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International Federation of Adapted Physical Activity

Rehabilitation effects of Adapted Physical Activity in Children and youth with Cerebral Palsy

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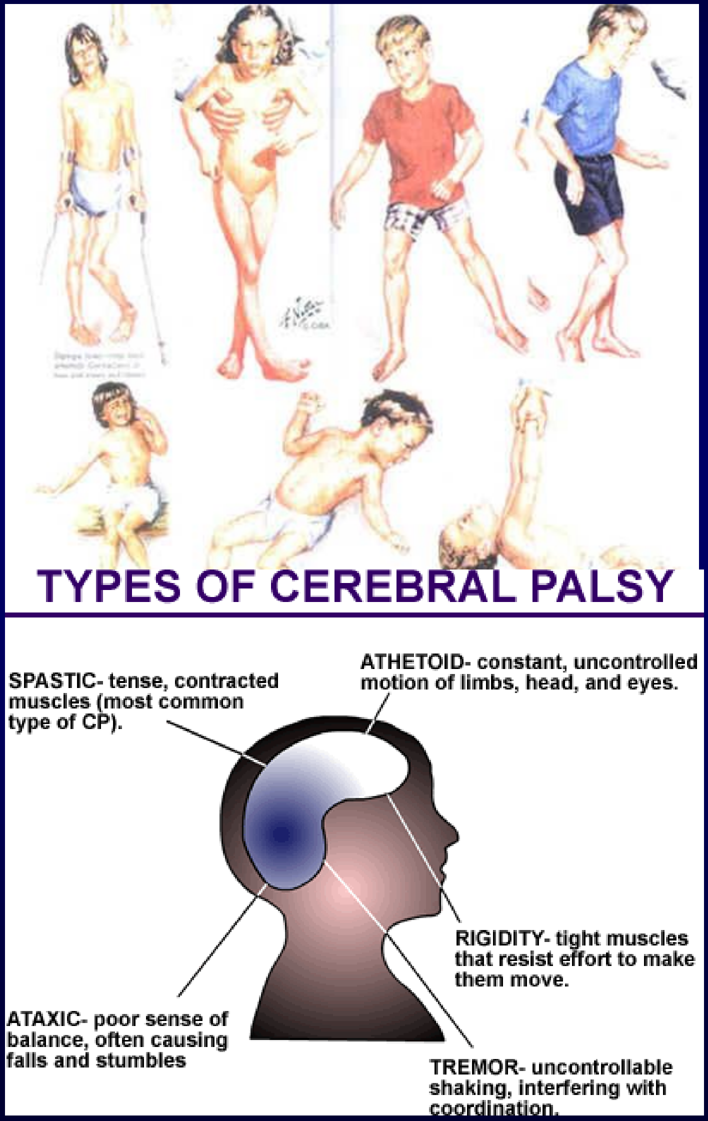
Outline

- Introduction
- Participation in physical activity
- Functional restrictions
- Assessment
- Intervention solutions
  - Evidence based
  - Practice based
- Conclusions & recommendations

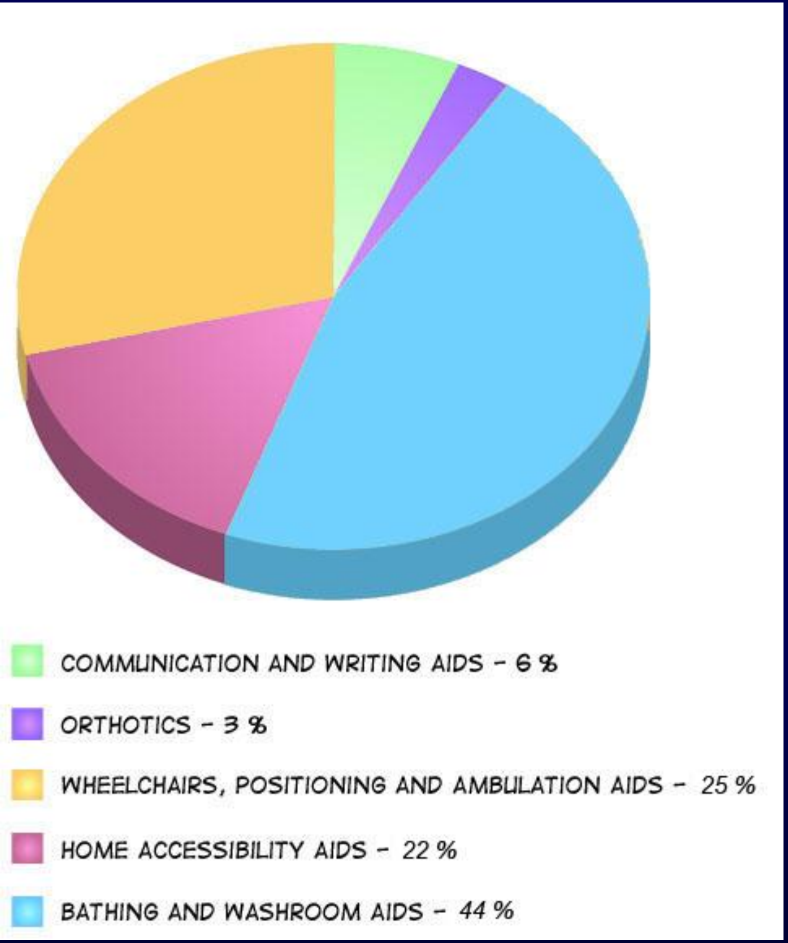
Cerebral Palsy (CP)

- Cerebral Palsy (CP) is a group of movement and postural disorders caused by an insult to the developing brain (usually age > 2 yrs.)
- CP causes mild to severe a limitation in function and activity (Bax 2005, Campbell 1994).



Epidemiology

- Around 764,000 children and adults in the USA are affected with CP.
- This disability has a mean lifelong const per person of $ 921.000 (Centers for Disease Control and Prevention, 2004).

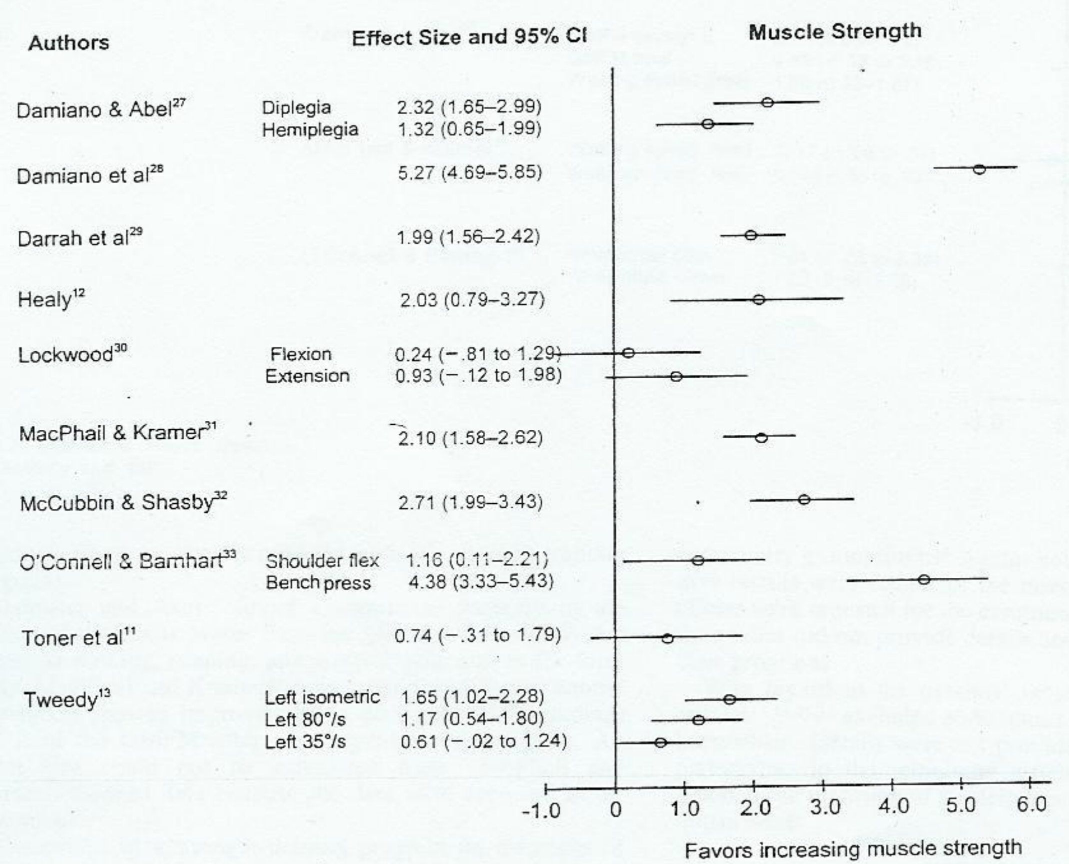


Traditional approach Bobath therapy

- Developed in the 1950s
- Very familiar and still common today in countries all over the world
- Valuing normal tone, posture and movement quality

Recent Systematic Literature Analyses

- Progressive strength training in children and adolescents (Mockford et al., 2008)
- 13 studies demonstrating moderate relationship between strength training and function (strength) and gait criteria
- However, when only RCT were analyzed strength training has not been found effective in children and adolescents with CP (Scianni et al., 2009)
- Based on 5 studies complying with inclusion creiteria
- Treadmill training with and without partial body weight supporting has not been supported in participants with CP (Damiano et al., 2009)
- 29 studies evaluating training in children with down syndrome, spinal cord injury and CP

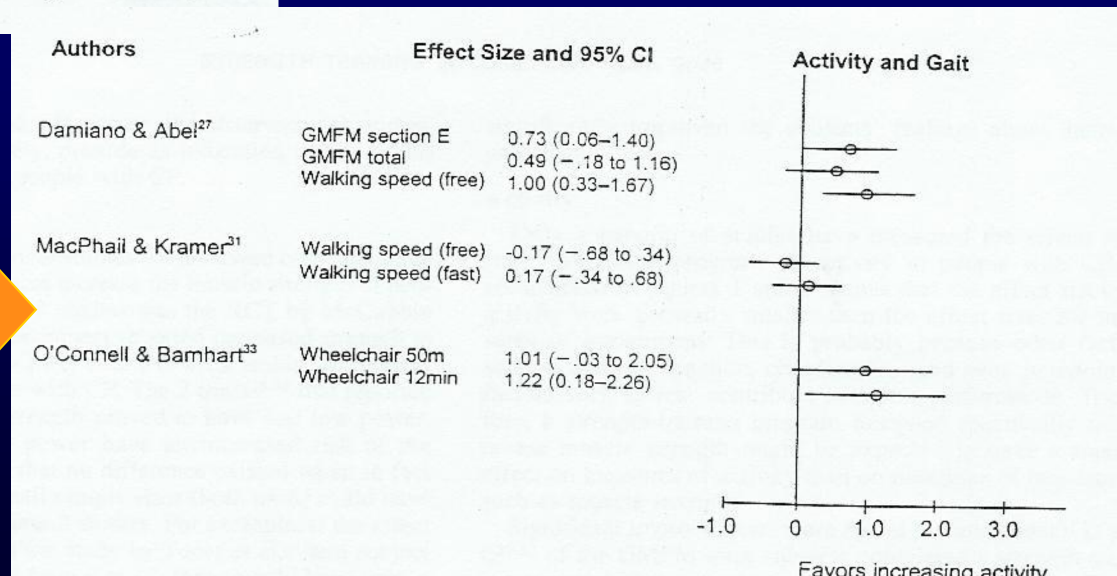


Effect sizes of strength training programs in chldren with CP

Dodd et al., Arch Phys Med Rehab, 2002

Strength training

Walking , wheelchair propulsion GMFM



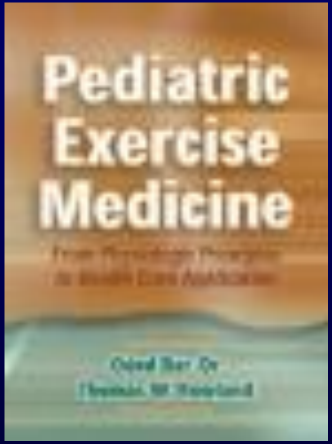
Systematic review on effectiveness of PT programs in young participants with CP

- A recent review article found 22 RCTs of PT Intervention divided into 8 categories (Antilla et al., 2008)
- Only strength training proven to have a moderate effectiveness on stride length and walking speed
- NDT had a moderate effect on general developmental status
- Equivocal findings with regard to effect of strength training with regard to walking and GMFM skills

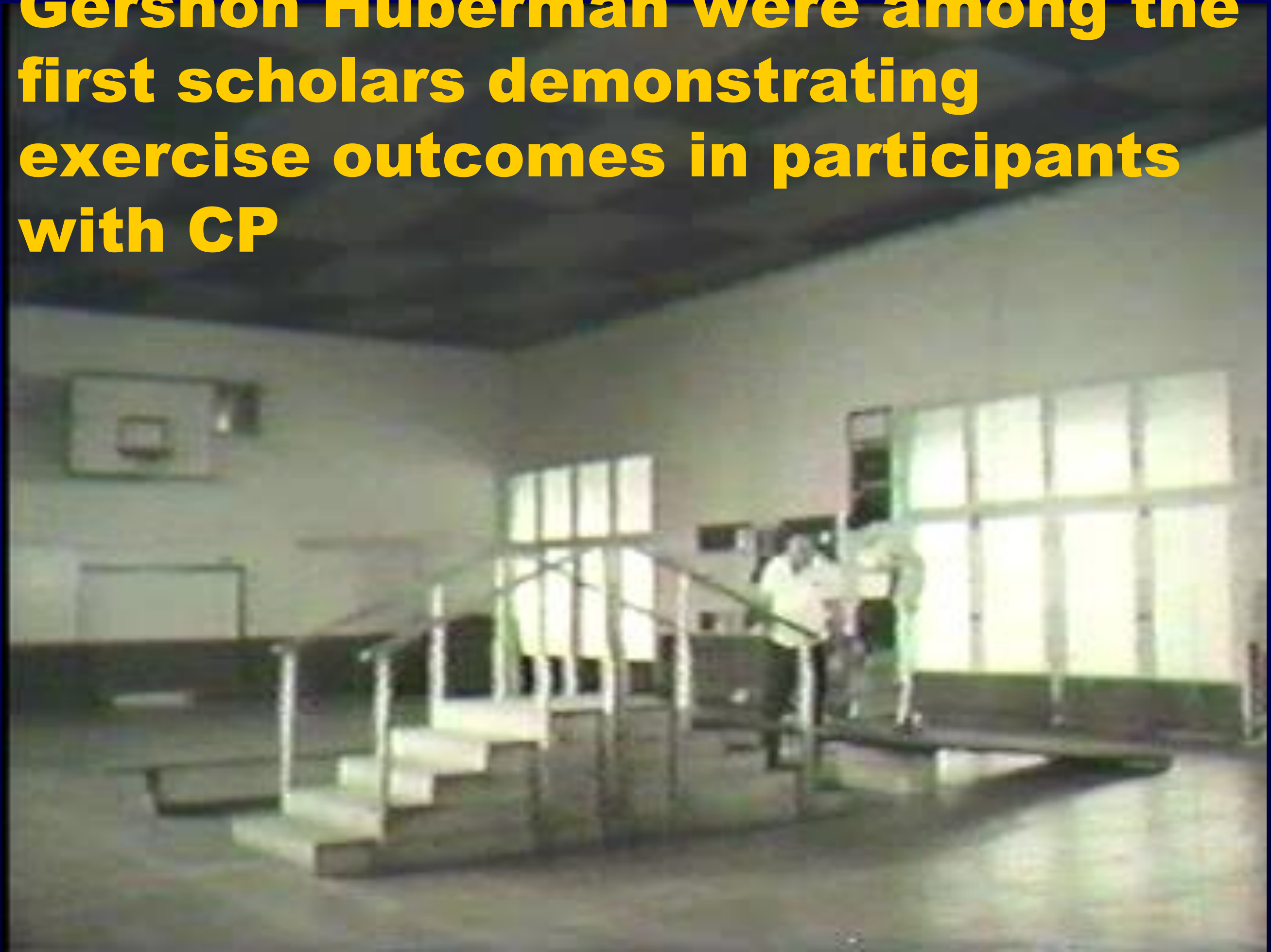
Israel Sport Center for the Disabled www.iscd.com

