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Adaptive Cycling

as an Effective Intervention

World Health Organization[1,2]

Guidelines on physical activity and sedentary behavior

Target population: children and adolescents (aged 5-17 years) including those living with disability

Recommendation 1: should perform on average 60 min/day of moderate-to-vigorous intensity, mostly aerobic, physical activity, across the week

Recommendation 2: should limit the amount of time spent being sedentary, particularly the amount of recreational screen time

Take Home Message: doing some physical activity is better than none

Global Action Plan on Physical Activity for 2018-2023[3]

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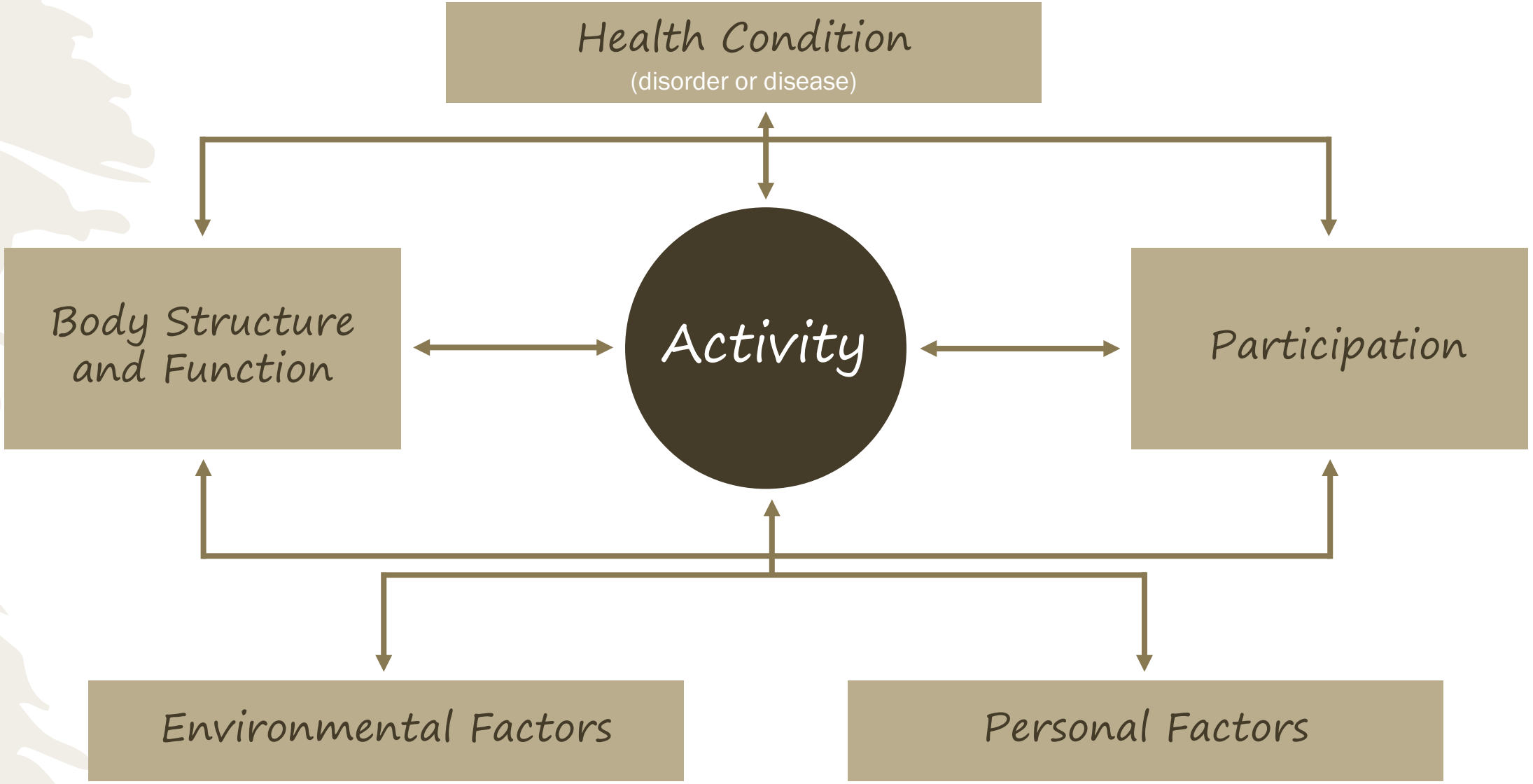
International Classification of Functioning, Disability & Health (ICF)[4,5]



The ICF Framework and the F-Words[6]

Body Structure and Function

FITNESS

Everyone needs to stay fit and healthy both physically and mentally. Help me find ways to keep fit.

