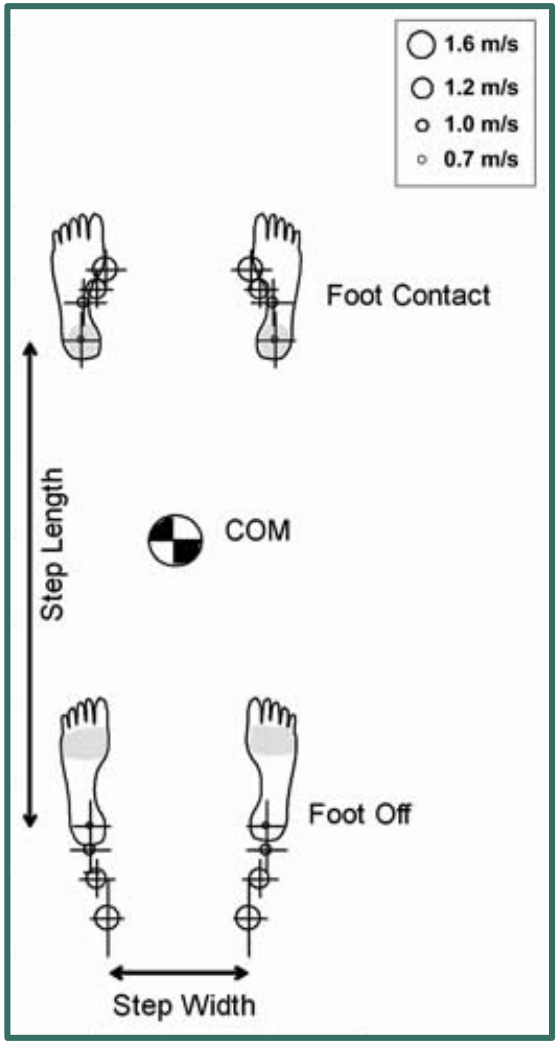
Dynamics of Human Gait

“Even normal individuals show significant medio-lateral center-of-mass displacement at slow speeds.”

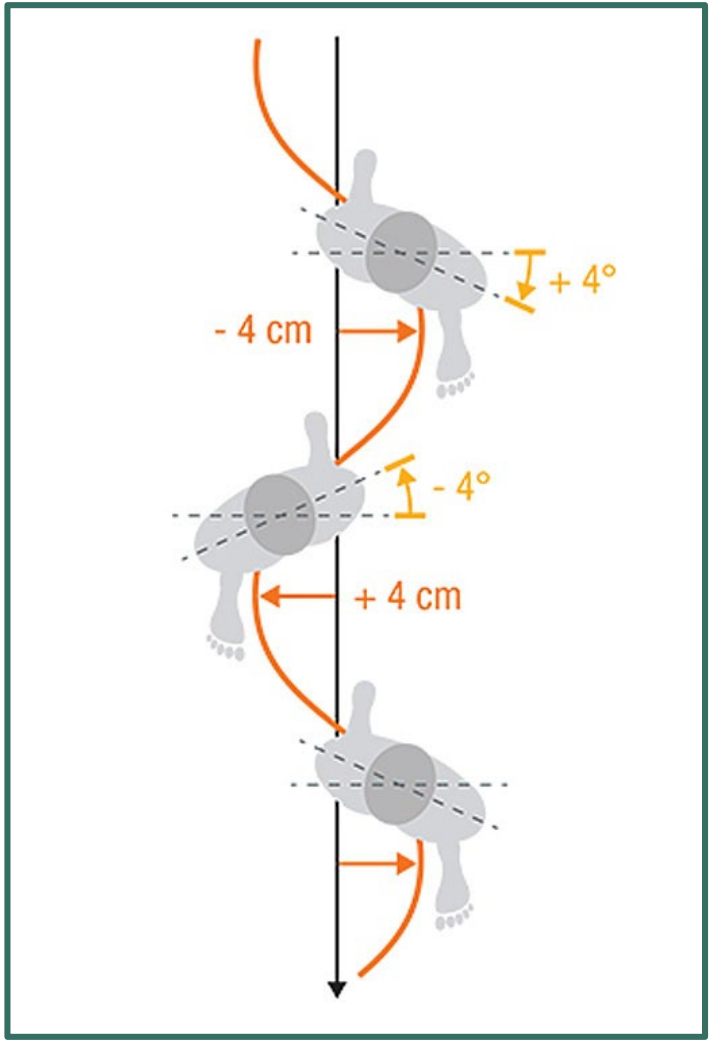
Source: Orendurff MS, Segal AD, Klute GK, Berge MS, Rohr ES, Kadel NJ. The effect of walking speed on center of mass displacement. *J Rehabil Res Dev.* 2004; 41(6A): 329-34. Available at: https://www.rehab.research.va.gov/jour/04/41/6/pdf/Orendurff.pdf