- **45 years experience in program development and implementation for children with neuromuscular disabilities**
- **Initiation and participation in numerous research projects**
- **Publication in Scientific Journals**
- DMCN; APAQ; Sports Medicine; Clinical Rehab

Early investigations on adapted physical activity



Prof Oded Bar-Or; Ralph Spira & Gershon Huberman were among the first scholars demonstrating exercise outcomes in participants with CP



Functional Impact of Exercise in CP

Impact of a two - year 2* 2 weekly session program on participants with CP (Adapted from Spira & Bar-Or, 1975)

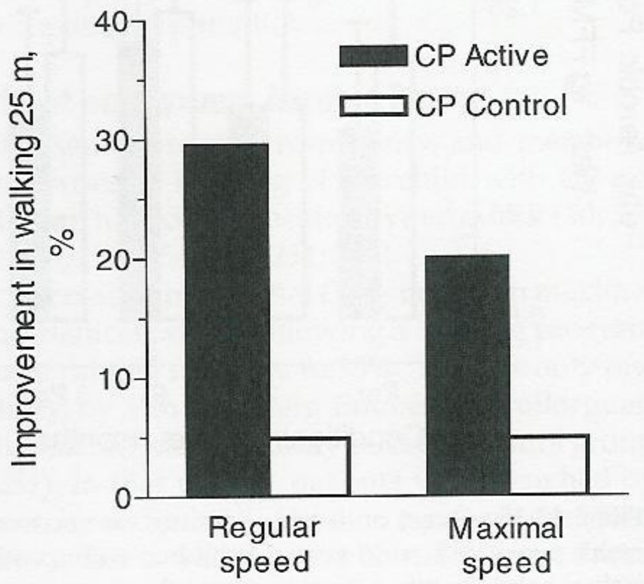


FIGURE 10.15 Effect of a 2-year training program on the walking speed of adolescents with cerebral palsy (CP). A comparison between active participants and sedentary controls. Values are percentage improvement.

Adapted from Spira and Bar-Or 1975 (231).

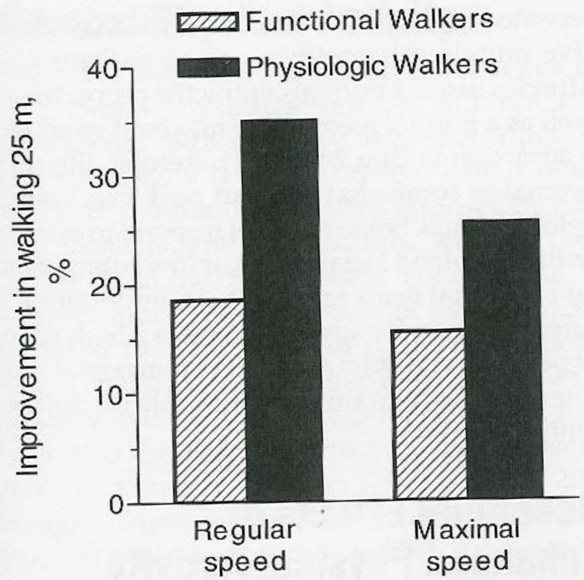


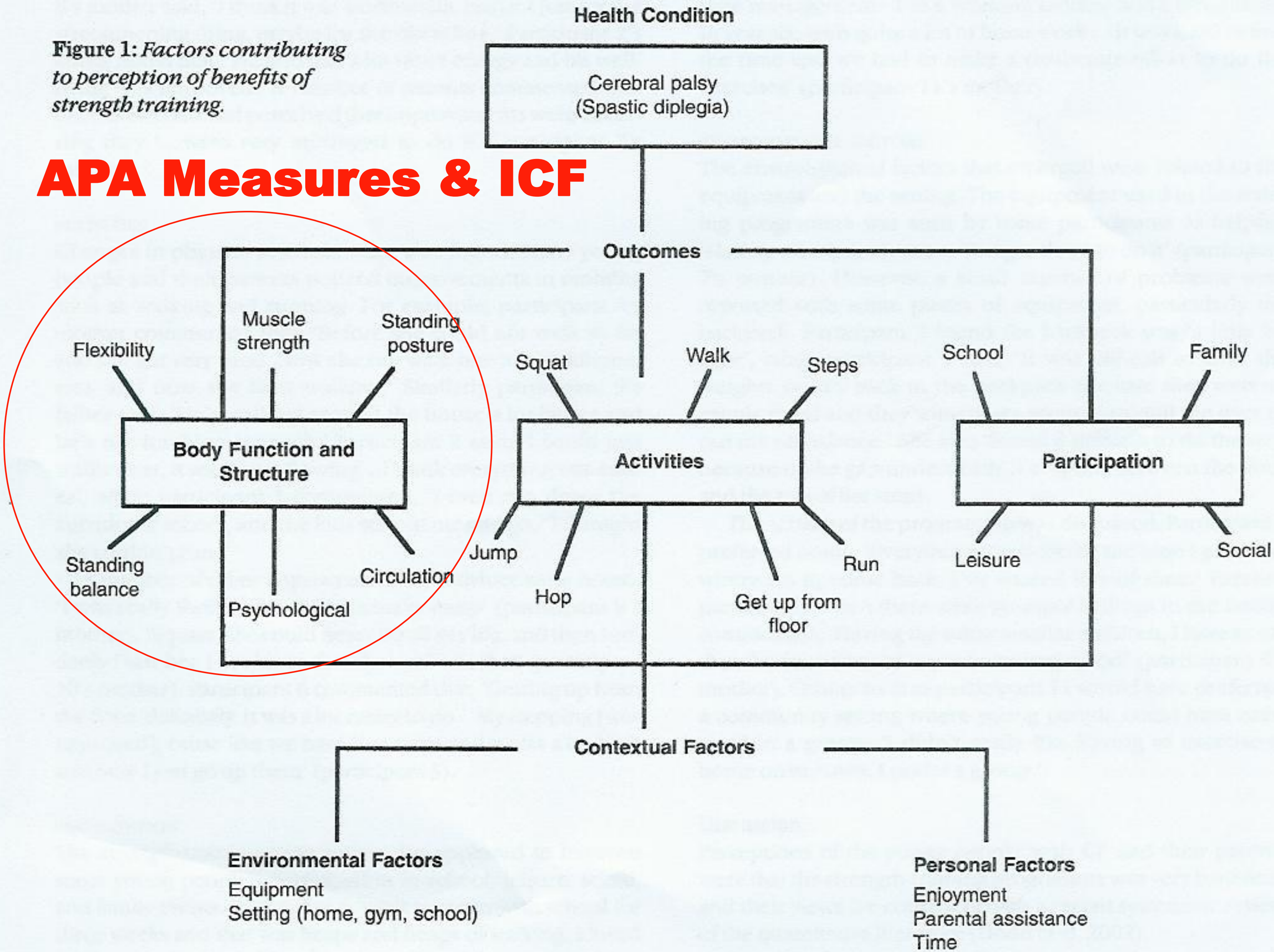
FIGURE 10.16 Relationship between the improvement in walking and the severity of disability in adolescents with cerebral palsy. Comparison between "functional" and "physiologic" walkers (see text for definitions) who took part in a 2-year training program. Values are percentage improvement.

Adapted from Spira and Bar-Or 1975 (231).

מתוך: Bar-Or & Rowland: Pediatric Exercise Science (2004)

APA Measures & ICF

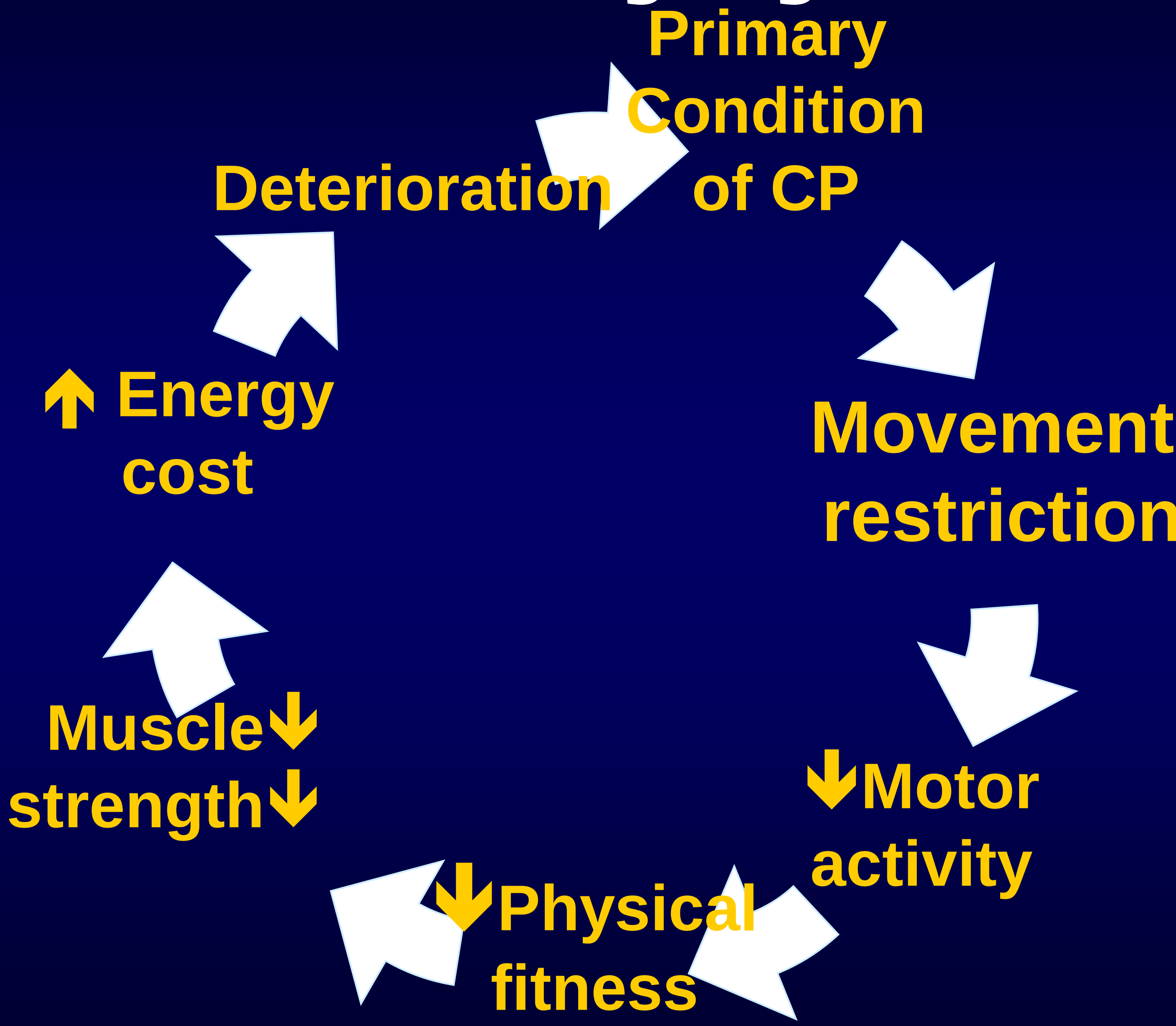
Figure 1: *Factors contributing to perception of benefits of strength training.*



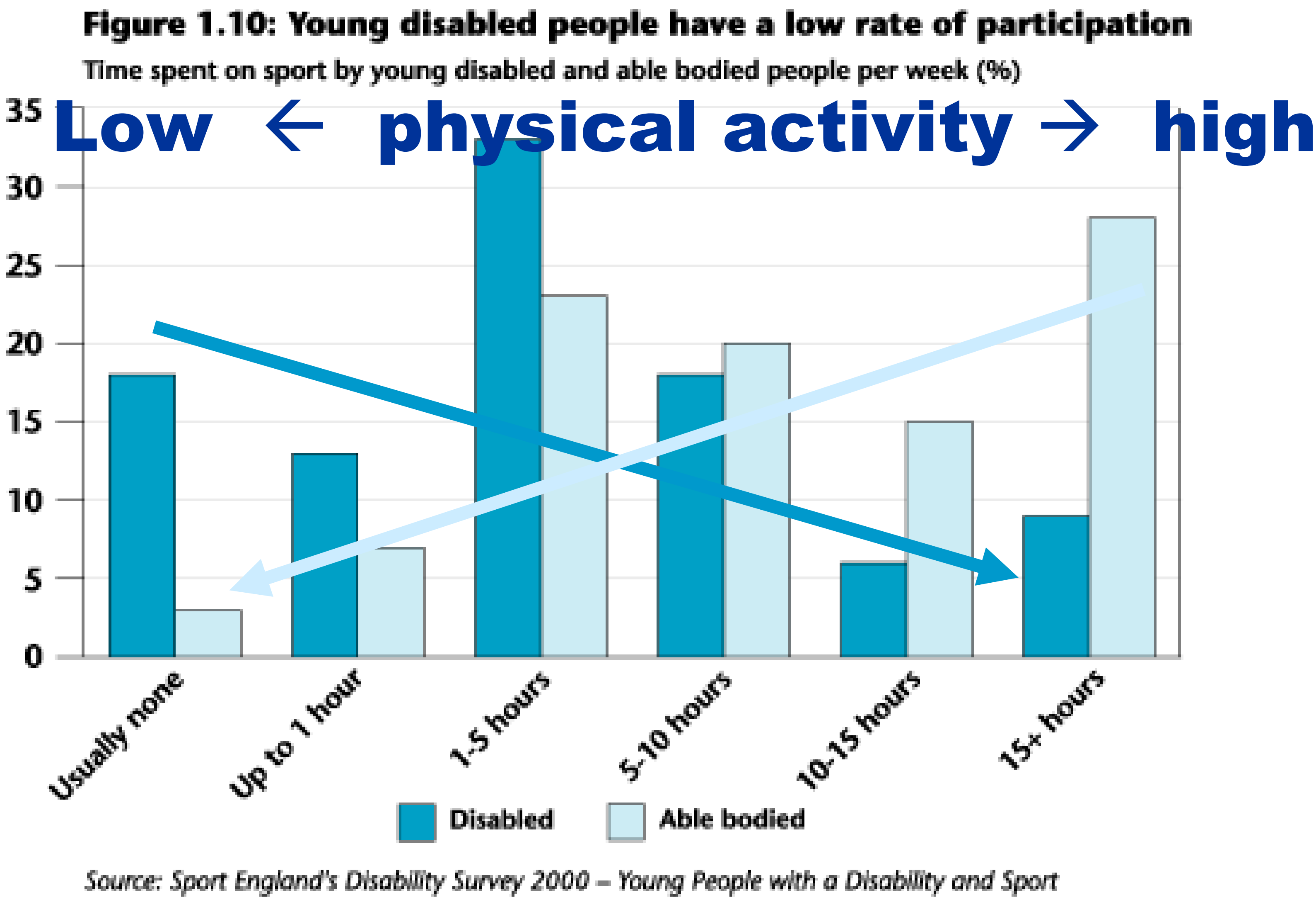
Source: McBurney, Taylor, Dodd, & Graham. A Qualitative analysis of the benefits of strength training for young people with cerebral palsy.