Activity

FUNCTIONING

I might do things differently but I CAN do them. How I do it is not important. Please let me try!

Participation

FRIENDS

Having friends is important. Please give me opportunities to make friends.

Environmental Factors

FAMILY

My family knows me best and I trust them. Talk to them. Hear them. Respect them.

Personal Factors

FUN

Life is about having fun. Please help me do the activities that I find the most fun.

FUTURE

I am growing up every day, so please find ways for me to participate and be included in my community.

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FITNESS

Everyone needs to stay fit and healthy both physically and mentally. Help me find ways to keep fit.

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FUNCTIONING

I might do things differently, but I CAN do them. How I do it is not important. Please let me try!

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FRIENDS

Having friends is important. Please give me opportunities to make friends.

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FAMILY

They know me best and I trust them. Listen to them. Hear them. Respect them.

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FUN

Life is about having fun. Please help me do the activities that I find the most fun.

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FUTURE

"For those who think biking is only recreational, I say come to my classroom and watch my students.

The health and therapeutic benefits of biking every day are unmistakable. I cannot begin to say how much each of them benefits from these trikes."

William Lynch, PT, DPT
Orange-Ulster BOCES, NY

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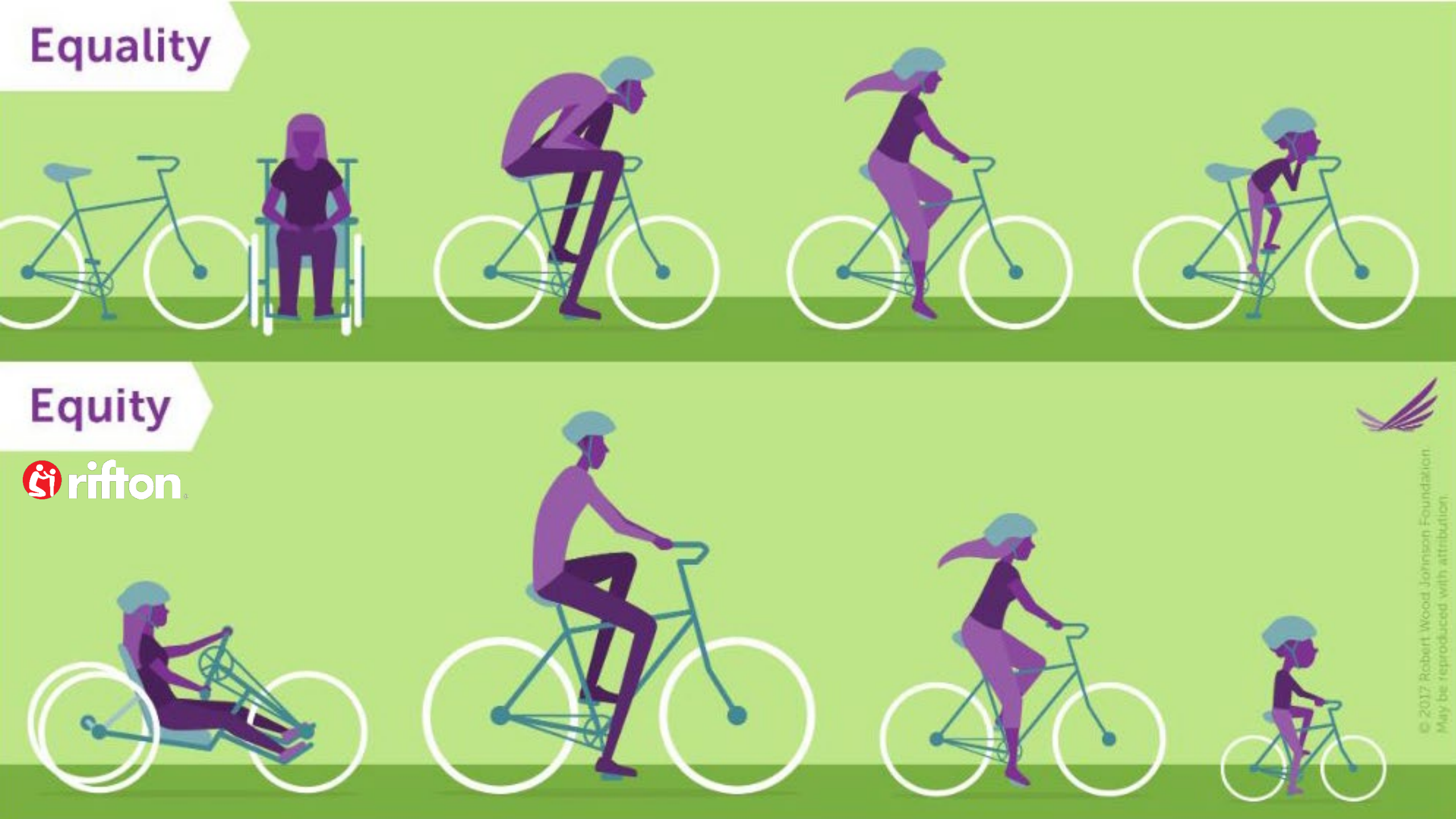
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A look at the published evidence...