Dynamics of Human Gait

- ✓ Vertical movement
- ✓ Lateral movement

Illustration Source: https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-019-0496-x/figures/1



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Dynamic Gait Training Research

Dynamic
Body Weight Support

Improved constancy of vertical unloading during the movement of the subject's center-of-gravity, results in more natural ground-reaction forces and gait characteristics.

Sources:
Frey M, Colombo G, Vaglio M, Bucher R, Jorg M, Riener R. A novel mechatronic body weight support system. *IEEE Trans Neural Syst Rehabil Eng*. 2006;14(3):311-21. Abstract: https://pubmed.ncbi.nlm.nih.gov/17009491/

Hidler J, Brennan B, Black I, Nichols D, Brady K, Nef T. ZeroG: Overground gait and balance training system. *J Rehabil Res Dev*. 2011;48(4): 287-98. Available at: https://www.rehab.research.va.gov/jour/11/484/hidler484.html

Munawar H, Patoglu V. Gravity-Assist: A series elastic body weight support system with inertia compensation. *IEEE Xplore*. 2016. Abstract: https://ieeexplore.ieee.org/document/7759470

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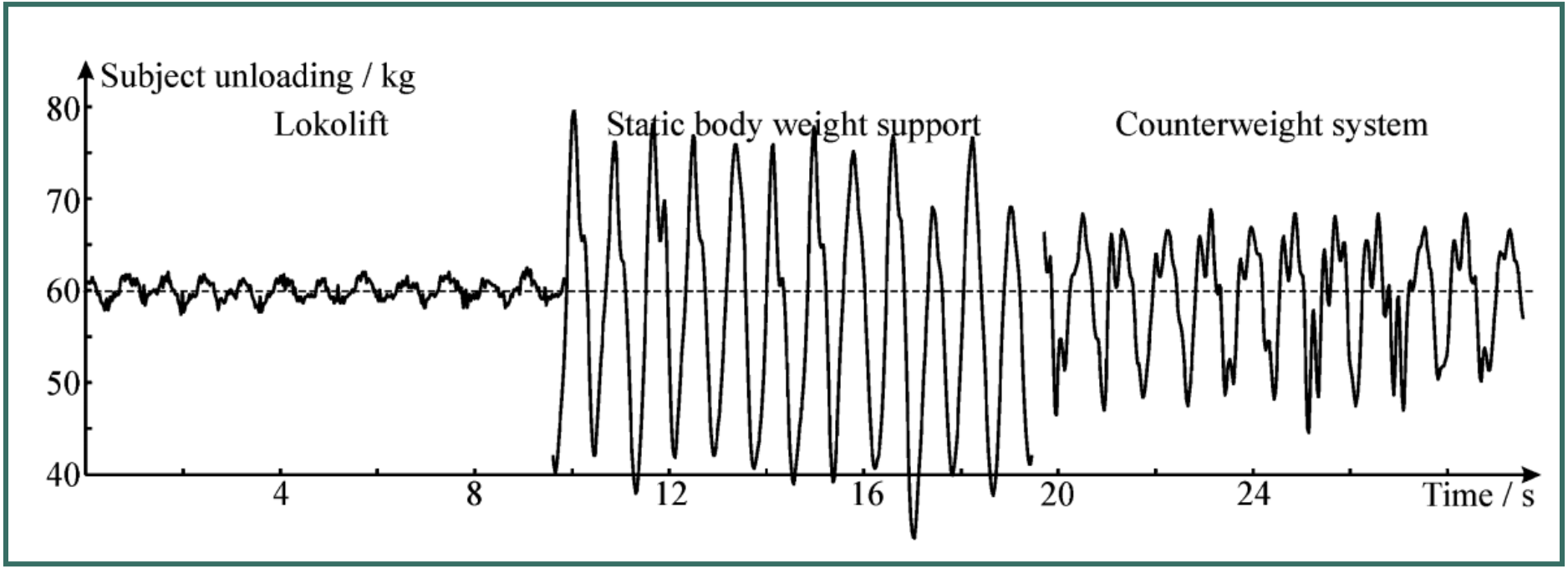
Dynamic Gait Training Research