Participation in physical activity

Inactivity cycle



Time spent on sport per week



GMFCS Levels

Gross Motor Classification System is a common method to classify participants across their locomotor capability

LEVEL I	-	Walks without Limitations
LEVEL II	-	Walks with Limitations
LEVEL III	-	Walks Using a Hand-Held Mobility Device
LEVEL IV	-	Self-Mobility with Limitations; May Use Powered Mobility
LEVEL V	-	Transported in a Manual Wheelchair

Participation in sports in children with CP across GMFCS

Palisano, Koepland & Galupi, 2007

Last week		GMFCS v-iv	GMFCS ii-iii	GMFCS i
I played sports with my friends	All the time	19	20	73
	Some time	28	42	20
	Never	53	38	7
	Had no chance	16	27	31

Daily step count in CP

Bjornson, Belza, Katrin et al., 2007

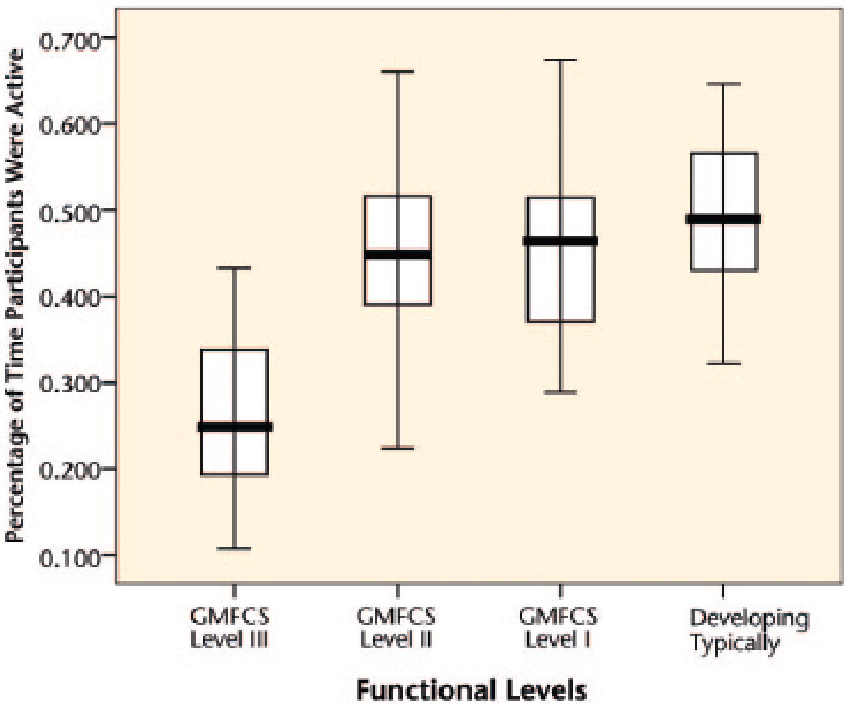


Figure 3.
Median and interquartile range for percentage of wearing time that the participants were active by functional levels (Gross Motor Function Classification System [GMFCS] levels). Comparison between children who were developing typically and children with cerebral palsy (CP) in GMFCS level III ($P<.001$); comparison between children who were developing typically and children with CP in GMFCS level II ($P=.10$); comparison between children who were developing typically and children with CP in GMFCS level I ($P=.39$); comparison between children with CP in GMFCS levels I and III ($P<.001$); comparison between children with CP in GMFCS levels I and II ($P=.88$); comparison between children with CP in GMFCS levels II and III ($P<.001$).

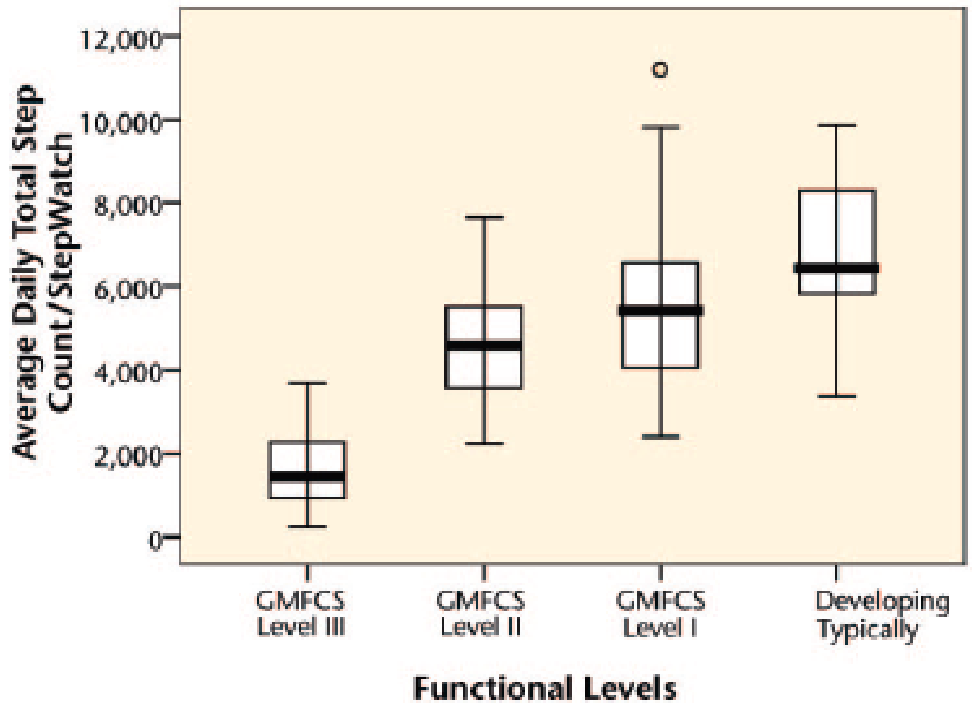
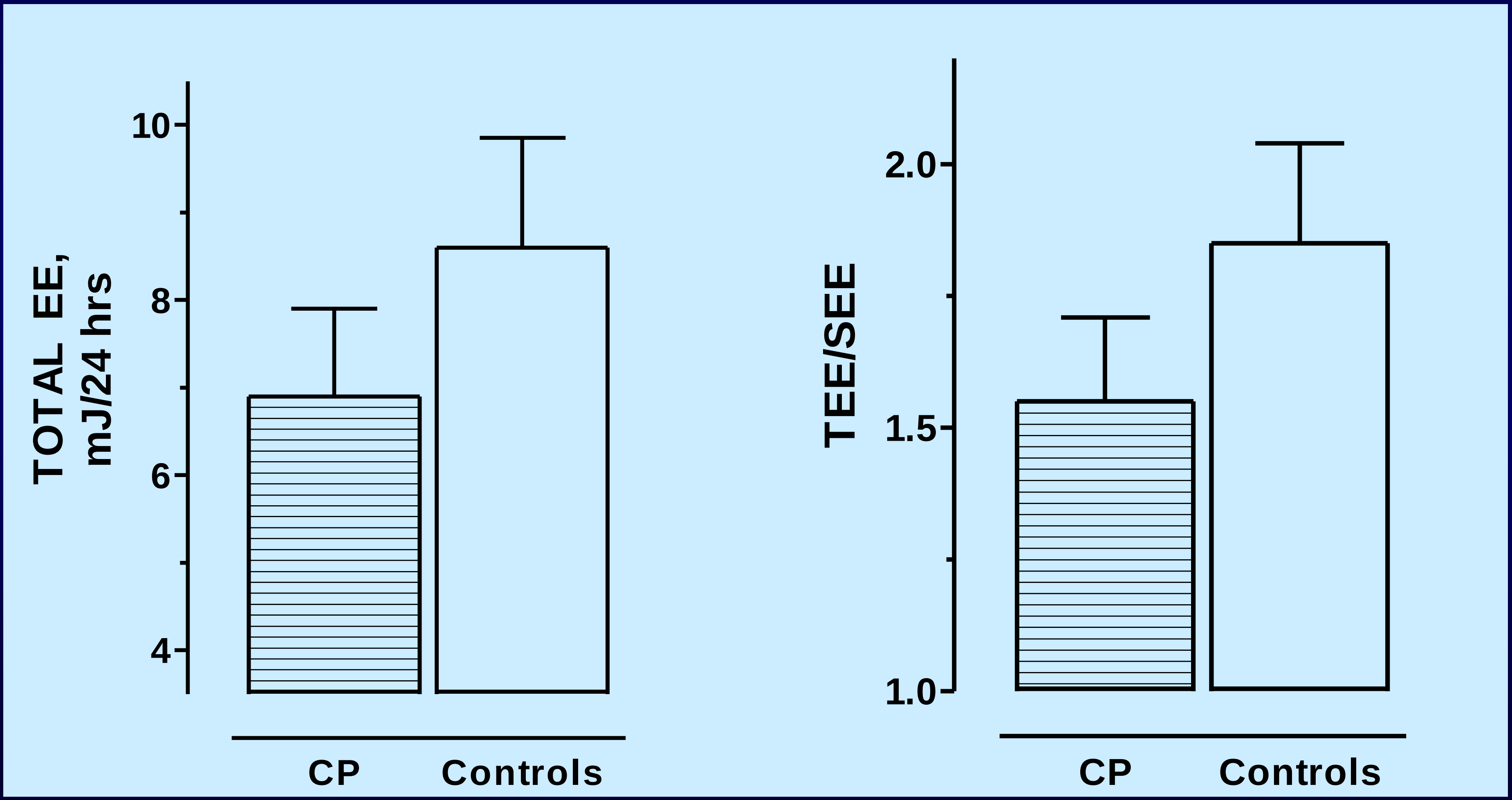


Figure 2.
Median and interquartile range for average daily step counts as measured by the StepWatch monitor by functional levels (Gross Motor Function Classification System [GMFCS] levels). Comparison between children who were developing typically and children with cerebral palsy (CP) in GMFCS levels I, II, and III ($P<.001$); comparison between children who were developing typically and children with CP in GMFCS level I ($P=.04$); comparison between children with CP in GMFCS levels I and II ($P=.09$); comparison between children with CP in GMFCS levels I and III ($P<.001$); comparison between children with CP in GMFCS levels II and III ($P<.001$).

24-HOUR ENERGY EXPENDITURE IN CHILDREN WITH SPASTIC CP

(van den Berg - Emons et al., J. Pediatr., 1995)



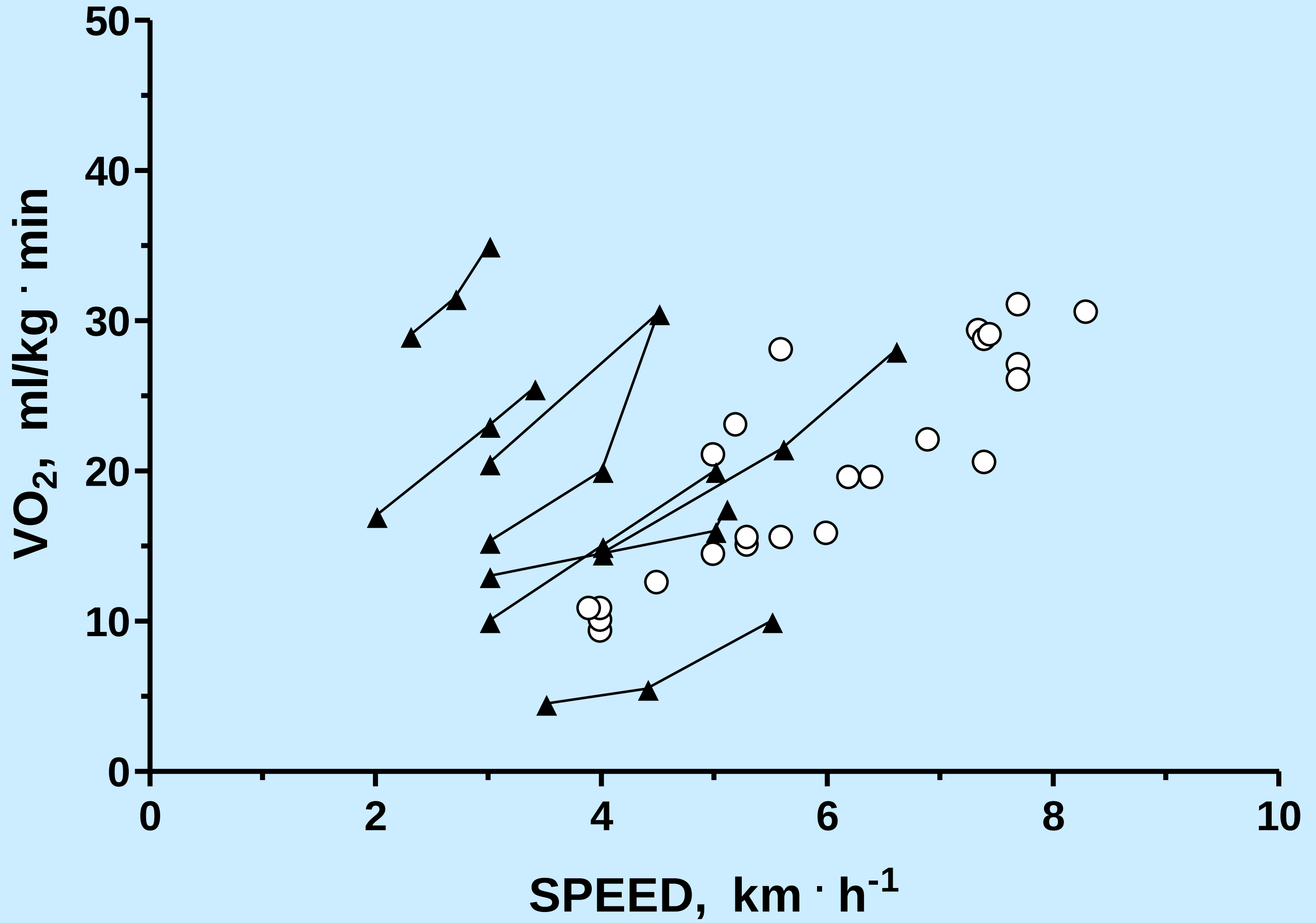
Functional Restrictions

Too high energy cost

Too low muscular strength

Energy cost while walking in children with CP

(Unnithan et al., Sports Med., 1998)