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Evidence-Informed Practice[7,8]

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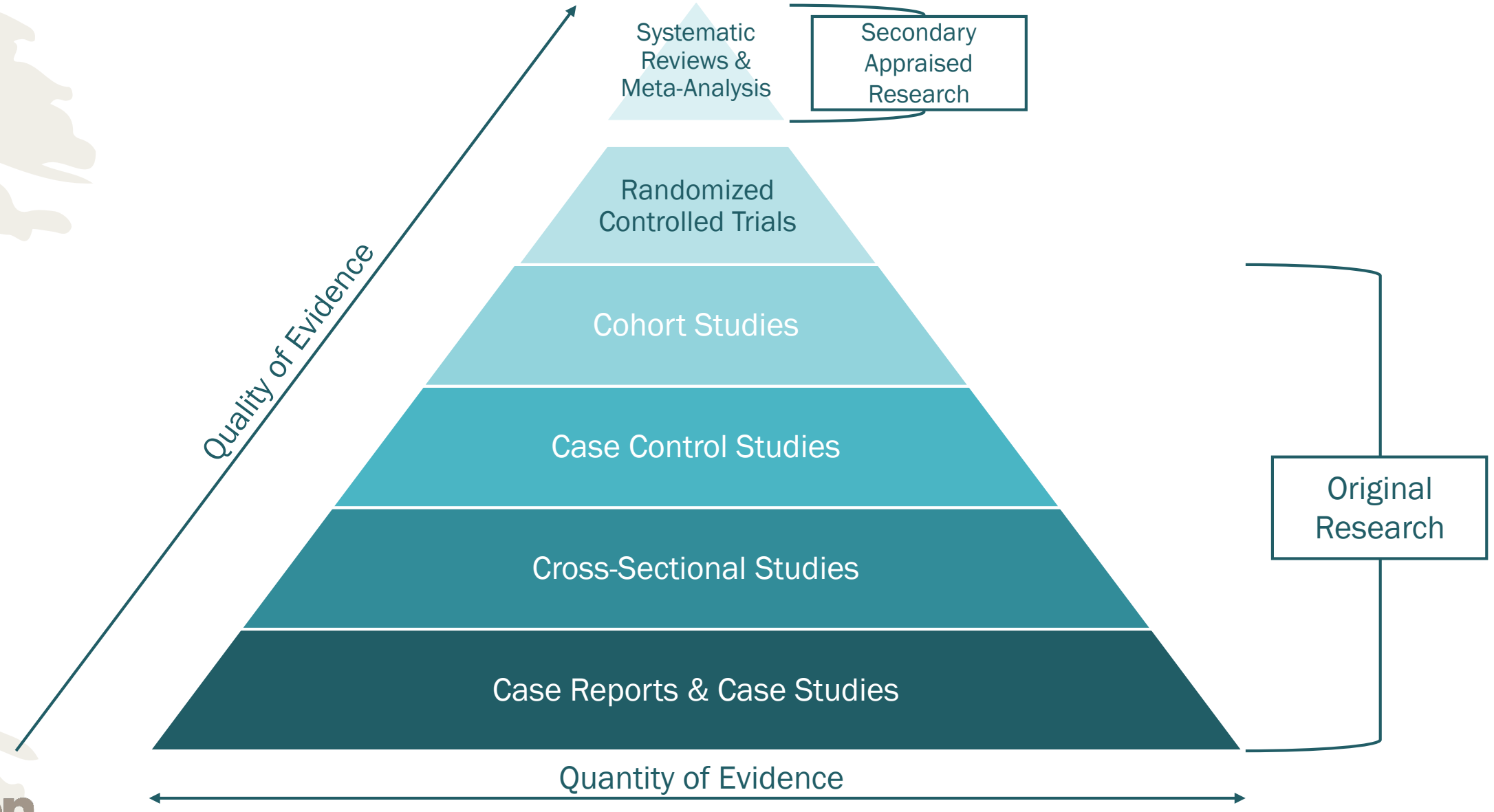
Levels of Evidence[9]