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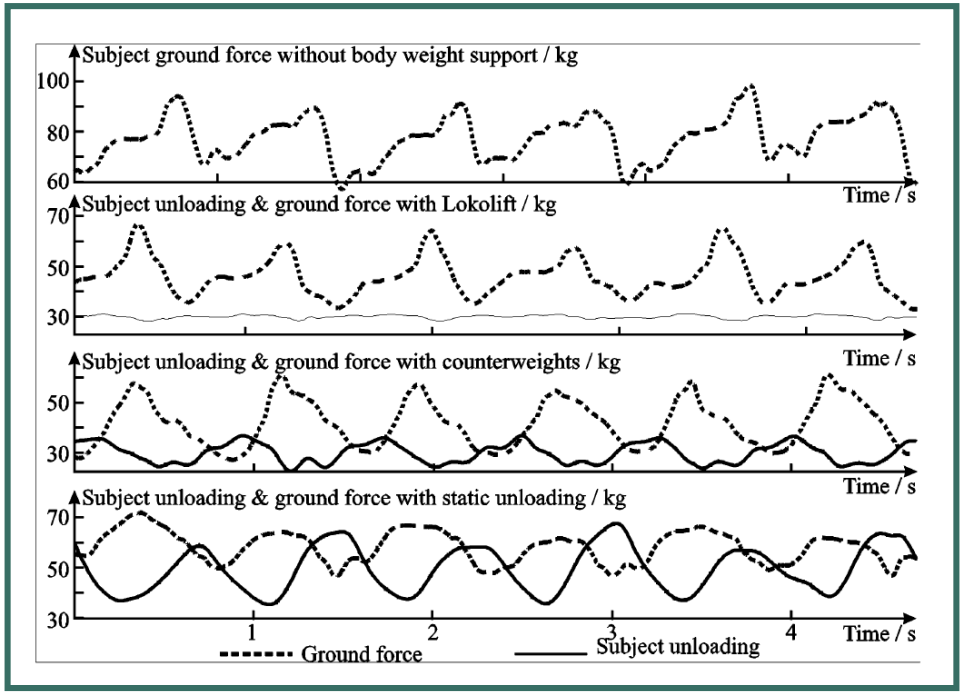

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Dynamic Gait Training Research

Dynamic
Body Weight Support

Statistically significant increase in velocity, cadence, and timed functional walk

Source: Low S, Westcott S. A comparison of two support walkers on the gait parameters of children with cerebral palsy- abstract. Dev Med Child Neurol. 2009;51:62.

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Dynamic Gait Training Research

Dynamic
Body Weight Support

The device facilitated better movement with minimal muscle effort with resulting increased access to community and home environments.

