

Evidence for Adaptive Cycling as an intervention for Cerebral Palsy and Autism Spectrum Disorders

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Fitness and Fun: Adaptive Cycling as a Therapeutic Intervention

“All children with cerebral palsy (CP) should be provided with an adaptive cycle in place of a wheelchair to enable active independent movement in community settings that will at the same time improve their endurance and function.”

Mohanty, 2015

A look at the published evidence...

Physical Activity and Children with Cerebral Palsy

Exercise and Physical Activity Recommendations for People with Cerebral Palsy

Daily Physical Activity

Frequency: > or = 5 days/week

Intensity: Moderate-to-vigorous physical activity

Time: 60 min.

Type: A variety of activities

< 2 hours/day sedentary time or break up sitting for 2 min. every 30-60 min.

Verschuren, 2016

Reducing Sedentary Behavior in CP

Cerebral Palsy GMFCS levels IV and V

Recommendation to increase base-line activity levels

- Light physical activity throughout day
- Sit-to-stand transitions during day

Recommendation to implement activity-based and participatory interventions

Verschuren, 2016



Exercise and Physical Activity Recommendations for People with Cerebral Palsy

Cardiorespiratory Endurance Exercise

Frequency: 3 sessions/week

Intensity: 60% of peak heart rate

Time: Minimum 20 min per session

Type: Regular, purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature

Verschuren, 2016

A look at the published evidence...

Adaptive Cycling and Children with Cerebral Palsy

Systematic Reviews – Adaptive Cycling	Articles
Efficacy of cycling interventions to improve function in children and adolescents with cerebral palsy: a systematic review and meta-analysis. Armstrong, 2019	9 studies N = 282 children with cerebral palsy
Cycle ergometer in the improvement of gross motor function of children with cerebral palsy: a systematic review with meta-analysis. Catelli, 2019	3 studies N = 127, ages 6–17 years, cerebral palsy
Efficacy of Lower Extremity Cycling Interventions for Youth with Intellectual Disabilities: A Systematic Review Fragala-Pinkham, 2021	8 studies N = 229, ages 7 – 26 years, all diagnoses
Impact of adapted bicycle riding on outcomes for children and adolescents with disabilities: A systematic review. Thevarajah, 2023	10 studies N = 234, ages 4 – 18 years, developmental disability

“Cycling can improve muscle strength, balance and gross motor function in children with cerebral palsy.”

Armstrong, 2019



“Evidence supports stationary cycling for short-term improvements in cognitive skills and two-wheeled riding intervention for increasing physical activity one-year after intervention.”

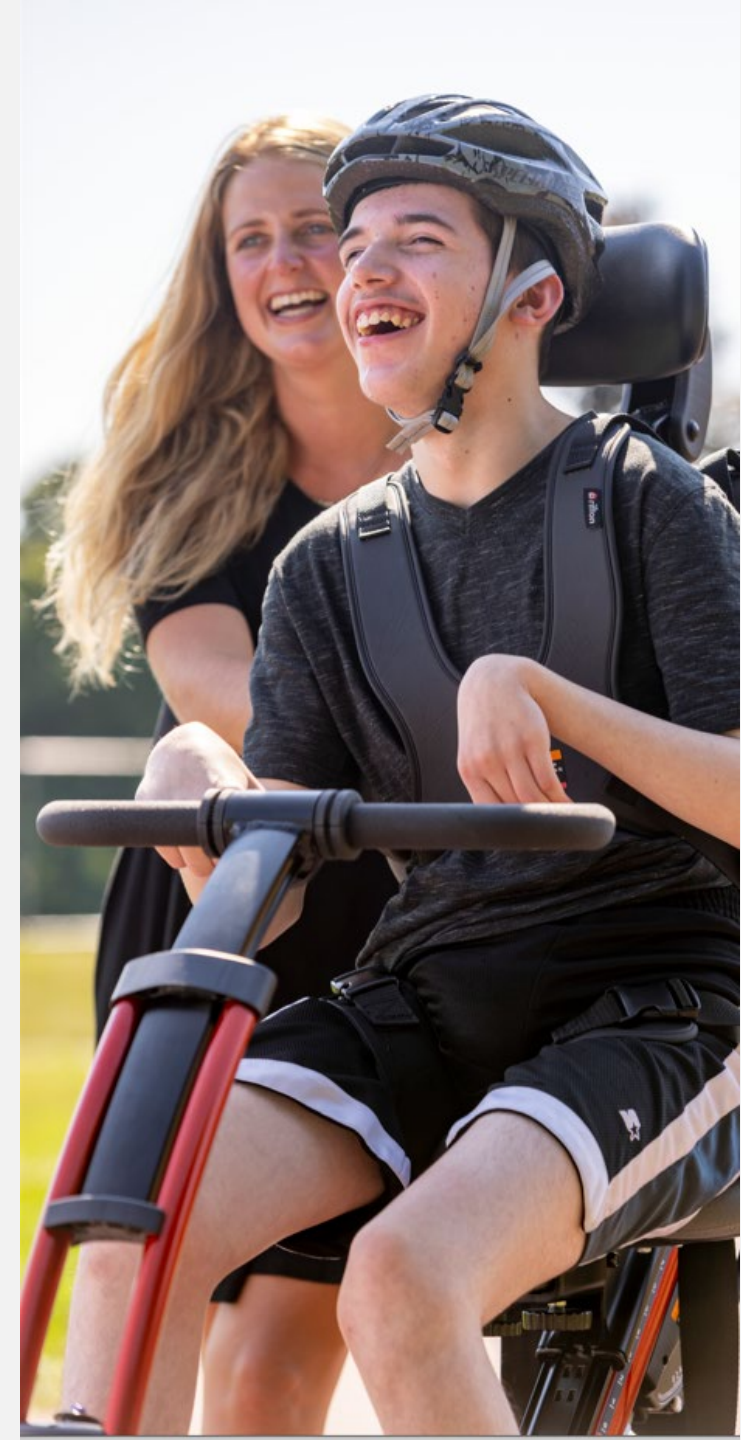
(Only moderate to weak evidence is available.)

