A decorative graphic consisting of a thin yellow circle on the left side, a thick yellow bracket on the right side, and a horizontal yellow bar across the middle. The title text is centered within the yellow bar.

Assessment of Fitness in Cerebral Palsy

Edward A. Hurvitz, M.D.

Dept. of PMR

The Cerebral Palsy Program

The Human Performance Laboratory

The University of Michigan, Ann Arbor

[Physical Fitness]

- A set of attributes that people have or achieve relating to their ability to perform physical activity

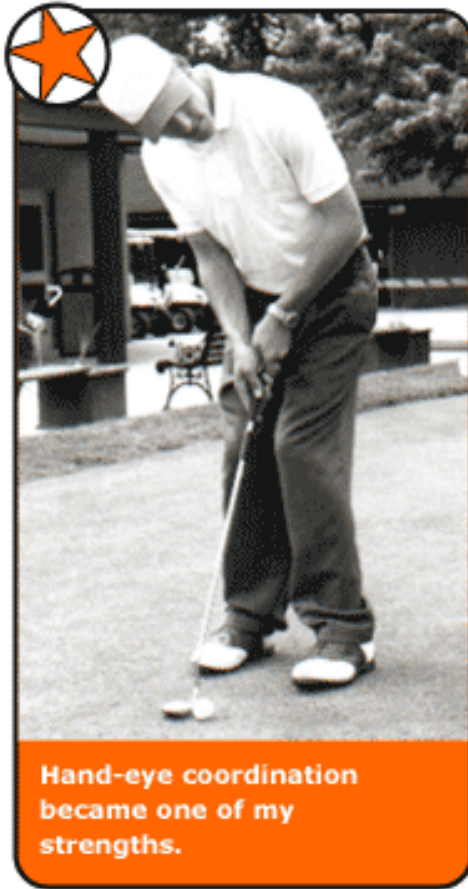


Health Related Physical Fitness

- Cardiorespiratory Endurance
- Muscular Strength
- Muscular Endurance
- Body Composition
- Flexibility



Skill Related Physical Fitness



- Agility
- Balance
- Coordination
- Power
- Speed
- Reaction Time

[Physiologic Physical Fitness]