Source: Altizer W, Noritz G, Paleg G. Use of a dynamic gait trainer for a child with thoracic level spinal cord injury. BMJ. Published October 7, 2017. Available at: https://casereports.bmj.com/content/2017/bcr-2017-220756
Video Source: https://casereports.bmj.com/content/casereports/2017/bcr-2017-220756/DC1/embed/inline-supplementary-material-1.avi?download=true

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Pediatric Gait Training Research

Use of support walkers

Reported purpose and perceived benefits of use:

- Increase physical activity, participation, and independence
- Improve postural control, muscle strength, mobility/motor abilities, peer and family interaction, respiratory function, bone mineral density

Sources:
George, C., Levin, W. & Ryan, J.M. The use and perception of support walkers for children with disabilities: a United Kingdom survey. BMC Pediatr 20, 528 (2020). Available at: https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-020-02401-5

Low SA, McCoy SW, Beling J, Adams J. Pediatric physical therapists' use of support walkers for children with disabilities: a nationwide survey. Pediatr Phys Ther. 2011;23(4):381–9. Available at: https://journals.lww.com/pedpt/Fulltext/2011/23040/Pediatric_Physical_Therapists__Use_of_Support.15.aspx

Pediatric Gait Training Research

Functional, mechanically-assisted, gait training improves:

- walking speed, walking distance, number of steps
- walking endurance
- gait-related gross motor function
- participation

Sources:
Chiu H-C, Ada L, Bania TA. Mechanically assisted walking training for walking, participation, and quality of life in children with cerebral palsy. Cochrane Database of Systematic Reviews 2020, Issue 11. Art. No.: CD013114. Available at: https://www.cochrane.org/CD013114/BEHAV_mechanically-assisted-walking-training-children-cerebral-palsy

Booth A, Buizer A, Meyns P, Lansink I, Steenbrink F et al. The efficacy of functional gait training in children and young adults with cerebral palsy: a systematic review and meta-analysis. Dev Med Child Neurol. 2018; 60:866-83. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/dmcn.13708

Paleg G, Livingstone R. Outcomes of gait trainer use in home and school settings for children with motor impairments: a systematic review. Clinical Rehabilitation. 2015;29(11):1077-1091. Abstract: https://journals.sagepub.com/doi/10.1177/0269215514565947

Pediatric Gait Training Research

Treadmill training improves:

- motor function
- balance
- endurance
- ambulation – walking skills, walking speed

Sources:
Ronan S, Bingham E, Mushkat S, Sedman E. Recommended treadmill training parameters for persons with cerebral palsy based on the GMFCS levels: a systematic review. Dev Med Child Neurol. 2015; S5: 67. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/dmcn.109_12887

Valentin-Gudiol M, Mattern-Baxter K, Girabent-Farres M, Bagur-Calafat C, Gadders-Algra M et al. Treadmill interventions in children under six years of age at risk of neuromotor delay. Cochrane Database Syst Rev. 2017; Jul 29;7. Available at: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD009242.pub3/full

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Pediatric Gait Training Research

Treadmill training may be no more effective than overground for improving walking in children with cerebral palsy.

"Adding concurrent overground walking practice to a treadmill training protocol may assist with carryover of improvements to overground walking."

Sources

Swe NN, Sendhilnnathan S, van Den Berg M, Barr C. Over ground walking and body weight supported walking improve mobility equally in cerebral palsy: a randomised controlled trial. Clin Rehabil. 2015 Nov;29(11):1108-16. Abstract: https://journals.sagepub.com/doi/10.1177/0269215514566249

Willoughby K, Dodd K, Shields N, Foley S. Efficacy of partial body weight-supported treadmill training compared with overground walking practice for children with cerebral palsy; a randomized controlled trial. Arch Phys Med Rehabil. 2010;91:333-9. Available at: https://www.archives-pmr.org/article/S0003-9993(09)00932-0/fulltext

