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Growth and nutritional assessment in children with cerebral palsy

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Introduction

- Children with cerebral palsy (CP): high risk of co-morbidities, malnutrition, failure-to-thrive, growth faltering
  e.g. oral-motor dysfunction (> 80%); gastroesophageal reflux (75%); chronic constipation (75%); swallowing disorders (60%); abdominal pain (30%)
- Monitoring linear growth and nutritional status is important but challenging
- Which parameters?
  Length, knee height, length of ulna or tibia
  Weight, skinfolds, BIA, DXA
- Which reference to use?
  Typical children, condition specific reference

- This presentation: knee height as a measure of linear growth

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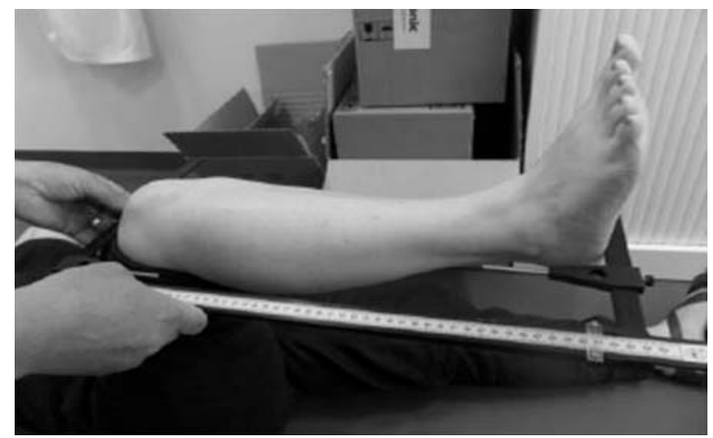
Why knee height?

- Recumbent length and height are (i) difficult to measure and (ii) often unreliable, because of contractures, high tone, involuntary movements, unable to stand independently, scoliosis or poor cooperation due to cognitive impairment.

→ use segments as a proxy for linear growth

→ knee height

- Smallest prediction error (length)
- Easiest to standardize
- Reference curves available



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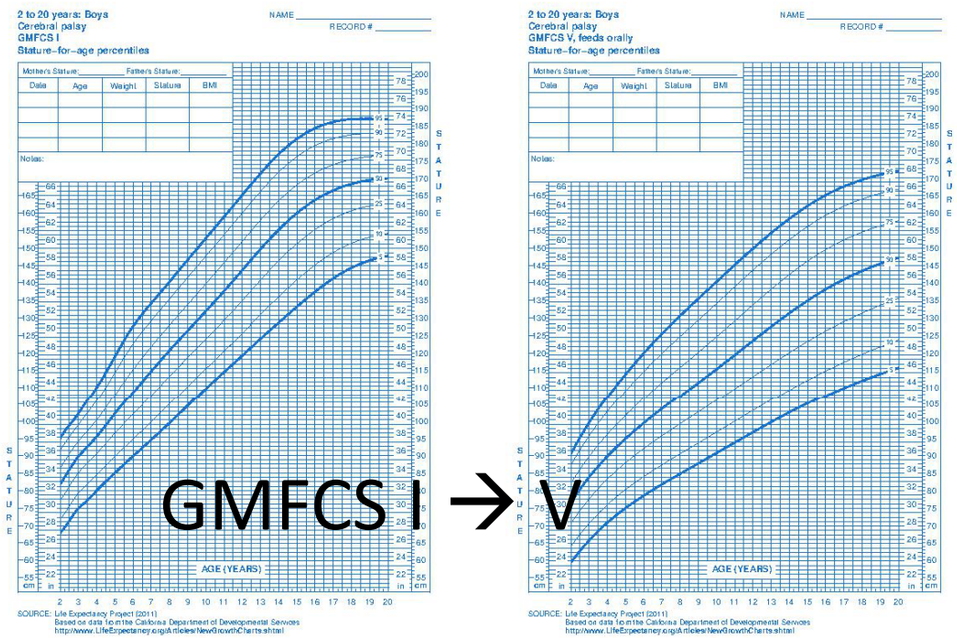
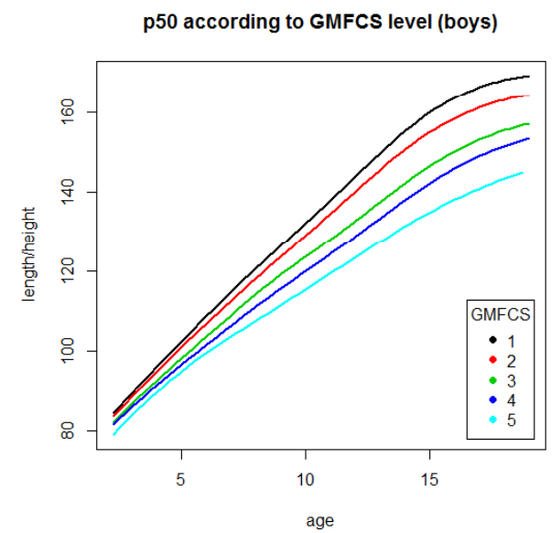
Existing growth references for CP

- NAGCPP: knee height (Stevenson et al., 2006)
- Lifeexpectancy.org: length/height, weight, BMI by GMFCS level (I – $V_{N/TF}$) (Day et al., 2007; Brooks et al., 2011)





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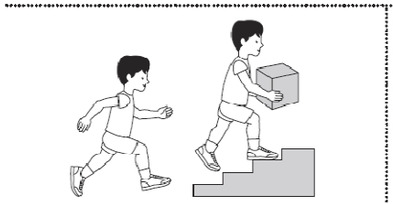
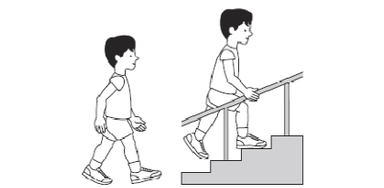
GMFCS E & R between 6th and 12th birthday: Descriptors and illustrations



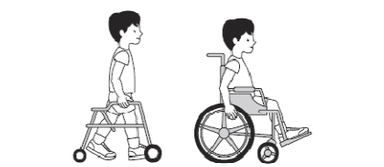
GMFCS Level I

Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited.