- Metabolic
- Morphologic
- Bone Integrity

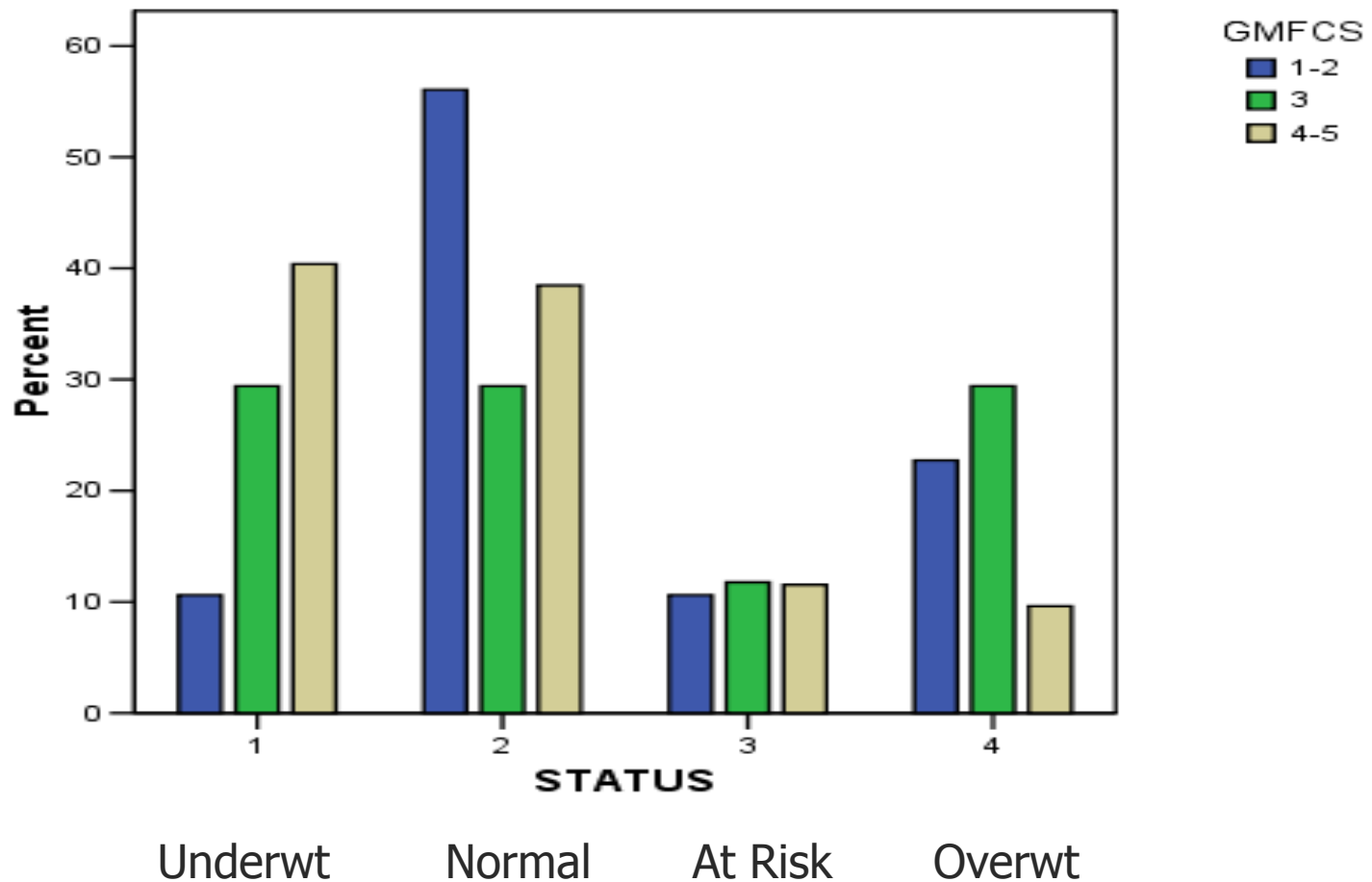


[Obesity in CP]

- GMFCS III-V—poor growth
 - Stevenson et al., Pediatrics 2006: 118:1010-1018
- GMFCS I-II
 - Van der Slot et al, Disability and Rehabilitation 2007: 29:179-189
 - Men had lower body fat than controls based on skinfolds