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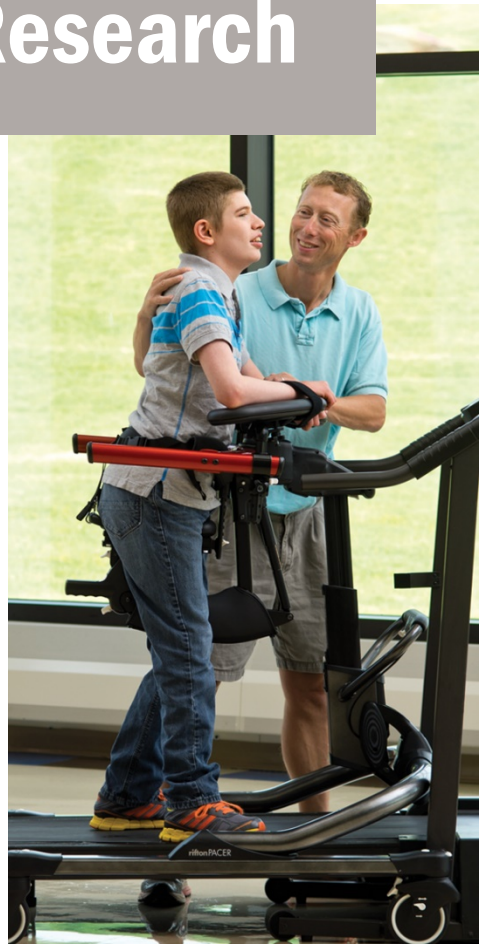


Pediatric Gait Training Research

Overground gait training compared to treadmill:

Children with spastic cerebral palsy

- hemiplegic or diplegic

With overground gait training:

- Longer steps
- Faster strides
- Improved range of motion

Sources:
Celestino M, Gama G, Longuinho G, Fugita M, Barela A. Influence of body weight unloading and support surface during walking of children with cerebral palsy. Fisioter Mov. 2014;27(4):591-9. Available at: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-51502014000400591

Matsuno V, Camargo M, Palma G, Alveno D, Barela M. Analysis of partial body weight support during treadmill and overground walking of children with cerebral palsy. Rev Bras Fisioter. 2010;14(5):404-10. Available at: https://www.scielo.br/scielo.php?pid=S1413-35552010000500009&script=sci_arttext&tlng=en