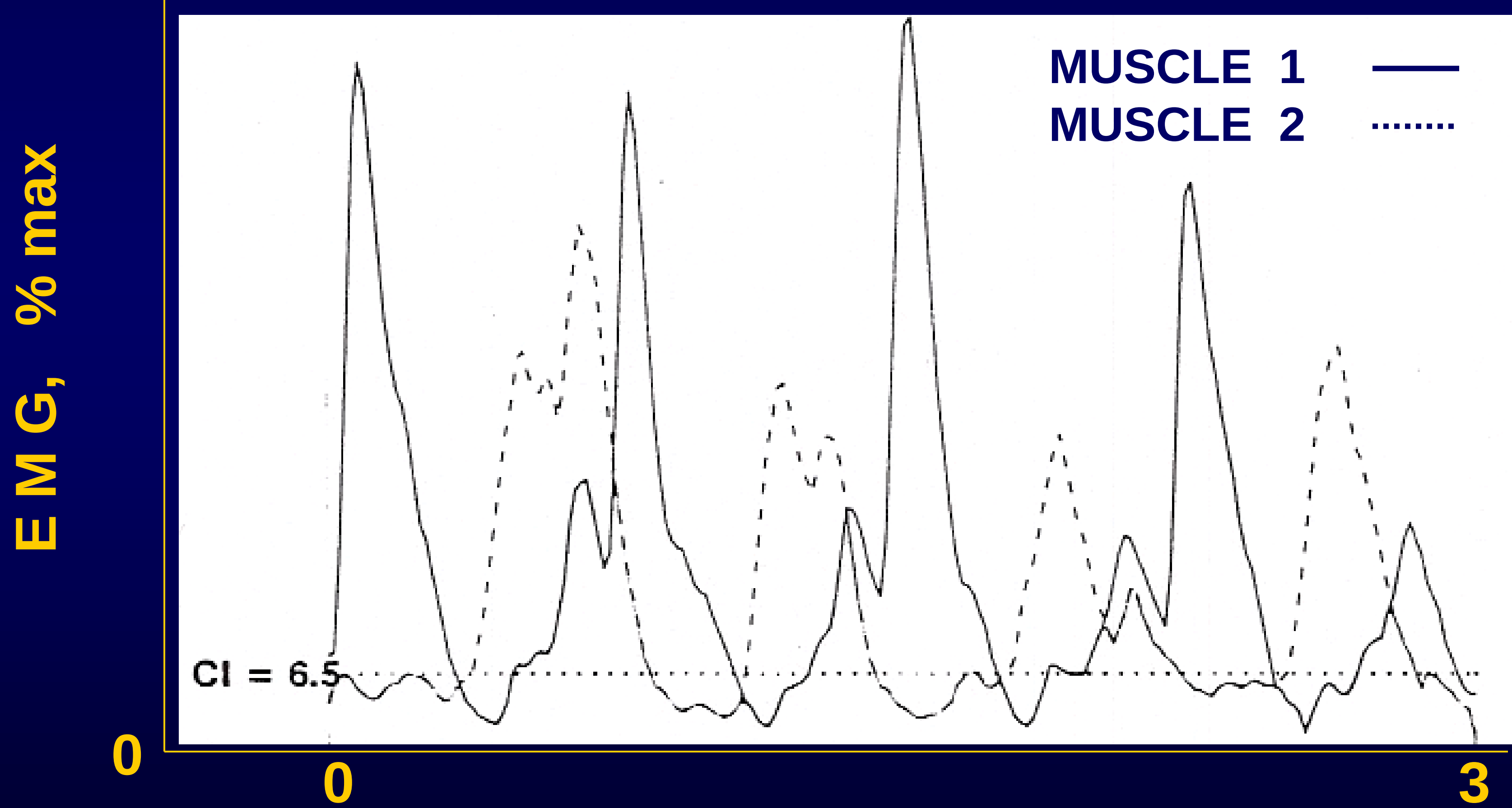


Muscular Co-contruction

(Frost et al., J. Electromyogr. Kinesiol. 1996)

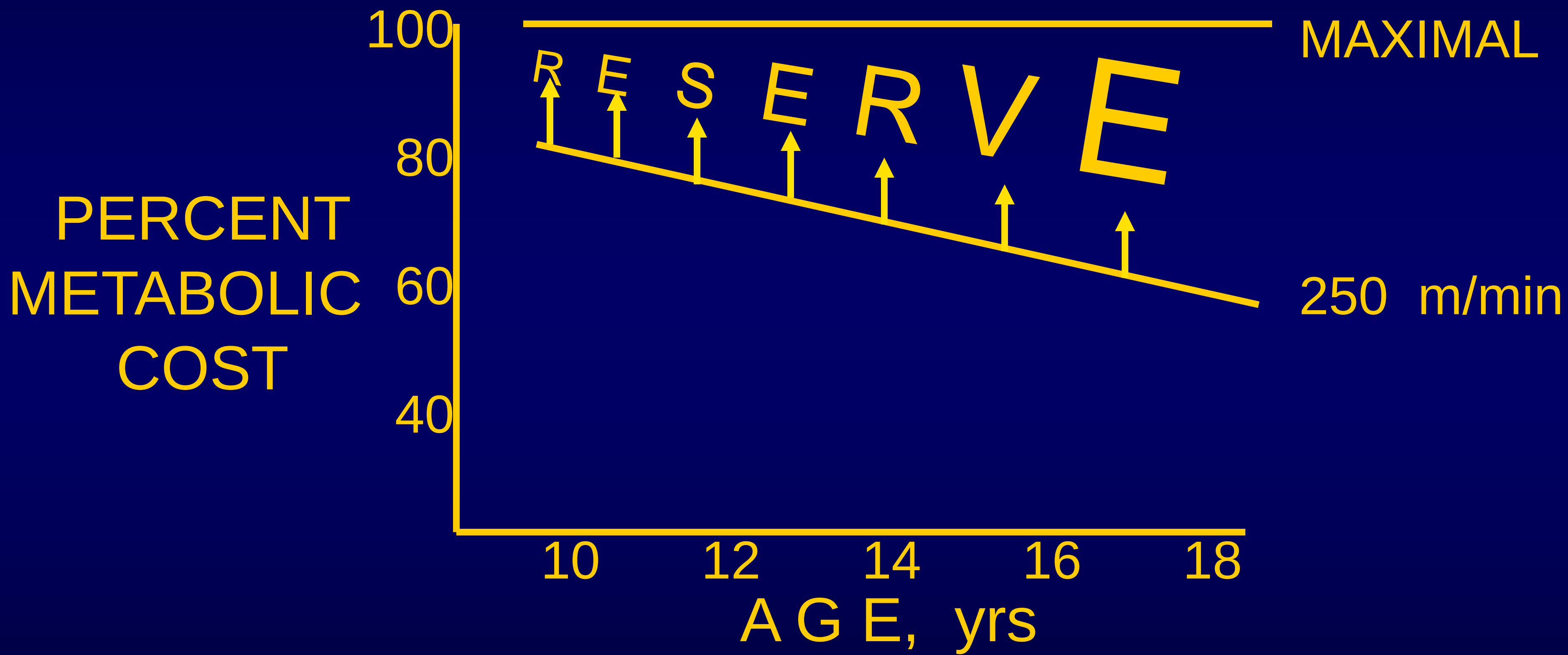
vastus lateralis vs. hamstrings;
tibialis anterior vs. soleus

50



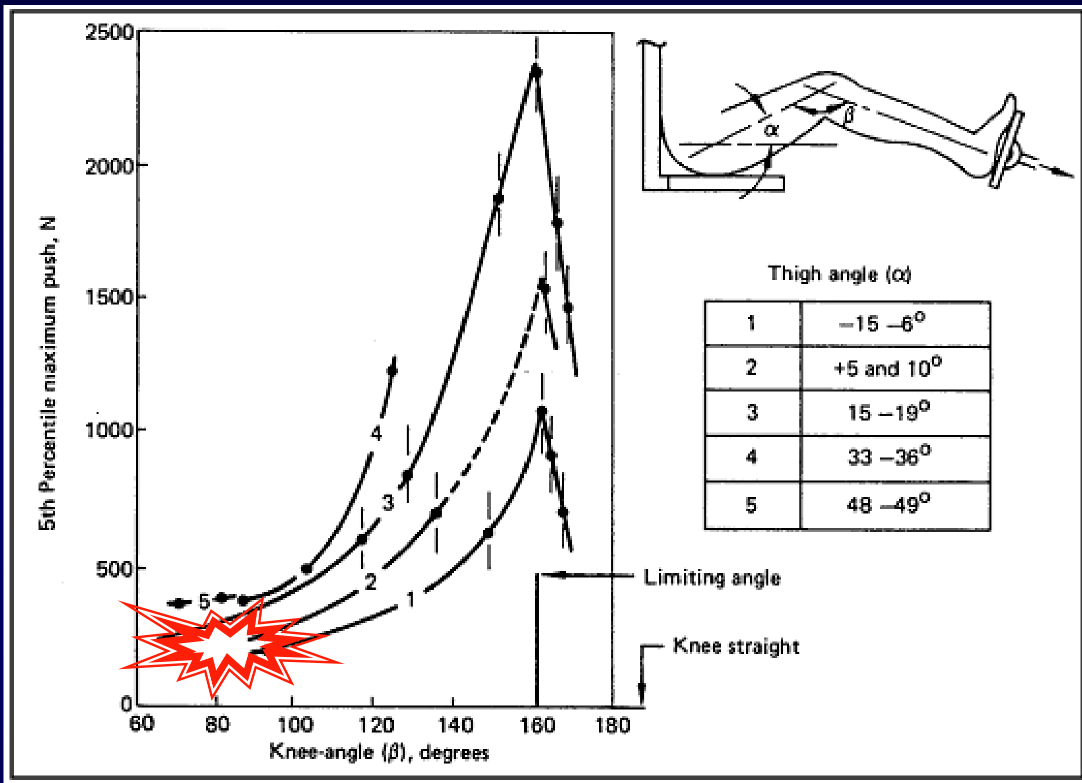
CI = co-contruction index TIME, s

Decreased reserve for ADL



For example completing a 10 – 20m walk raises the HR to 150

Muscular Strength



In this slide strength across the angular strength production arc is displayed as a percentage of typically developing children.

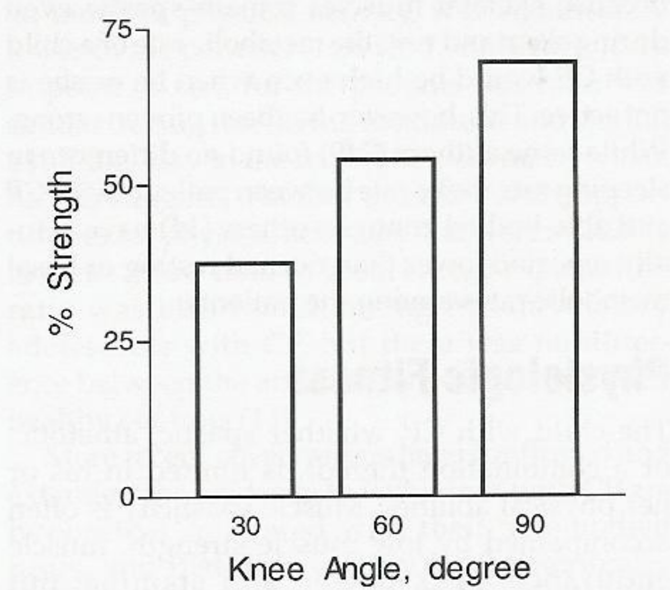


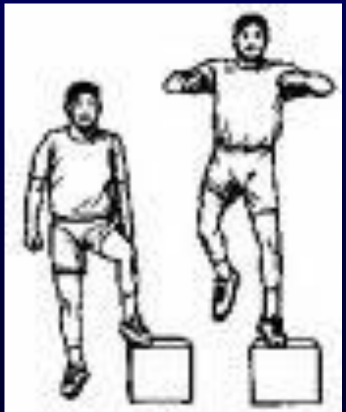
FIGURE 10.4 Isometric quadriceps extension strength in children with cerebral palsy as a percentage of the value in able-bodied controls. Fourteen 6- to 14-year-old patients with spastic diplegia were compared with 25 healthy controls. Measurement of strength was performed at 30°, 60°, and 90° knee flexion. Data from Damiano et al. 1995 (54).