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A look at the published evidence...

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Differences in Habitual Physical Activity Levels[10]

Children and youth with Cerebral Palsy…

- Perform 13% to 53% less physical activity than typically developing peers
- Overall, this is 30% lower than physical activity recommendations
- 2x the maximum recommended amount of sedentary time

Longitudinal Trajectories of Physical Activity[11]

Longitudinal Trajectory

- From ages 3 to 12 – children with cerebral palsy have an overall decrease in physical activity

Exercise and Physical Activity Recommendations for People with Cerebral Palsy[12]

Cardiorespiratory (Aerobic) Exercise

- **Frequency:** 3 sessions/week
- **Intensity:** 60% of peak heart rate
- **Time:** Minimum 20 min./session
- **Type:** Regular, purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature

Exercise and Physical Activity Recommendations for People with Cerebral Palsy[12]

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.

Efficacy of Cycling Interventions[13]

Systematic Review

- **Population:** 9 studies, N = 282
- **Intervention:** Adaptive cycling
- **Outcome:** Improved hamstring strength, cardiorespiratory fitness, balance, distance with 3-minute walk test, and gross motor function in standing and walking

Effects of a Static Bicycling Programme[14]

Randomized Controlled Trial

- **Population:** N = 11, age 11-15 years, non-ambulatory cerebral palsy
- **Intervention:** Stationary cycling, 3 sessions/week for 6 weeks
- **Outcome:** Improved pedaling duration, speed, resistance, improved standing and walking (GMFM-66 dimensions D and E)

Pediatric Endurance and Limb Strengthening (PEDALS) Stationary Cycling and Children with Cerebral Palsy[15, 16,17]

Randomized Controlled Trial

- **Population:** N = 62, ages 17-18 years, spastic diplegic cerebral palsy, ambulatory
- **Intervention:** Stationary cycling, 30 sessions over 12 weeks
- **Outcome:** Improved Walk-Run Test, GMFM-66 D and E scores, strength measures. Pediatric Quality of Life Inventory – emotional functioning, psychosocial health, school functioning

Can a 6-week exercise intervention improve gross motor function for non-ambulant children with cerebral palsy?[18]

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)

Comparison of Dynamic Cycling Vs. Static Cycling[19]

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. Improved standing, walking, running (GMFM-66 scores)

"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."[19]

Interviews with Children with Cerebral Palsy about Adapted Cycling[20,21,22]

Qualitative Analysis

- **Population:** N = 17, ages 2-17 years
- **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

Locomotion Efficiency While Riding an Adapted Tricycle Compared to Walking[23]

- **Population:** N = 7, ages 5-10 years
- **Comparison:** 6-min. cycling/6-min. walking. 55-meter path
- **Outcome:** Cycling – travelled farther with less energy expenditure

Pilot Evaluation of a School-Based Programme[24,25]

Case Report

- **Population:** N = 3, ages 8-14 years, non-ambulatory cerebral palsy
- **Intervention:** Up to 30 min./day. 8-week intervention (2 phases)
- **Outcome:** Improved standing (GMFM-88D scores). Cardiorespiratory fitness – energy expenditure index (1 subject)

A look at the published evidence...