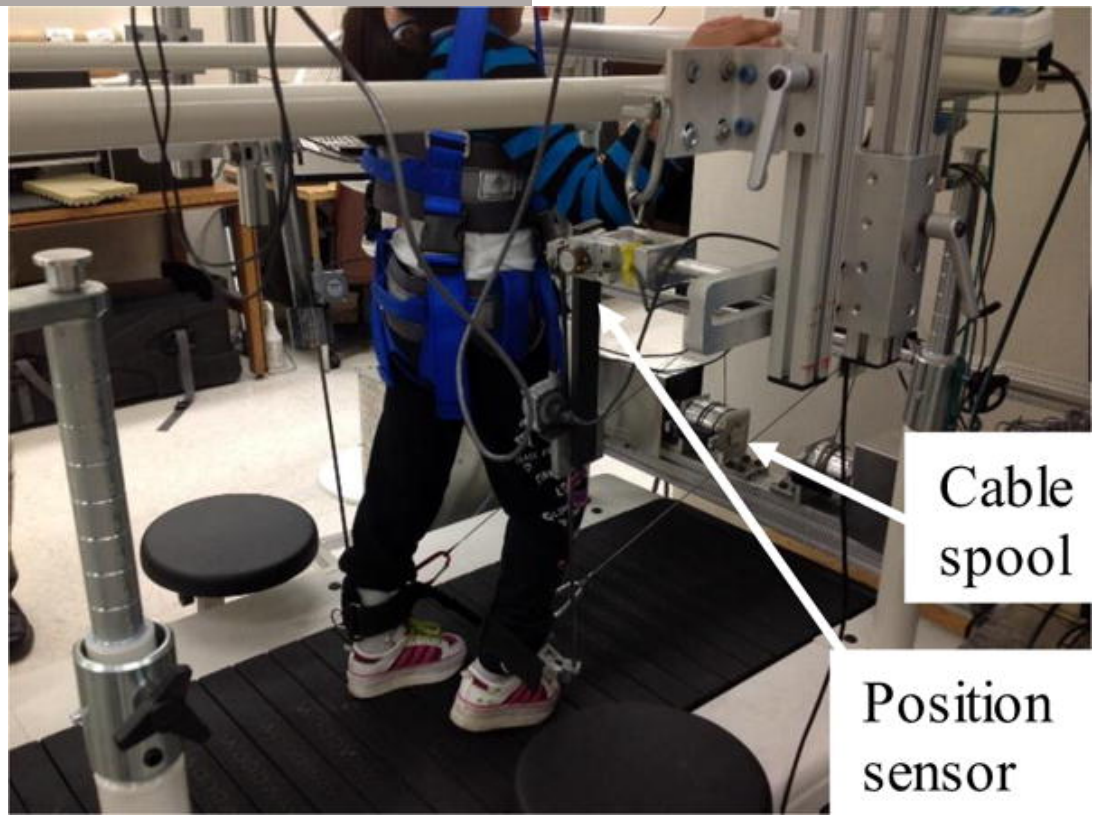
Pediatric Gait Training Research

Resistance to legs during gait compared to Assistance to legs during gait

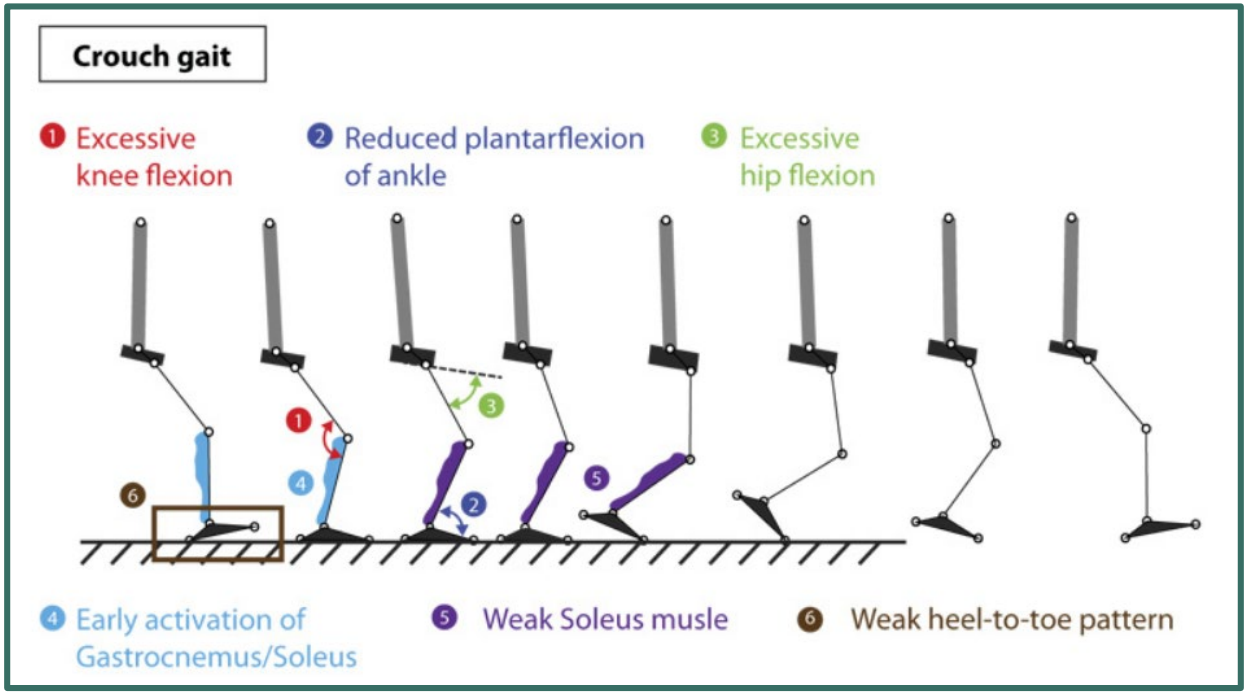
Resistance group showed increases to

- Speed (18%)
- Distance (30%)