A significant decrease in maximal and mean strength over time is a secondary limitation in participants with CP

Lab & Field-testing

- Isokinetics
- Dynamometry
- Sit to stand: Time for 10 reps.
- Step-up sideward n of step-ups in 15-s
- Half-kneel test
- Stair climbing test time for 10 stairs
- standing up from lowest sitting height,




Field testing – Endurance

10-meter shuttle run test (Vershuren, 2007)

- Two versions for GMFCS-I & GMFCS-II separately
- I starts at 5 km/hr and II ar 2 km/hr
- Increments every min velocity raised at 0.25 km/hr
- 10-meter distance between markers
- Stopped when distances to marker occured twice =>1.5 m

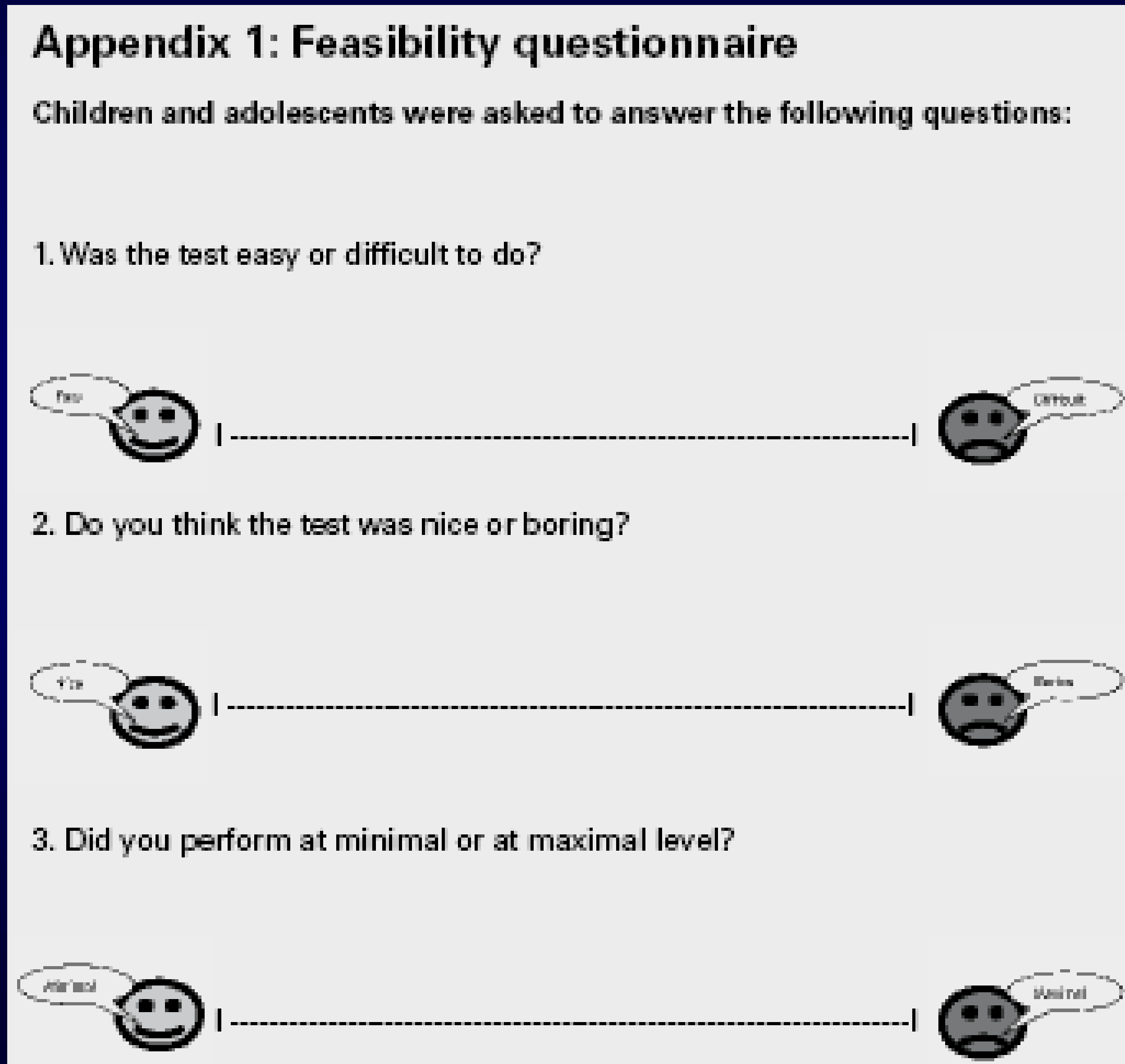
Anaerobic field test – MPST

6X15-meter sprint test (Vershuren, 2007)

- A field test based on the WANT principle of 6 units of maximal velocity running accumulating to about 30-sec
- The test is performed on a 15-m distance back and forth 6 times with 10-sec intermission used to turn around
- After each completion of the 15-m distance a countdown is started 10,9,8….1
- Power is measured as follows:

  - Velocity (m/sec) = 15 meter / Time
  - Acceleration (m/sec^2) = Velocity / Time
  - Force (kgm/sec^2) = Body mass x Acceleration
  - Power (Watts) = Force x Velocity

Practicability questionnaire



Appendix 1: Feasibility questionnaire

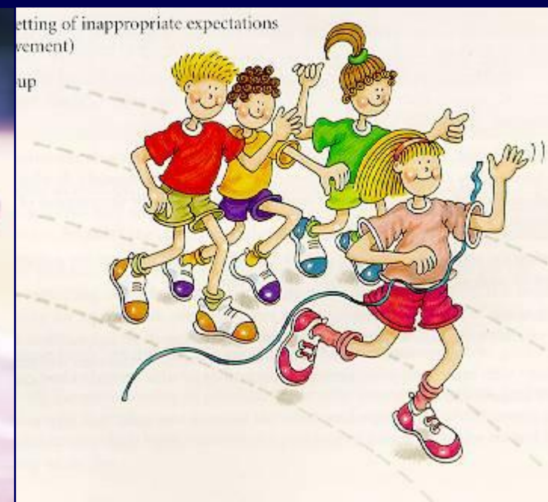
Children and adolescents were asked to answer the following questions:

1. Was the test easy or difficult to do?

2. Do you think the test was nice or boring?

3. Did you perform at minimal or at maximal level?

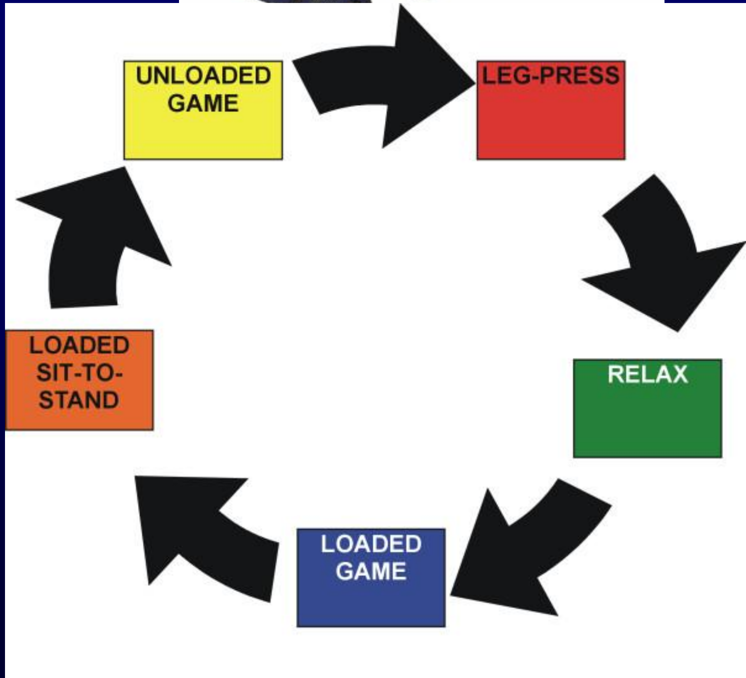
Intervention programs

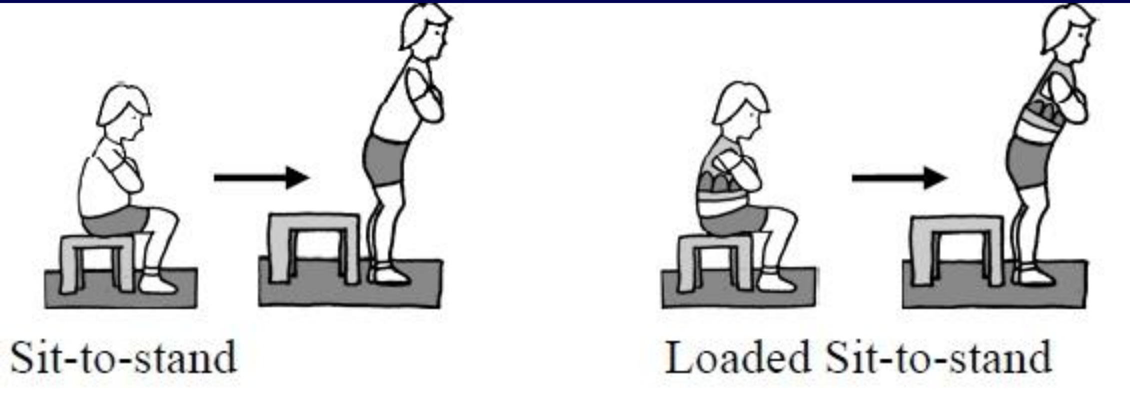


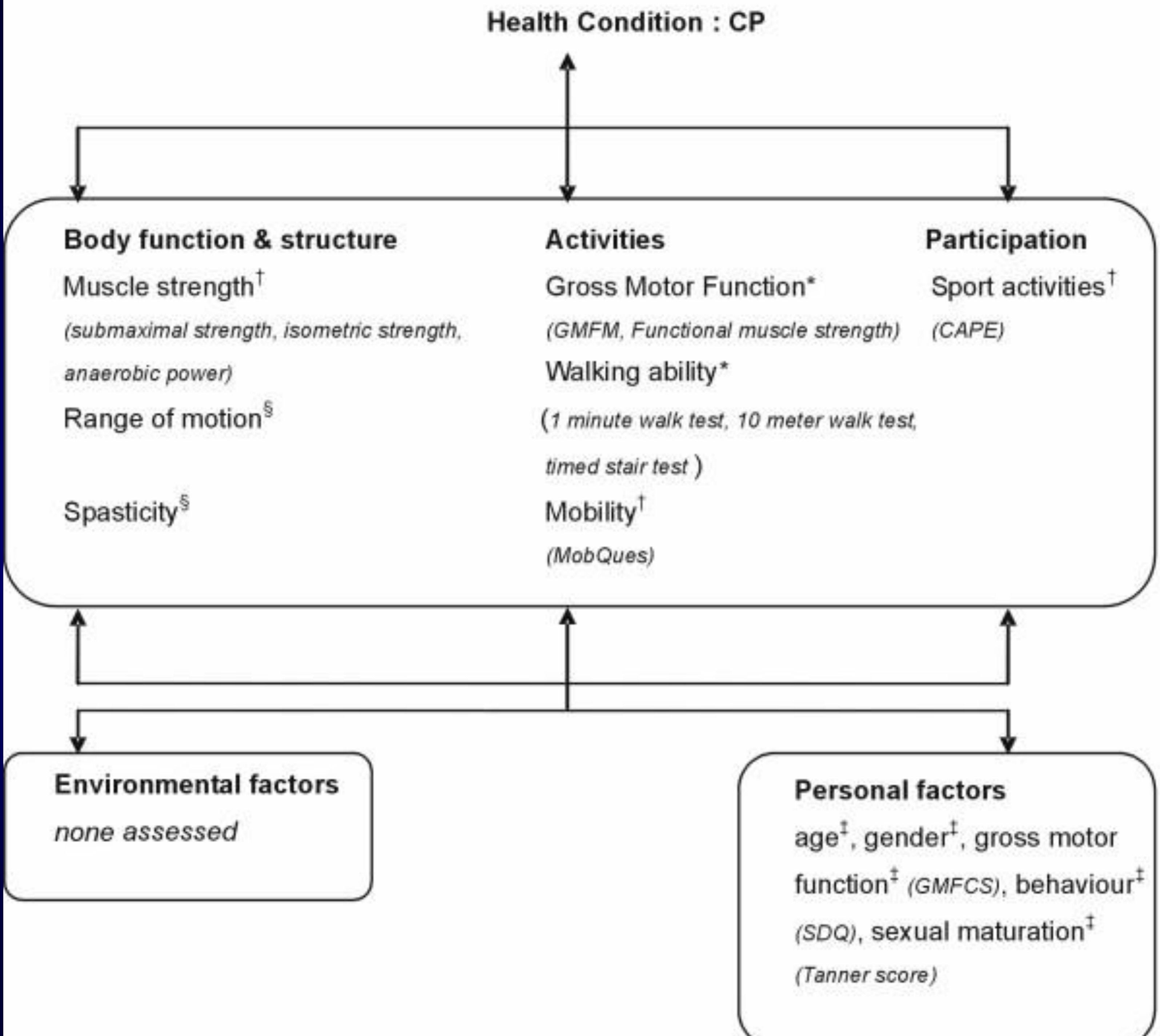
A Recent Innovative Study Protocol

Lower limb strength training in children with cerebral palsy – a randomized controlled trial protocol for functional strength training based on progressive resistance exercise principles (Scholtes et al., BMC Pediatrics, 2008)

Circuit training principles







Health Condition : CP
Body function & structure
Muscle strength†
(submaximal strength, isometric strength, anaerobic power)
Range of motion§
Spasticity§
Activities
Gross Motor Function*
(GMFM, Functional muscle strength)
Walking ability*
(1 minute walk test, 10 meter walk test, timed stair test)
Mobility†
(MobQues)
Participation
Sport activities†
(CAPE)
Environmental factors
none assessed
Personal factors
age‡, gender‡, gross motor function‡ (GMFCS), behaviour‡ (SDQ), sexual maturation‡ (Tanner score)