Autism Spectrum Disorder (ASD)

Attention-Deficit Hyperactivity Disorder (ADHD)

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Effect of Motor and Physical Activity Intervention on Motor Outcomes[26]

Systematic Review

- **Population:** 41 studies, N = 1,173, ages 3-19 years

"Up to 83% of children with autism spectrum disorder have difficulty performing age-appropriate motor skills."

Motor Functional Characteristics in ADHD and ASD[27]

- **Population:** 33 studies of ADHD, 10 studies of ASD, 1 study of both ADHD and ASD

"People with ADHD/ASD generally exhibited poorer physical abilities for all types of activities, possibly because of low levels of physical activity."

Gross Motor Profile and Its Association with Socialization Skills[28]

Cross Sectional Study

- **Population:** N = 40 ASD, N = 40 age-matched typically developing controls, ages 18 months – 6 years
- **Comparison:** Gross motor and socialization skills
- **Outcome:** Lower gross motor skills (20% of ASD children). Lower socialization skills

Relationships Between Social, Communication and Motor Skills[29]

Longitudinal Analysis

- **Population:** Children with ASD – same participants
  N = 621, age 7 years
  N = 352, ages 8-10 years
  N = 317, ages 10-12 years

"Increased motor skills may improve social skills for students with autism in elementary school."

Effect of Physical Activity Interventions on Executive Function

Meta-Analysis – 34 studies, N = 1,058, ages 5-33

"This meta-analysis provides support for effectiveness of physical activity interventions on executive function." [30]

Clinical Article

"Regular exercise engagement benefits executive function." [31]

Mini Review

"Physical activity has been shown to reduce maladaptive behavior." [32]

Stationary Cycling[33]

Clinical Article

"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."

Stationary Cycling[34]

- **Population:** N = 3, ages 16-21 years, autism with mild mental retardation
- **Intervention:** Stationary cycling, 20 minutes, 3x/week, 6-7 weeks
- **Outcome:** Aerobic fitness increased 33%, 50%, and 33% for the 3 participants

Immediate Reinforcement Increased Duration of Time[35]

Pilot Study: Crossover Design

- **Population:** N = 7, ages 5-18 years, autism diagnosis
- **Intervention:** Stationary cycling with viewing favorite DVD contingent upon cycling in target heart rate zone
- **Outcome:** The DVD intervention motivated participants to exercise > 10 minutes in moderate-to-vigorous physical activity

Effects of Physical Exercise on Stereotyped Behavior[36]

Systematic Review with Meta-Analysis

- 8 studies
- N = 129, average age ~8 years

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

Effects of Physical Exercise on Stereotyped Motor Behaviors[37]

Systematic Review and Multi-Level Meta-Analysis

- 22 studies
- N = 274 children with ASD
- This study revealed that exercise interventions were effective in reducing stereotyped motor behaviors, with higher intensity exercise enhancing the effect significantly.
- Exercise interventions appear to be an evidence-based and sustainable approach to managing stereotyped motor behaviors in children with ASD as such interventions can be easily conducted and made affordable and accessible to clients.

The Effects of Exercise Dose on Stereotypical Behavior[38]

- **Population:** N = 7, mean age = 13 years
- **Intervention:** Participants self-selected the physical activity.
  Treadmill, N = 4
  Stationary bike, N = 3
- **Outcome:** Low- to moderate-intensity exercise produces significant and large reductions in stereotypic behaviors.

The Effects of Deep Pressure Therapies and Antecedent Exercise on Stereotypical Behaviors[39]

Single-case alternating treatments design

- **Population:** N = 3, elementary students with ASD
- **Comparison:** Deep pressure therapy (compression vest and weighted blanket) vs. stationary bike
- **Outcome:** Cycling activity markedly reduced stereotypical behaviors for two of the three elementary school students. Deep pressure therapy provided little reduction of stereotypical behaviors

Cycling for Students with ASD: Self-Regulation Promotes Sustained Physical Activity[40,41,42]

- **Population:** N = 3, ages 15-17 years, autism – primary diagnosis (non-verbal)
- **Intervention:** Cycling activity, 3 days/week, over 16 weeks. Self-monitoring. Goal setting. Self-reinforcement
- **Outcome:** By end of program, participants regularly completed 30 minutes of self-initiated over ground cycling.

Ethan

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Annie Garcia Rojas

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Thank you!