Source: Wu M, Kim J, Gaebler-Spira D, Schmit B, Arora P. Robotic resistance treadmill training improves locomotor function in children with cerebral palsy: a randomized controlled pilot study. Arch Phys Med Rehabil. 2017;98:2126-33. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5660940/ Illustration Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5660940/figure/F2/



Pediatric Gait Training Research



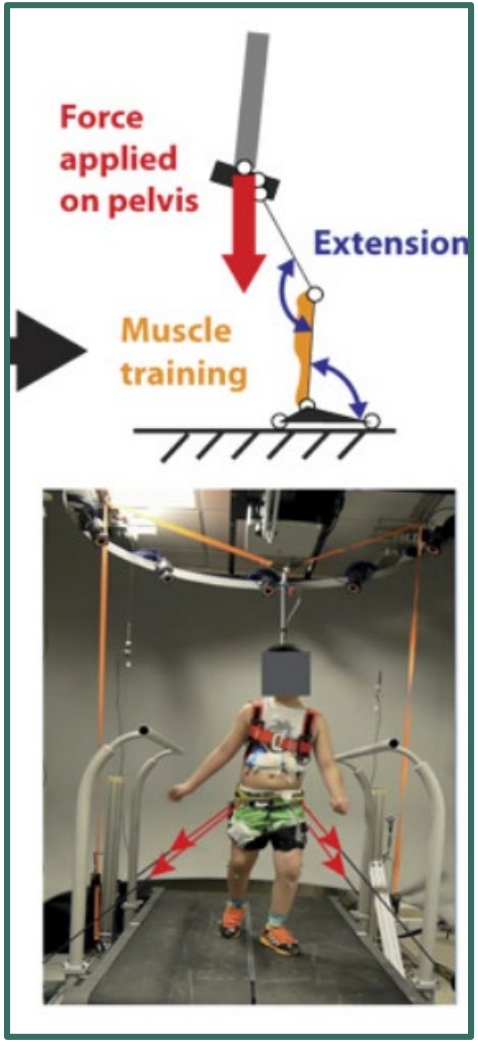
Source: Kang J, Martelli D, Vashista V, Martinez-Hernandez I, Kim H et al. Robot-driven downward pelvic pull to improve crouch gait in children with cerebral palsy. Sci Robot. 2017;2(8). Available at: https://robotics.sciencemag.org/content/2/8/eaan2634 | Illustration Source: https://robotics.sciencemag.org/content/robotics/2/8/eaan2634/F1.large.jpg

Pediatric Gait Training Research

Outcomes:

- Enhanced upright posture
- Improved muscle coordination
- Improved walking features (step length, range of motion, toe clearance, heel-to-toe pattern in gait)

Source: Kang J, Martelli D, Vashista V, Martinez-Hernandez I, Kim H et al. Robot-driven downward pelvic pull to improve crouch gait in children with cerebral palsy. Sci Robot. 2017;2(8). Available at: https://robotics.sciencemag.org/content/2/8/eaan2634
Illustration Source: https://robotics.sciencemag.org/content/robotics/2/8/eaan2634/F1.large.jpg



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Source: Kang J, Martelli D, Vashista V, Martinez-Hernandez I, Kim H et al. Robot-driven downward pelvic pull to improve crouch gait in children with cerebral palsy. Sci Robot. 2017;2(8). Available at: https://robotics.sciencemag.org/content/2/8/eaan2634 | Video Source: https://www.youtube.com/watch?v=ibZW974d0xE

Overground Robotic Therapy

tréxō robotics

Logo/Picture Source: https://trexorobotics.com/

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Research: Overground Robotic Therapy