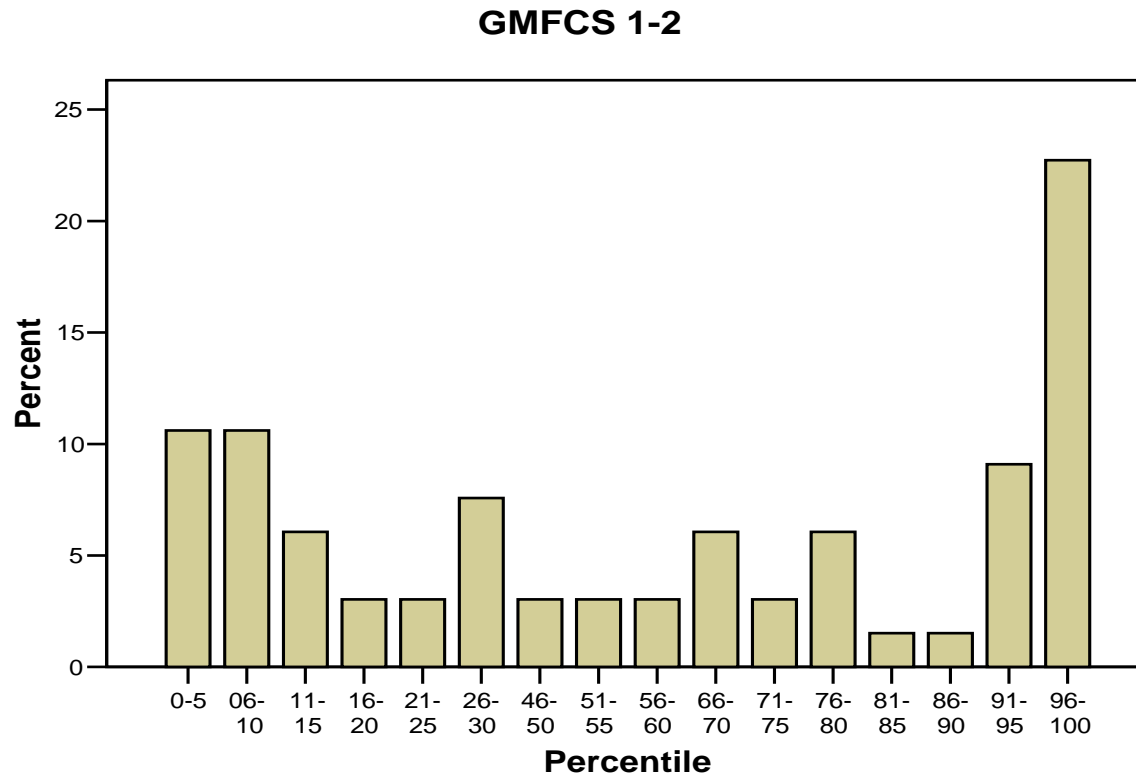
BMI in CP

Figure 2. Weight status by GMFCS level



BMI, GMFCS I-II

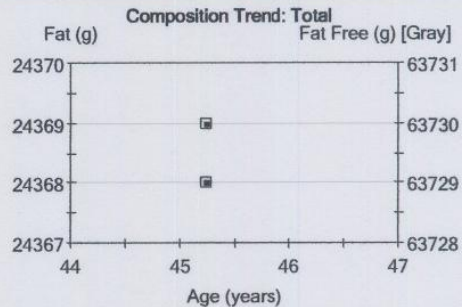
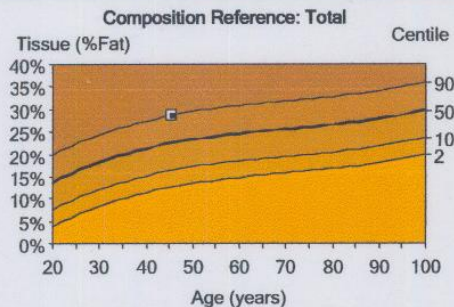
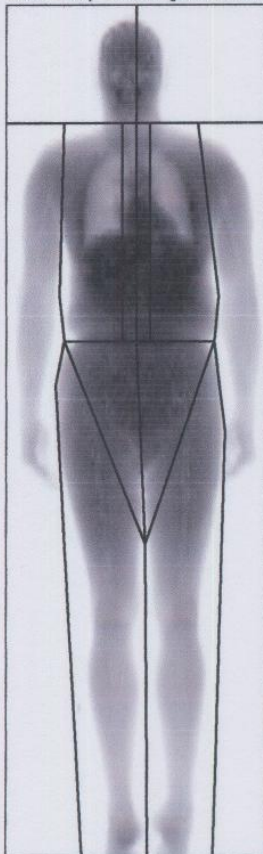
Figure 1. Distribution of Percentiles for



University of Michigan General Clinical Research Center Ann Arbor, MI 48109

| | | | |
|-------------------------|----------------------|-----------------------------|------------------------------|
| Patient: | ID-101 | Facility ID: | |
| Birth Date: | 4/18/1962 45.2 years | Referring Physician: | 2137-Dr. Hurvitz |
| Height / Weight: | 75.0 in. 196.0 lbs. | Measured: | 7/13/2007 8:52:58 AM (10.51) |
| Sex / Ethnic: | Male White | Analyzed: | 7/13/2007 9:27:38 AM (10.51) |