Fragala-Pinkham, 2021

“Adapted bicycle riding interventions may improve gross motor function, enhance lower-limb muscle strength, and promote physical activity.”

(Certainty of evidence rated very low using GRADE.)

Theverajah, 2022





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Policy brief: adaptive cycling equipment for individuals with neurodevelopmental disabilities as durable medical equipment

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Maintenance of Functional Gains Following a Goal-Directed and FES-Assisted Cycling Program



Hospital:
30 minutes FES
30 minutes goal-
directed training

Home program:
Adaptive cycling and
goal-directed training

- Outcomes:** Improvements in
- gross motor function
 - goal performance and satisfaction
 - cycling resistance
 - sit-to-stand speed
 - capacity for activities of daily living.

Gains maintained for 8 weeks

Effects of a Static Bicycling Programme

Randomized Controlled Trial

Population: N = 11, age 11-15 years, non-ambulatory cerebral palsy (GMFCS IV and V)

Intervention: Stationary cycling with resistance, 3 sessions/week for 6 weeks

Outcome:

Significant improvements in cycling ability:
duration, speed, resistance

Significant improvements in gross motor function:
standing and walking (GMFM-66 dimensions D and E)

Williams, 2007



Can a 6-week exercise intervention improve gross motor function for non-ambulant children with cerebral palsy?

Pilot Randomized Controlled Trial

Population: N = 35, ages 8-17 years, non-ambulatory cerebral palsy

Intervention: Stationary cycling, 3 sessions/week for 6 weeks

Outcome: Improved standing ability (GMFM-88D scores)

Take-Away: Adaptive cycling can be a safe and effective intervention for children with significant involvement.

Bryant, 2013

Comparison of Dynamic Cycling Vs. Static Cycling

Randomized Controlled Trial

Population: N = 30, age 4-10 years, spastic diplegic cerebral palsy

Intervention: Dynamic cycling, stationary cycling, no cycling.
60 min. session, 5 days/week for 6 weeks

Outcome: Improved cardiovascular endurance, distance with 3-min. walk test, balance, standing, walking, running (GMFM-66 scores)

Mohanty, 2015

Clinical Implications:

“All children with cerebral palsy should be provided with an adaptive cycle in place of a wheelchair to enable active independent movement in community settings that will at the same time improve their endurance and function.”

Mohanty, 2015



Interviews with Children with Cerebral Palsy about Adapted Cycling

Qualitative Analysis

Population: N = 35, Ages 2-17 years, GMFCS I-IV

Intervention: Adaptive cycling outdoors in park, 6-week period

Outcome: Survey responses: Improved sense of well-being. Learning a new skill, positive impact on family/friends. **Opportunity for social participation.**



“A good hour cycling, where Becky did most of the work and even some decent steering. We went right over into the park and back over the bridge. Becky was breathless at times. The weather was bright, but a bit cold. We all enjoyed it.”

- Becky's diary (parent report)



“I normally tag along, walk for awhile, ponder my thoughts, get bored.... The bike's great, easier to get around than walking. Clever, clever invention whoever invented it, I want to thank them.”

- Diane (10 y/o, spastic diplegia)

“We cycle in the park and I go down the slope...and then I change it, you know, I put into 3 (3rd gear) and it makes me fast.”