Good Shepherd Rehabilitation Hospital Allentown, PA

- Research Study
- Children with Cerebral Palsy

2020-2021

Photo Source: https://health.usnews.com/best-hospitals/area/pa/good-shepherd-rehabilitation-network-6239015

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Case Studies & Case Stories

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Case Study – 26 Year Old

4 years post–traumatic brain injury

Severe motor impairments

Had not walked outside of therapy since his injury

- 79 treatments were delivered over 62 weeks
- Walking practice outside of therapy was encouraged

At the conclusion of therapy:

- Walk independently with a gait trainer (over 3000 ft)
- Walk in the community with the assistance of his mother using a rocker bottom crutch (330 ft)

Source: McCain K, Searin S. A clinical framework for functional recovery in a person with chronic traumatic brain injury: a case study. J Neurol Phys Ther. 2017; 41(3): 173-181. Available at: https://journals.lww.com/jnpt/Fulltext/2017/07000/A_Clinical_Framework_for_Functional_Recovery_in_a.5.aspx
Illustration Source: Courtesy of Sean Carter and https://cdn.rifton.com/-/media/images/rifton/blog/blog-images/2011/tbirecoverypatientseancarterdoctorkarenmccain.jpg?la=en&d=20210204T234021Z

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Case Study – 18 Year Old

Case study

18 year old male with spastic Cerebral Palsy

Not a functional ambulator; uses a wheelchair

Goal: Activities and Participation

With body-weight-supported treadmill training: made significant gains in duration and intensity (and transfers and self-care)

Source: DiBiasio P, Lewis C. Exercise training utilizing body weight-supported treadmill walking with a young adult with cerebral palsy who was non-ambulatory. Physiother Theory Pract. 2012; 28(8):641-52. Abstract: https://www.tandfonline.com/doi/full/10.3109/09593985.2012.665983

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Case Study – 15 Year Old

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Table 1: Treadmill gait trainer walking time at 0% incline

Date	Speed (mph)	Time tolerated (minutes)
9/18/2018	0.5	10
9/20/2018	0.7	10
9/24/2018	0.7	10
10/9/2018	0.8	12
10/15/2018	0.8	15
10/23/2018	0.9	15
1/8/2019	**0.7**	**20**

Table 2: Time to Walk 0.2 miles over ground in gait trainer

Date	Time (minutes)
9/26/2018	10:28
10/4/2018	7:59
10/11/2018	9:47
10/17/2018	7:24
11/2/2018	**8:40**

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Case Study – 21 Year Old

Case study

- Tall, large, active, with global developmental delay
- Presents with sudden drop seizures
- Poor balance, displays movement sensory seeking behavior
- Uses a helmet to prevent head injury
- With no device, requires 2 or 3 staff to keep him safe while walking
- He is currently on a weight loss program

Outcomes: Now walks for up to an hour or more, indoors/outdoors and reduced weight by 40 lb

Source: Rifton. (2016, January 8.) The Advantage of Dynamic Movement. Available at: http://www.rifton.com/resources/videos/2016/the-advantage-of-dynamic-movement Video retrieved from https://www.youtube.com/watch?v=r3tKtvvBt1U

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Case Study – 16 Year Old

Case study

- 16-year-old with global developmental delay
- Presents with significant hip, knee, and ankle contractures

Outcomes:

- Less energy required to generate movement, less fatigue
- Improved speed – can now approach a jogging pace
- Increased enjoyment and participation with walking

Source: Rifton. (2016, January 8.) The Advantage of Dynamic Movement. Available at: http://www.rifton.com/resources/videos/2016/the-advantage-of-dynamic-movement Video retrieved from https://www.youtube.com/watch?v=r3tKtvvBt1U

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Case Study – 22 Year Old

Source: Blankley. A. (2018). The Magic of the Floating Frame. [Blog post]. Adaptive Mobility and Positioning Blog. Available at https://www.rifton.com/adaptive-mobility-blog/blog-posts/2018/march/rifton-dynamic-pacer-success-story

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Questions & Answers

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