Total Body Tissue Quantitation



Trend: Total

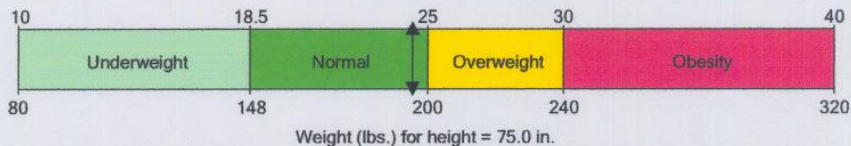
| Measured Date | Age (years) | Tissue (%Fat) | Centile ^{2,3} | T.Mass (kg) | Region (%Fat) | Tissue (g) | Fat (g) | Lean (g) | BMC (g) | Fat Free (g) |
|---------------|-------------|---------------|------------------------|-------------|---------------|------------|---------|----------|---------|--------------|
| 7/13/2007 | 45.2 | 28.7 | 91 | 88.1 | 27.7 | 84,928 | 24,369 | 60,559 | 3,169 | 63,729 |

Trend: Fat Distribution

| Measured Date | Age (years) | Android (%Fat) | Gynoid (%Fat) | A/G Ratio | Total Body (%Fat) |
|---------------|-------------|----------------|---------------|-----------|-------------------|
| 7/13/2007 | 45.2 | 39.4 | 32.4 | 1.22 | 28.7 |

COMMENTS:

World Health Organization BMI Classification
Body Mass Index (BMI) = 24.5



Challenges of Measurement Body Composition

- BMI
- Height Measurement
- Accuracy vs. Simplicity

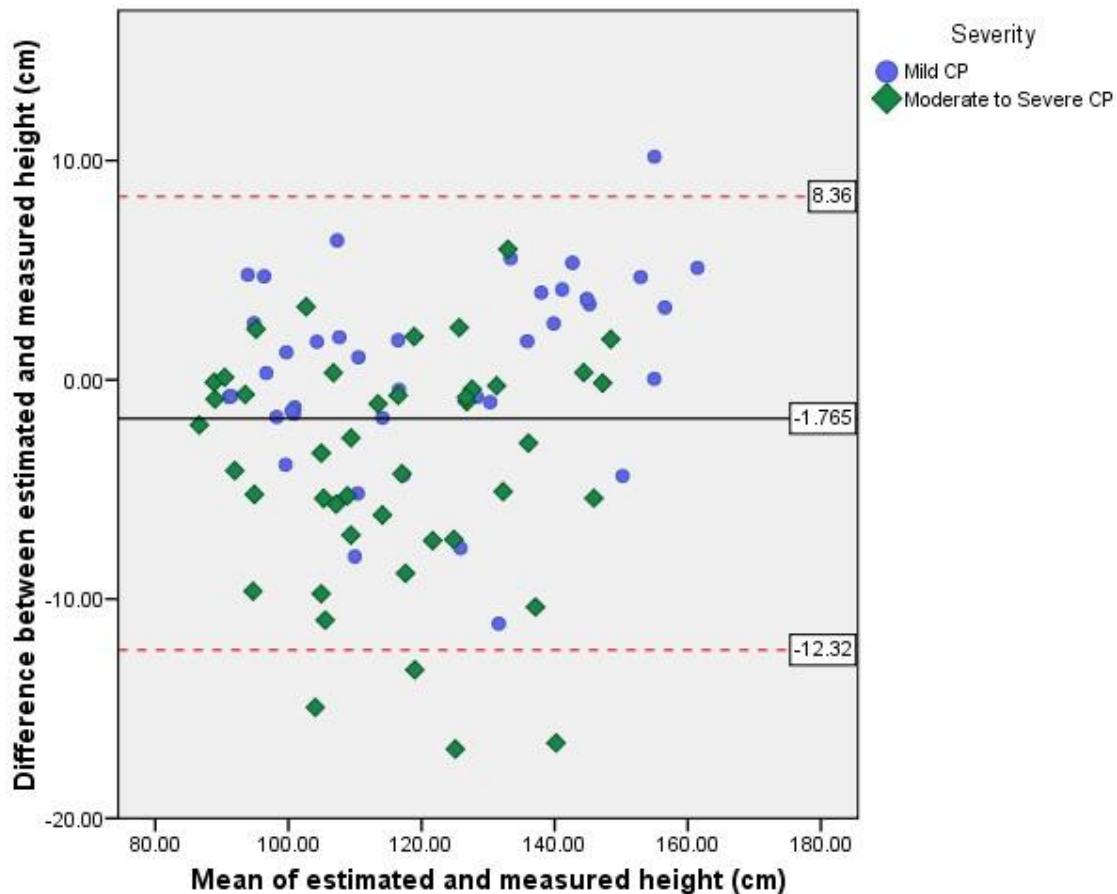


[Segmental Measures]