Impact of Strength Training performance in field tests

Blundel, Shephard et al., 2003

1 Hour 2 times per week X 4 weeks training

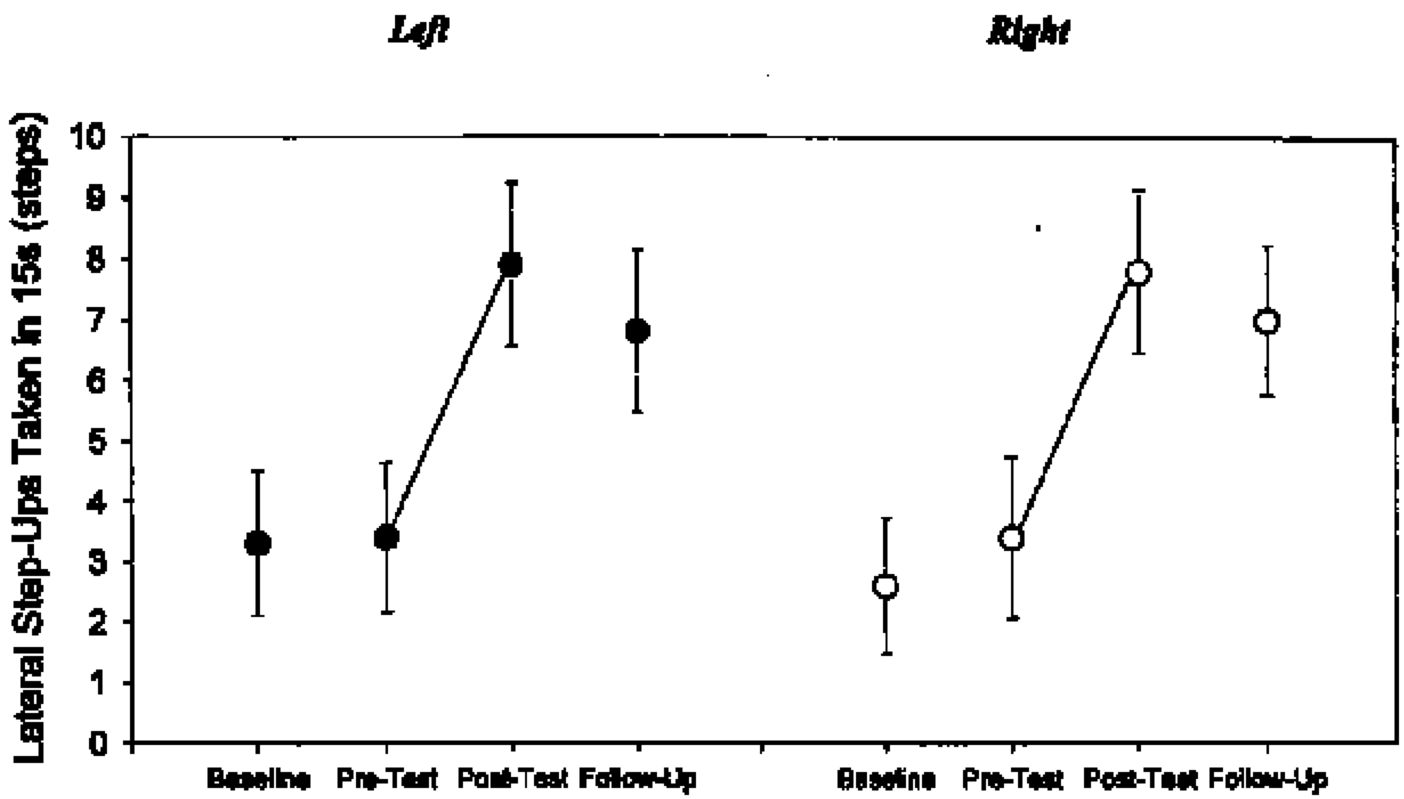


Figure 1 Results of the left and right Lateral Step-up Tests. The figure indicates the means and standard errors at baseline, pre-test, post-test and follow-up.

Impact of Strength Training performance in field tests

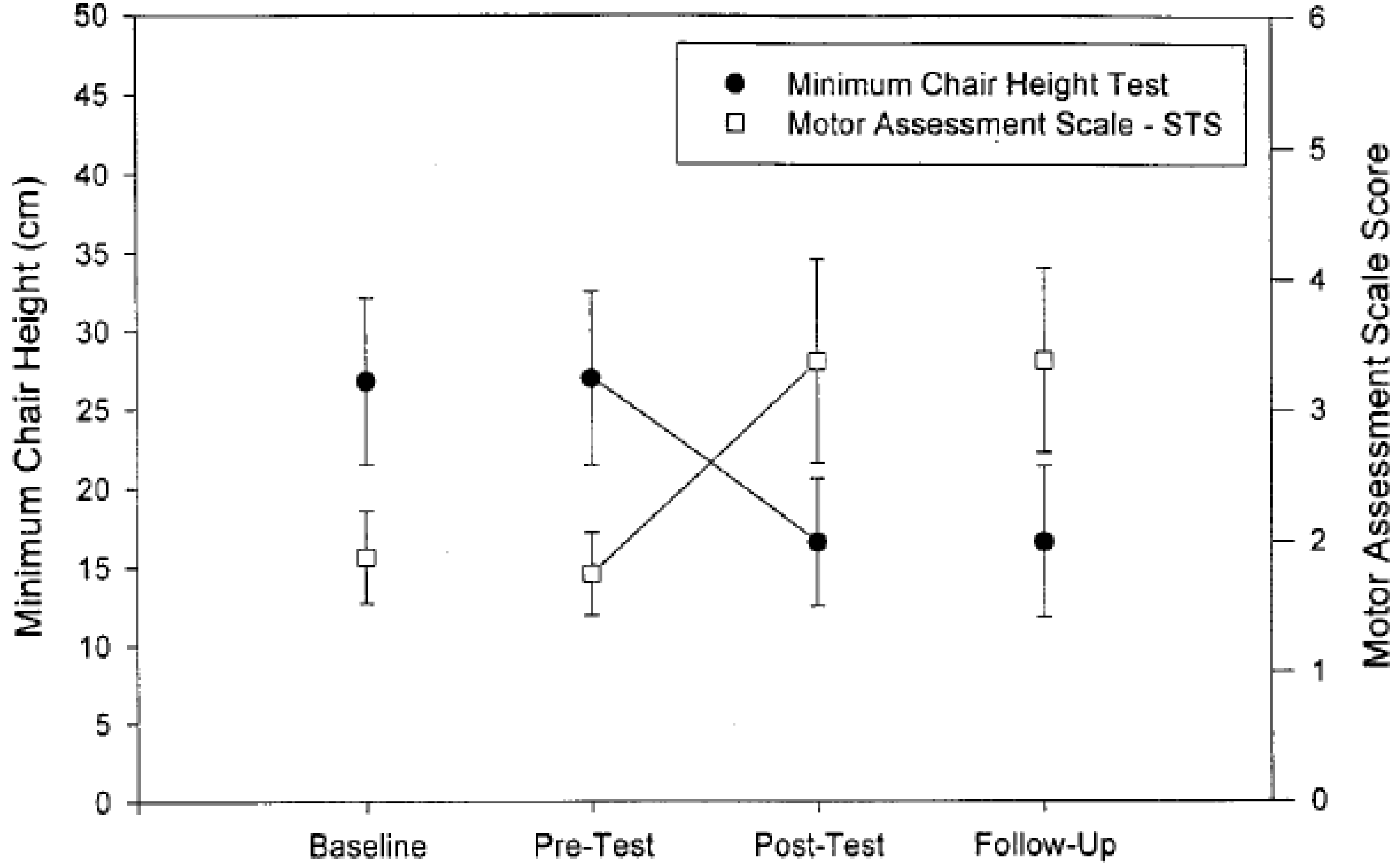
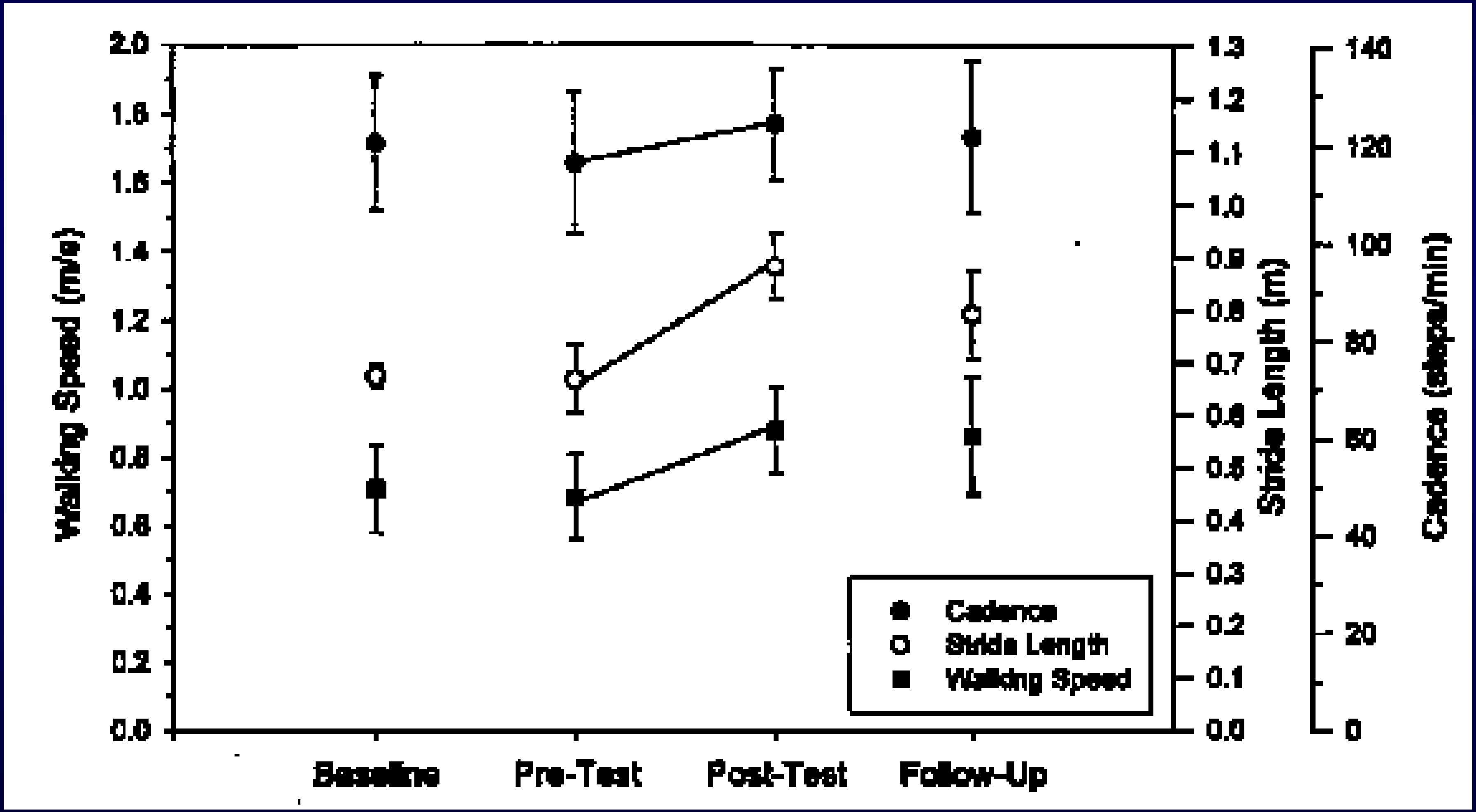


Figure 2 Results of the sit-to-stand tests. The figure indicates the means and standard errors for the Motor Assessment Scale and minimum chair height test at baseline, pre-test, post-test and follow-up.

Impact of Strength Training on Walking

Blundel, Shephard et al., 2003



Impact of Strength Training on Walking Contd.

Blundel, Shephard et al., 2003

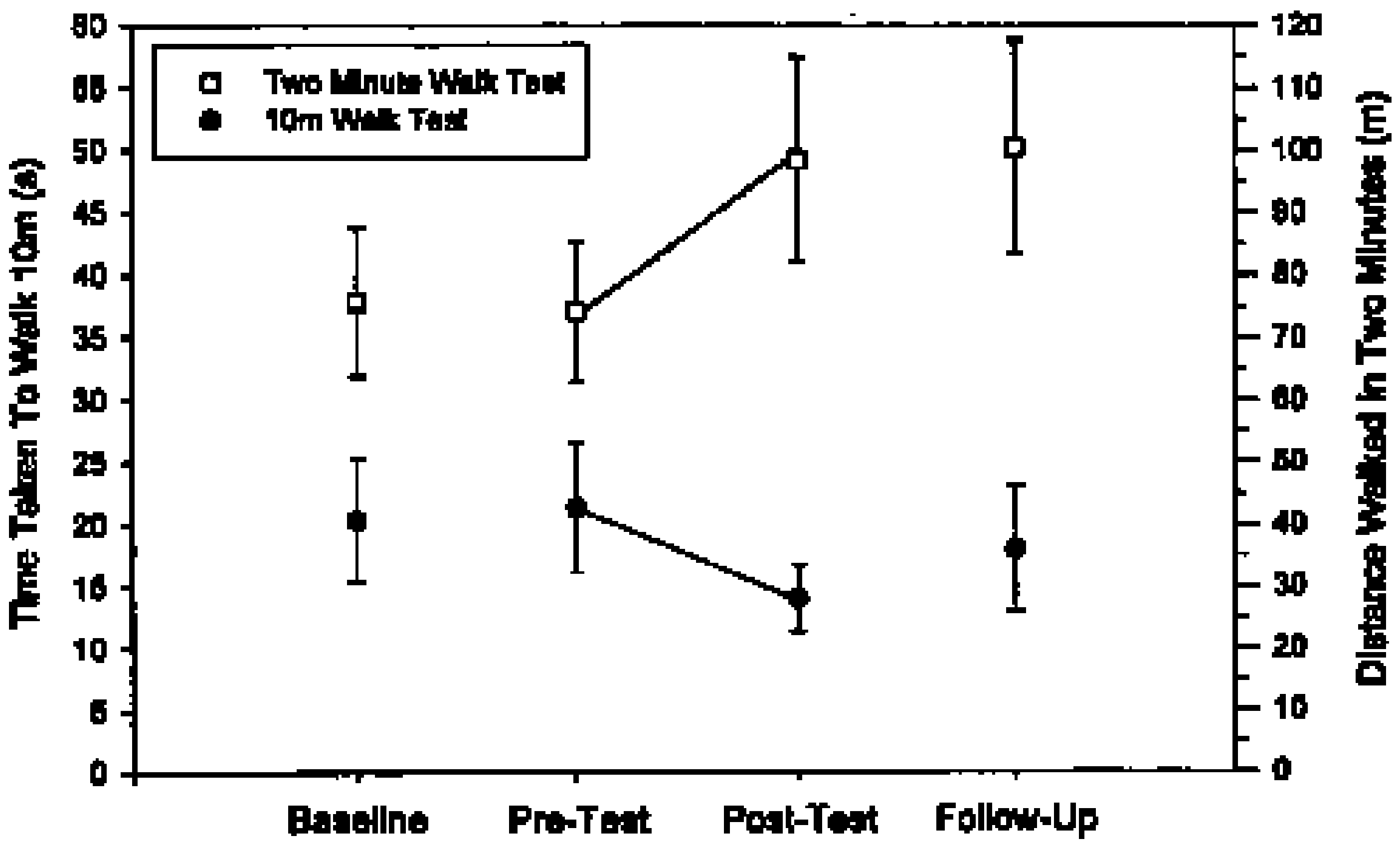
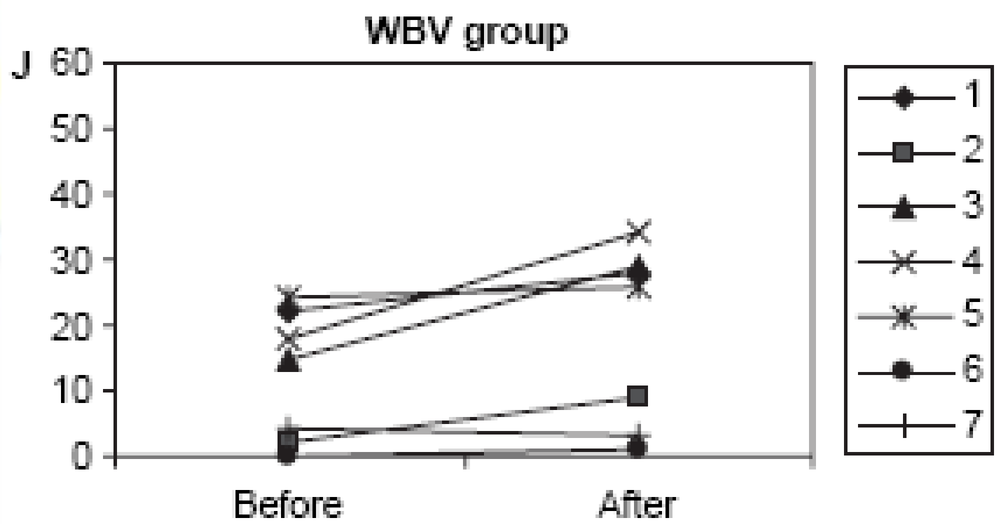
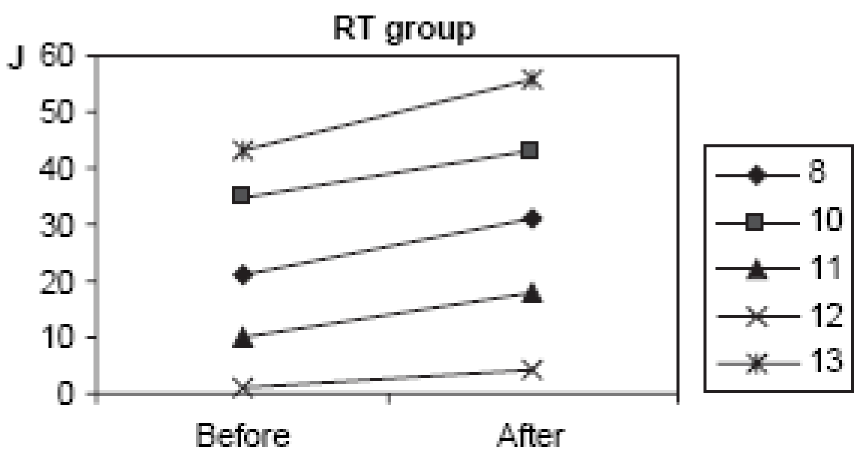