- Andrew (17 y/o, athetosis and autism)

Pediatric Endurance and Limb Strengthening (PEDALS) Stationary Cycling and Children with Cerebral Palsy

Randomized Controlled Trial

Population: N = 62, ages 17-18 years, spastic diplegic cerebral palsy, ambulatory

Intervention: Stationary cycling, 30 sessions over 12 weeks

Outcome: Pediatric Quality of Life Inventory – improvement in emotional functioning, psychosocial health, school functioning

Improved Walk-Run Test, GMFM-66 D and E scores, strength measures.

Fowler 2010
Demuth, 2012

A look at the published evidence...

Physical Activity, Motor Skills and
Children with Autism Spectrum Disorder

Differences in habitual physical activity levels

Children and youth with ASD and ADHD

Are overall physically inactive with only 42% meeting physical activity guidelines.

Spend over 62% more time on screen-based activities than age-matched peers.

School settings account for the most time spent in MVPA (recess, lunch break, physical education, after school activities)

Liang, 2020
Li, 2021
Mazurek, 2013

Motor Functional Characteristics

Children and youth with ASD and ADHD

Up to 83% have difficulty performing age-appropriate motor skills.

Low levels of physical activity contribute to poorer physical abilities in all types of activities (coordinated movements, resistance and aerobic activities).

Motor delay and deficits found to be most significant barrier for students with autism when participating in physical activity

Association Between Social Skills and Motor Skills

Systematic Review

Literature: 16 studies, N = 3355, children with ASD

Outcome: Found a “highly likely” association between motor and social skills.

- Gross motor: object control and ball skills most related to social development
- Fine motor: manual dexterity most related to social development

Ohara, 2020

Effect of Physical Activity Interventions on Executive Function

Meta-Analysis

Literature: 34 studies, N = 1,058 individuals with neurodevelopmental disorders, ages 5-33

Outcome: Engagement in physical activity improves executive performance (inhibitory control, cognitive flexibility, working memory and planning)

EF outcomes significantly influenced by length of time spent in physical activity

Physical activity modality was not a significant moderator of EF outcomes although aerobic exercise yielded a larger positive impact than other forms of exercise

Effects of Physical Exercise on Stereotyped Behavior

Systematic Review with Meta-Analysis

Literature: 8 studies, N = 129 children with ASD, ~8 years old

Outcome: “Evidence was found to support physical exercise as an effective tool in reducing the number of episodes of stereotypical behaviors.”

“Physical exercise programs can be used for preventive behavior management”

Ferreira, 2019

A look at the published evidence...

Adaptive Cycling and Children with Autism Spectrum Disorder



Adaptive Cycling and Children with ASD

Clinical Article

Specific Recommendations for Clinicians

- “Given the presence of motor impairments in more than 50% of children with ASDs, they may need adaptive modifications...for a bicycle.”
- “For children with balance impairments, supported stationary cycling might be more appropriate...due to lower demands on the postural system.”
- “Children with motor incoordination will benefit from activities enhancing upper-limb or whole-body coordination in comfortable, non-competitive, and non-intimidating environments”

Stationary Cycling and Aerobic Fitness

Population: N = 3, ages 16-21 years, autism with mild mental retardation

Intervention: Stationary cycling at 65-75% HRM, 20 minutes, 3x/week, 6-7 weeks,

Outcome: Aerobic fitness increased 33%, 50%, and 33% for the 3 participants

Lochbaum, 2003

Stationary Cycling and Immediate Reinforcement as Motivation

Pilot Study: Crossover Design

Population: N = 7, ages 5-18 years, autism diagnosis

Intervention: Stationary cycling with viewing favorite DVD contingent upon cycling in THRZ.

Outcome: The DVD intervention motivated participants to exercise > 10 minutes in moderate-to-vigorous physical activity

Nam, 2022



The Effects of Exercise Dose on Stereotypical Behavior

Population: N = 7 children with ASD, mean age = 13 years

Intervention: Participants self-selected the physical activity, 10 and 20 minute duration conditions, low and high intensity conditions

Treadmill, N = 4

Stationary bike, N = 3

Outcome: Low- to moderate-intensity exercise of shorter duration produces significant and large reductions in stereotypical behaviors.

Interventions compatible with school environments.

Olin, 2017

Cycling for Students with Autism: Self-Regulation Promotes Sustained Physical Activity

Population: N = 3 students with ASD (non-verbal),
ages 15-17 years

Intervention: Cycling activity, 3 days/week, over 16 wks.
Self-monitoring. Goal setting. Self-reinforcement

Outcome: By end of program, participants regularly
completed 30 minutes of self-initiated over ground
cycling.

Todd, 2010
Sorensen, 2014
Thevarajah, 2022



Impact of Adapted Bicycle Riding on Outcomes for Children and Adolescents with Disabilities

Systematic Review

Literature: 10 studies, N=234 children with dev. disabilities, ages 4-18y/o

Outcome: Adapted bicycle riding interventions may improve gross motor function, enhance lower limb muscle strength and promote physical activity

Thevarajah, 2022

FUTURE