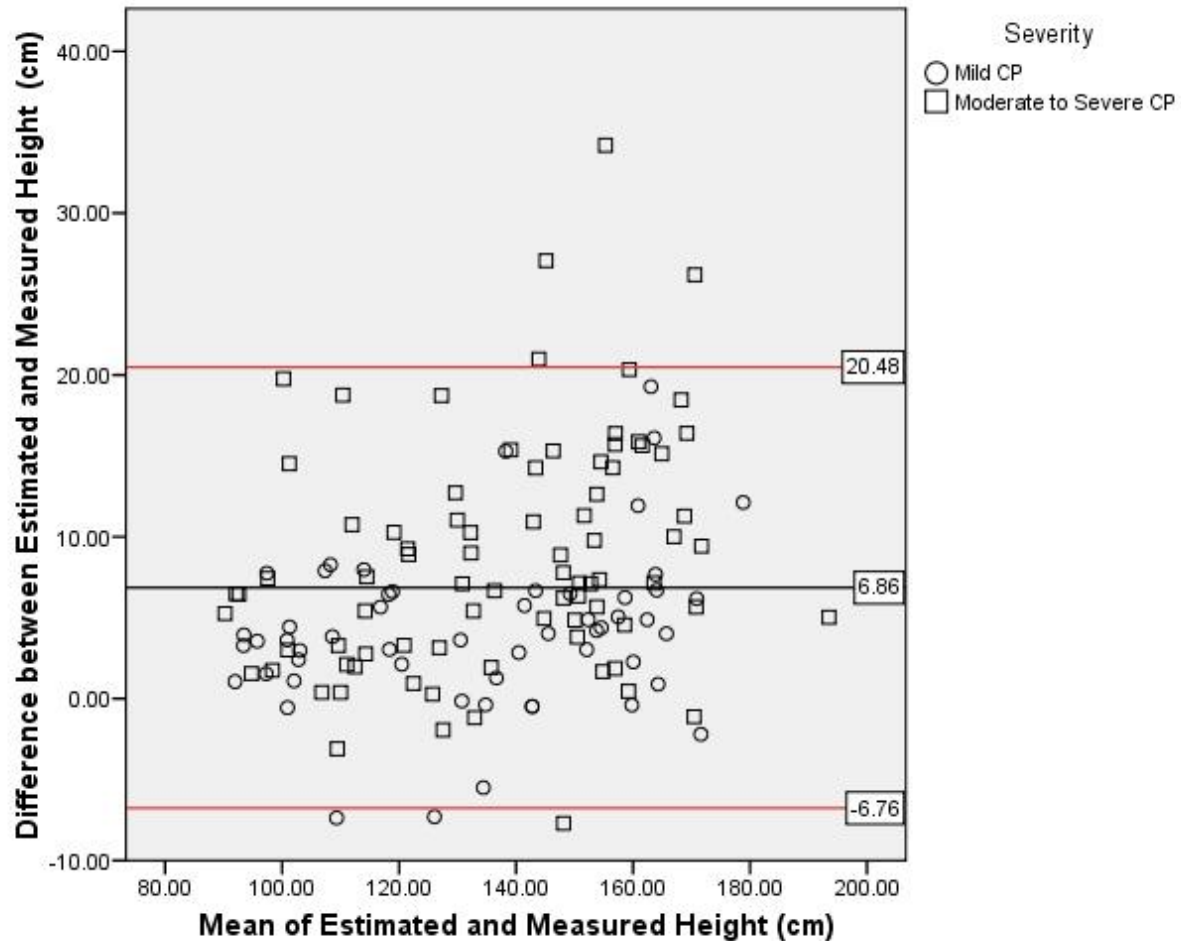
Estimation of Height with Knee Heights

Height estimated from Stevenson knee height equation vs. Measured Height



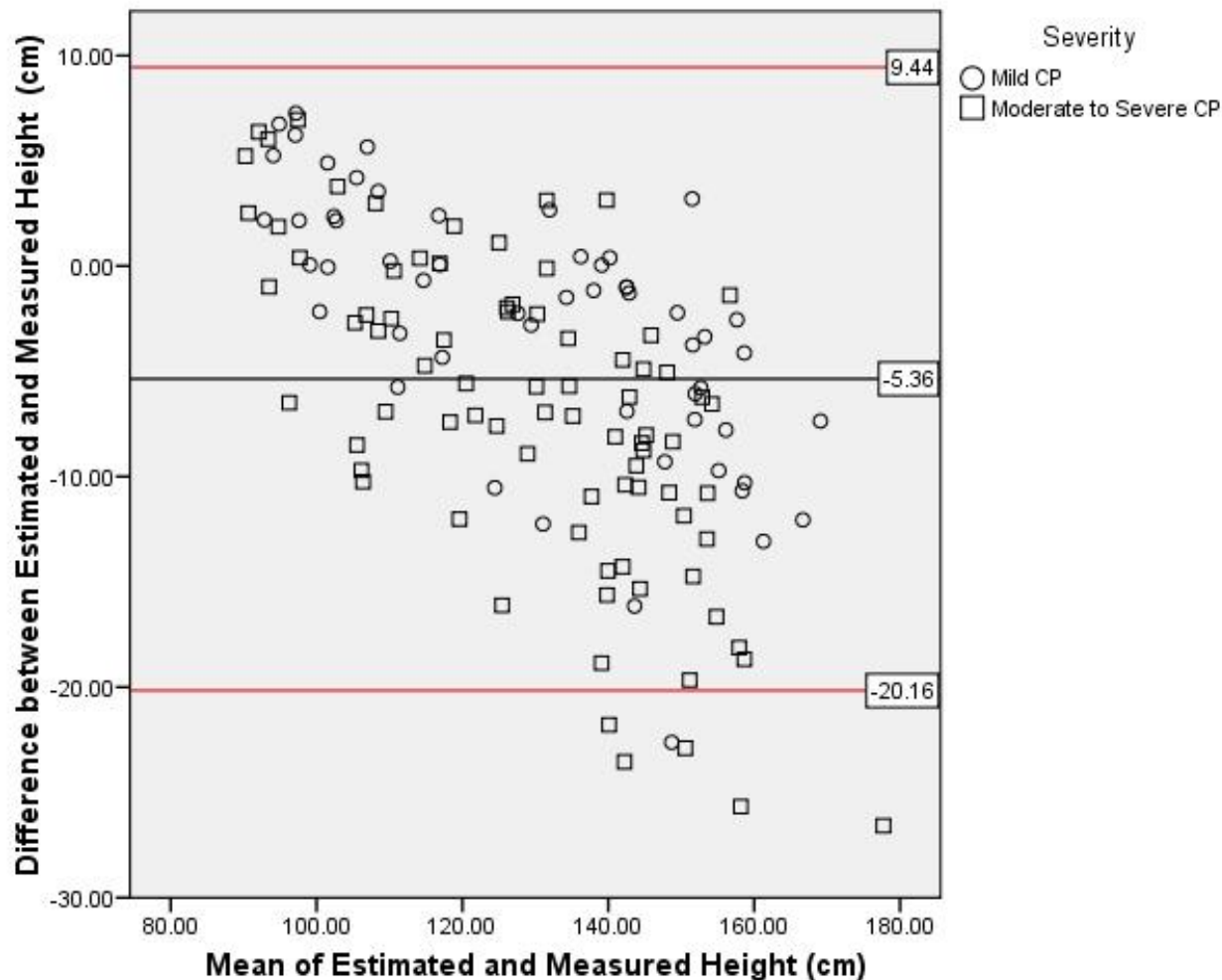
Height Estimation with Ulna Length

Estimated Height from Gault Ulna length vs. Measured height



Knee Height, Equation for Non-CP

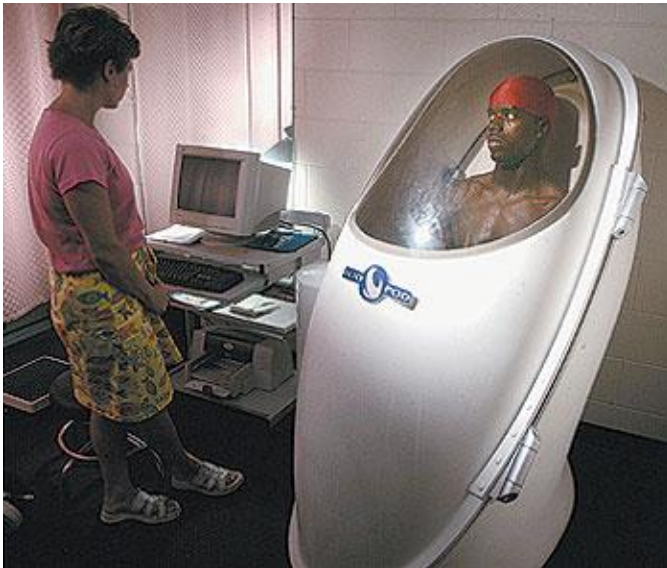
Estimated Height from Chumlea Knee Height vs. Measured Height



[Measuring Body Composition]



[More Advanced]



[Aerobic Capacity]

- Lundberg, DMCN 1978 20:205-210
 - Lower level of fitness (HR response, O₂ uptake)
- Tobimatsu et al, APMR 1998 79:991-3
 - Peak VO₂ not different from controls
- Fernandez and Pitetti, multiple
 - Poor level of aerobic fitness, but responds to exercise

Challenges of Measurement Aerobic Capacity

- Use of equipment
 - Varied population, varied ability
- Attaining VO₂ max
 - Max vs. Peak

Exercise Testing



[Physical Activity in CP]

- Van der Slot et al, Disability and Rehabilitation 2007: 29:179-189
 - Hemiplegic CP, no difference from controls
- Maher et al, DMCN 2007:450-7
 - Adolescents, PAQ-A, Less activity, less structured, lower intensity

Physical Activity in CP

- Maltais et al, Med Sci Sport Ex 2005
37:347-353
 - Energy cost of walking predicts physical activity
- Bandini et al, Pediatric Research 1991
29:70-77
 - Adolescents, decreased TEE/RMR and FFM

Challenges of Measurement Physical Activity

- Many surveys
 - Reliance on memory
 - Bias
- Activity monitors/Accelerometers
- Double labeled water