Figure 3 Results of walking tests. The figure indicates the means and standard errors for walking speed, stride length and cadence (top), and the 10-m walk test and the 2-minute walk test (lower) at baseline, pre-test, post-test and follow-up.

Isokinetic strength (RT) vs. Vibration Training (WBV) – 8 weeks duration

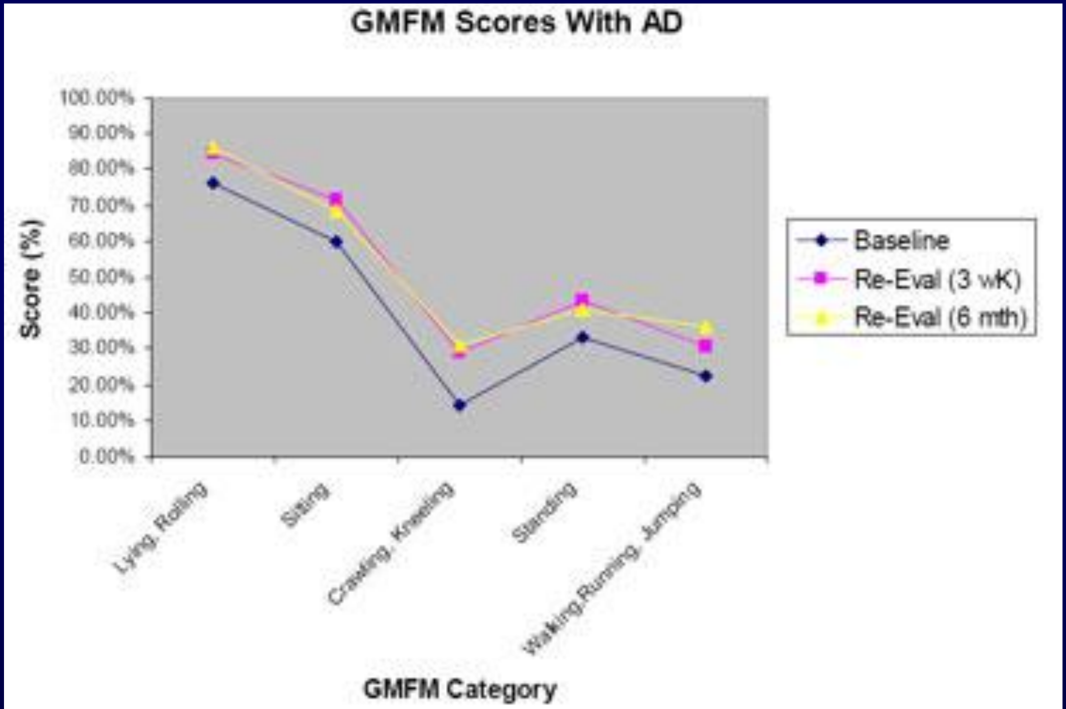
Ahlborg, Andersson &Julin, 2006





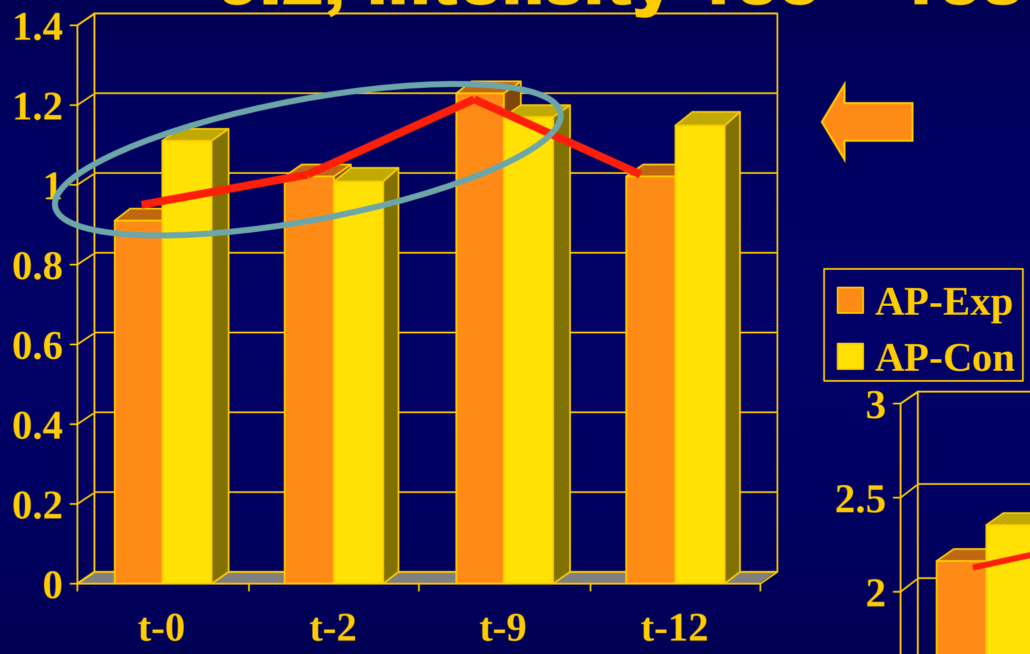
Thera (Elastic cords) Suite

Anecdotal Reports of success

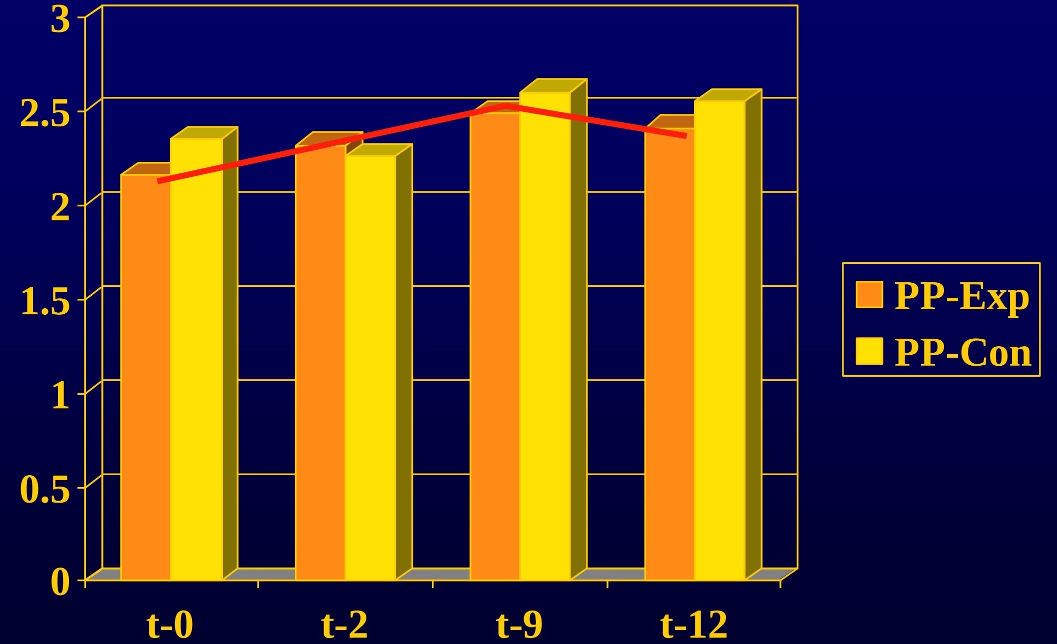


Impact of a 9-Month training program (adapted from Berg-Emons, 1996)

- 9-months 2Xweek for 45-min; mean age 9.2; intensity 135 – 138 HR => 70% HRmax



Peak Aerobic Power W/kg

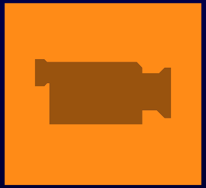


Peak Anaerobic Power W/kg

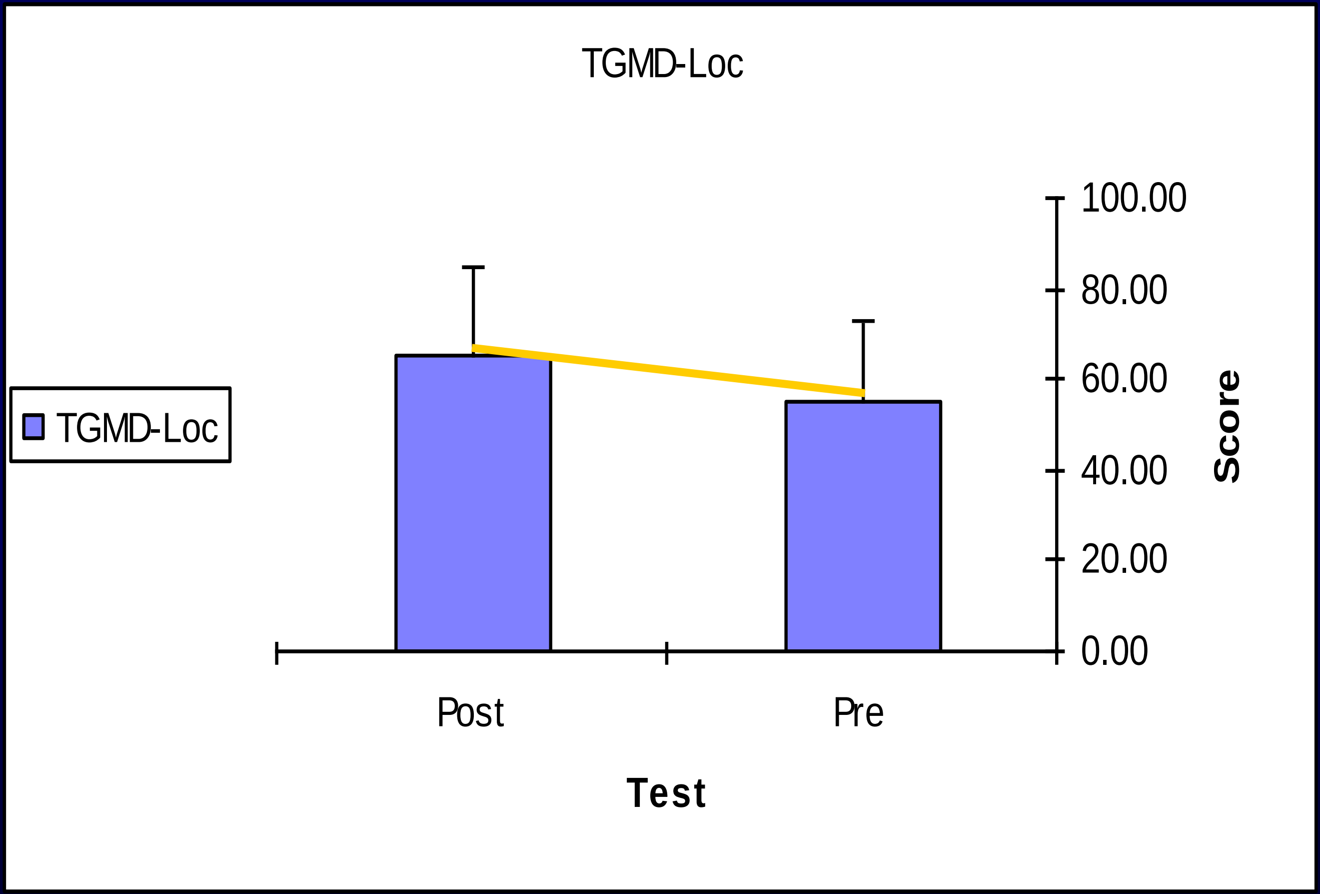
APA intervention, strength and quality of fundamental motor skills in CP

Hutzler, Ayalon, & Ben Uziel, 2004

- **11 students ages 8 – 15 yrs (11.6± 2.3 yrs) participated in training program 90 min, 1 X week, 6 months**
- **Training included strength training, endurance training and skill training**
- **Outcome Measures included Isokinetic strength of lower limbs and TGMD**



% Score in Locomotor skills (From 100)