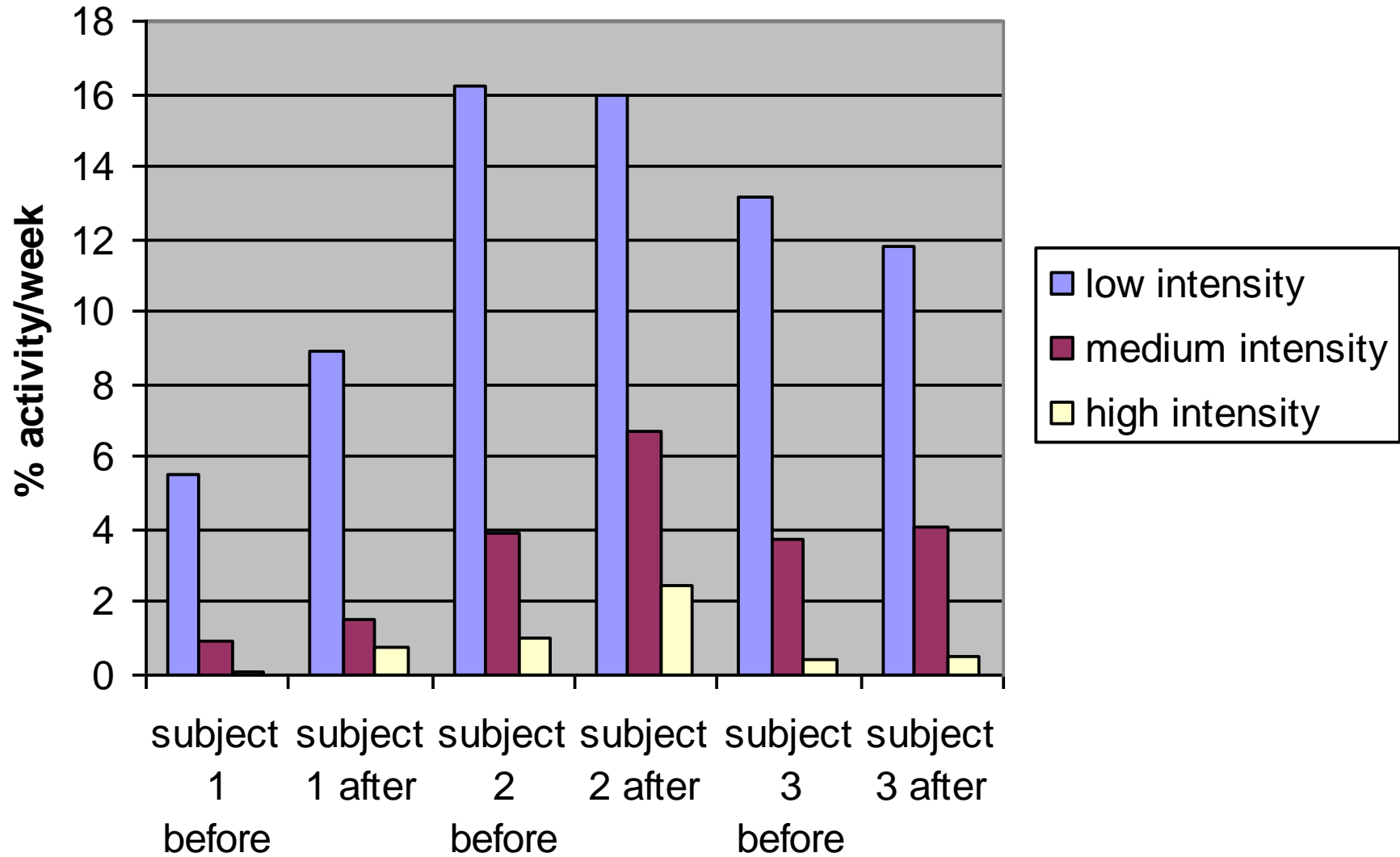
[Accelerometers]



- Activity counts
- Activity levels
- Subject input
- IDEAA—describes activity



Figure 5. Activity intensity before and after rhizotomy



[Strength]

- Damiano et al, multiple
 - Children with cerebral palsy are weak, and can get stronger with exercise
 - They benefit functionally from this as well
- Macphail et al, DMCN 1995 37:763-775
 - Adolescents benefit from strengthening
- Ross and Engsberg, APMR 88:1114-20
 - Children-strength influences gait more than spasticity

Challenges of Measurement Strength

■ MMT

- Isolation of movement
- Reliability and technique



■ Handheld Dynamometer

- Reliability and technique

■ Biodex

- Difficult to have in



CPOP: Cerebral Palsy Outcomes Project

- Objective: To study relationships between Health / Fitness and Participation / QOL
- Model
 - Multisite—large population (500 from 6 sites)
 - Clinic based—less complex measures
 - Highly feasible assessment
 - Internet based data collection

[Fitness Assessment]

- Body Composition
 - Height (Knee Height), Weight
 - Triceps Skin fold
 - Mid-Arm Circumference
 - Waist circumference
- Aerobic Fitness
 - Walk test—3 vs. 5 vs. 6 minutes

[Fitness Assessment]

- Flexibility

- Modified Apley test
- Popliteal angle
- Thomas test

- Strength

- Hand held dynamometer—knee extension
- Grip strength dynamometer

[Summary]

- Physical Fitness in Cerebral Palsy
 - On the research agenda
- Challenges of Assessment
 - Difficulties with standard assessments
 - Search for solutions
- Identifying the issues
 - Multisite clinic based study
 - Pave the way for more elegant studies