Intervention outcomes

p	t	(%) Δ	Post	Pre	Variable
>.02	-3.02	(10.7) 6.7	(18.5) 70.9	(21.0) 59.4	Manipulation skills (%)
>.07 *	-2.1	(8.6) 6.7	(22.2) 55.7	(22.4) 43.75	Locomotor skills (%)
NS	-0.34	(6.9) 0.8	(15.0) 31.3	(16.5) 30.4	Flexion D limb (Nm)
.NS	-1.35	(3.3) 1.6	(8.3) 20.4	(8.9) 18.8	Flexion N limb (Nm)
>.005	-4.53	(7.3) 11.75	(28.8) 69.9	(24.5) 58.1	Extension D limb (Nm)
NS	-2.1	(7.2) 5.4	(12.1) 46.1	(13.4) 40.7	Extension N limb (Nm)

D = dominant; N = non dominant ; NS= non significant * ES= .54 (Cohen, 1988)

Vershuren et al., 2007

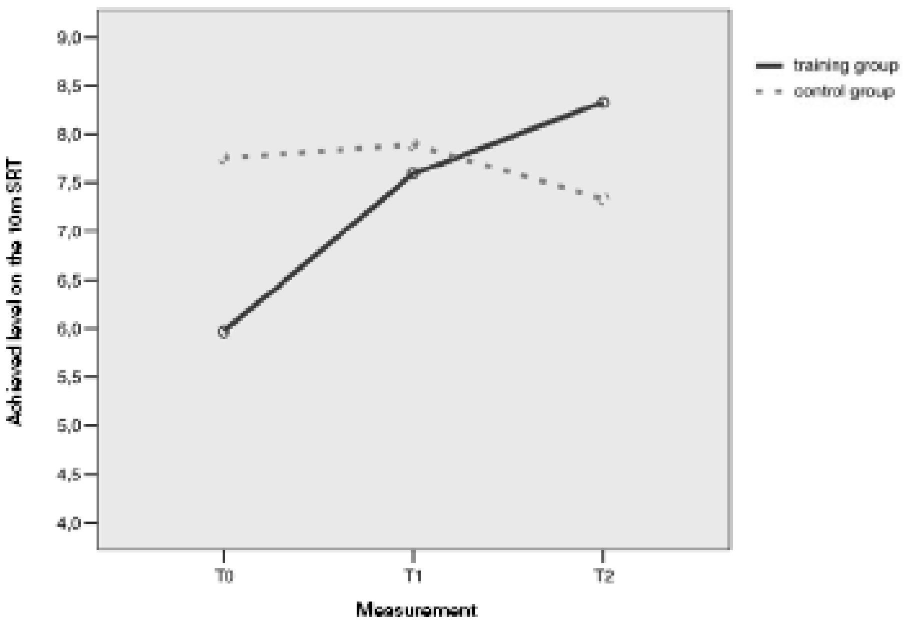
- Participants randomly sampled from 4 special schools into Ex (2X45-min week) and control (n=34 each group)
- Activity included an introduction and then 8 aerobic exercises 3-6 min each + 8 strength exercises lasting 20-30-sec.
- First 4 m; accent on aerobic tr. Then on anaerobic tr.

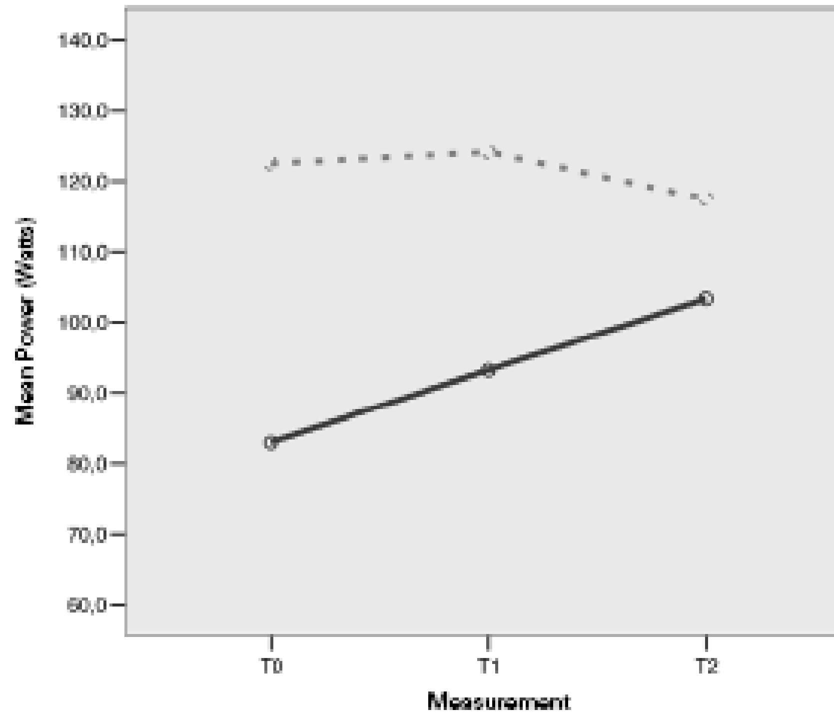
Outcomes

Aerobic

Anaerobic

Figure 2. Profile plots for aerobic capacity (p<0.001) and anaerobic capacity (p=0.004).
P-values are for the repeated-measures analysis of variance (group [2] x time [3]). T0 indicates baseline; T1 after 4 months; T2 after 8 months.



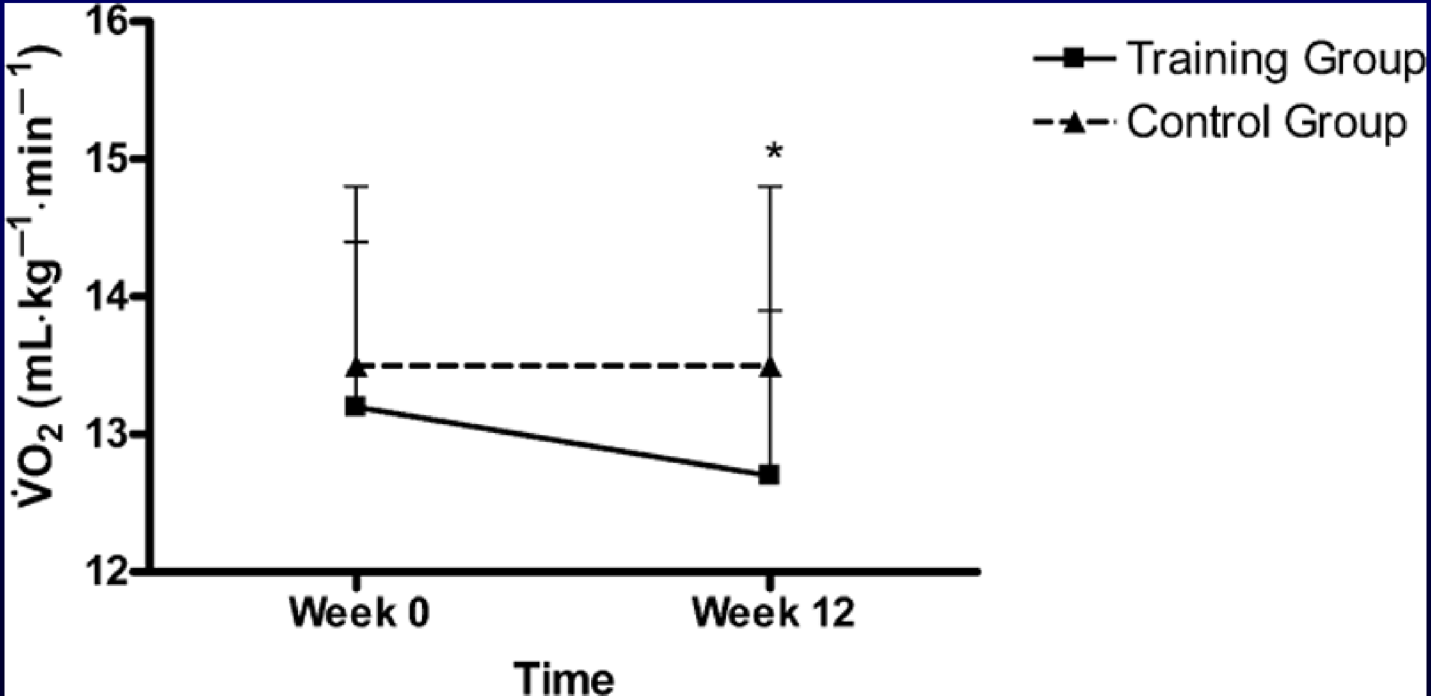


GMFCS I & II

Community Exercise Program

Unnithan, Katsimenis, Evanelinou et al., MSSE, 2007

- Indoors + outdoors Exercise (n=7) vs. Control gr: 12 weeks; 3X weekly sessions 70 min each; aerobic intervals + repetition exercise (3X20 -> 5X10)
- Measurement on Armcycle ergometer 2.5 W increments from 2.5 W every 4 min.



Partial Body weight Supported Training (PBWST)

Physiological Impact of PBWST

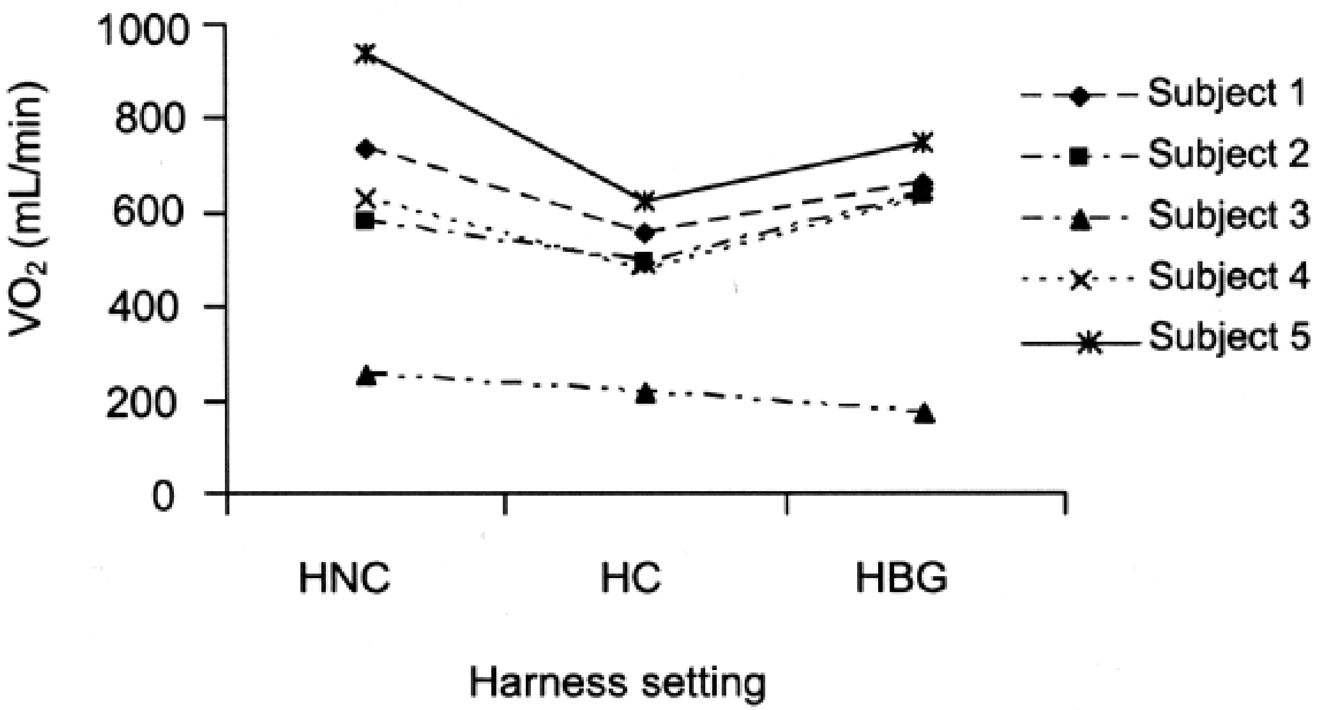
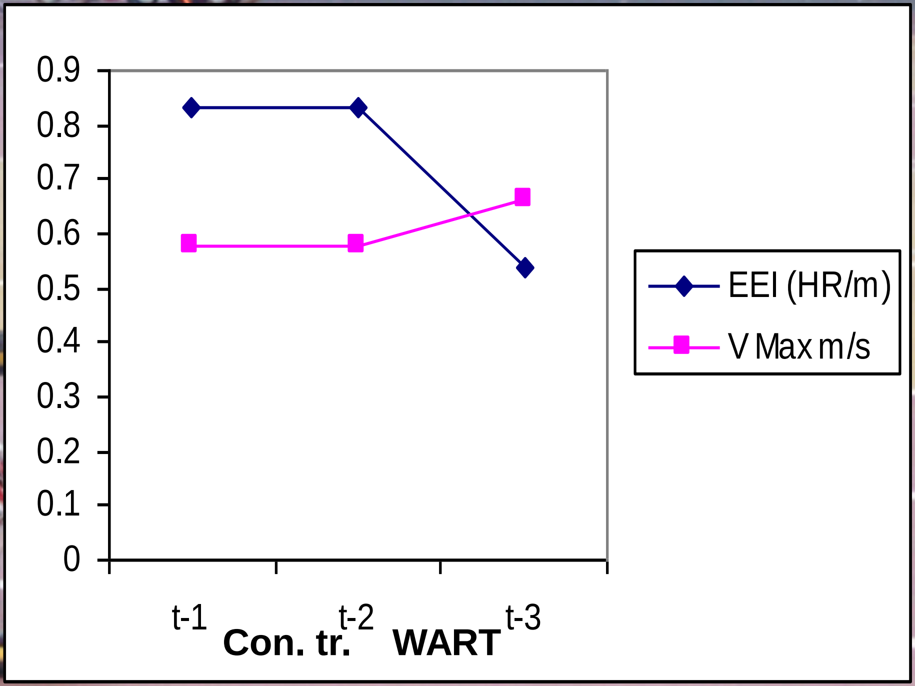


Figure 1 — Individual data points for the oxygen cost of walking (VO_2 [ml/min]) for 5 participants at three different harness settings. HNC = partial body weight support harness on but not connected to the weight displacement system; HC = partial body weight support harness on with weight displaced; HBG = partial body weight support harness on, weight displaced, and lateral stabilizing bungee cords attached to the harness.[ml/min]

Wheel Assisted Running Training (WART)

Single subject



V max = walking 10-m test; EEI = (Work HR – Rest HR / V)

Conclusions & Recommendations

- There is substantial evidence supporting the impact of both strength and endurance training on function and activity performance in young persons with CP.
- Treadmill walking training both with and without partial body-weight support is recommended
- A variety of training methods have hardly been evaluated (elastic cords, vibrations, wheel assisted running) and should receive more attention in future studies.
- The intensities, protocols and order of training units (e.g., strength, aerobic, anaerobic focus) are still unexplored