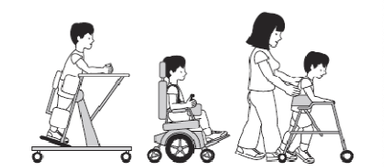
GMFCS Level II

Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces. Children may walk with physical assistance, a hand-held mobility device or used wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.



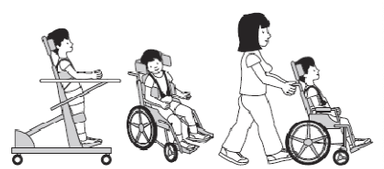
GMFCS Level III

Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when traveling long distances and may self-propel for shorter distances.



GMFCS Level IV

Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.



GMFCS Level V

Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements.

GMFCS descriptors: Palisano et al. (1997) Dev Med Child Neurol 39:214-23
CanChild: www.canchild.ca

Palisano et al. Dev Med Child Neurol. 1997

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Methods

- Multicentre mixed-longitudinal study
- n = 332; 799 measurements (baseline, 6, 12 months)
- GMFCS I (15%), II (29%), III (15%), IV (17%), V (24%)
- 61% boys
- 80% spastic, 13% dyskinetic; 7% ataxic type
- 80% bilateral distribution
- 52% premature birth
- 6% tube fed

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Methods

1. Predict height, compare with a reference for typical developing children;
2. Compare with existing reference for knee height;
3. Estimate a single reference curve (GMFCS I - V) (LMS);
4. Estimate GMFCS specific reference curve (GAMLSS)

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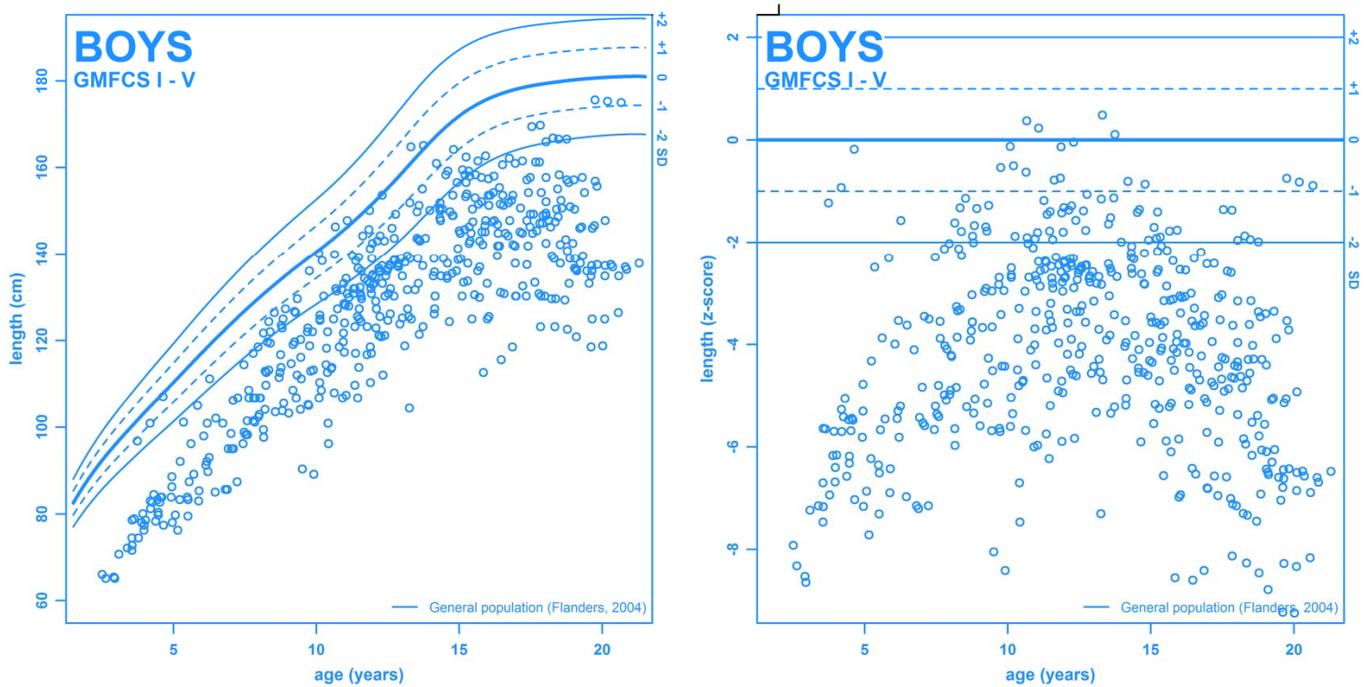
Results (1)

predict height, compare with typical developing children



- S = (KH x 2.93) + 12.88 cm (SD 4.16 cm; n = 65) [pilot]
- Few children are in the “normal range”; Additional prediction error
- Mean (SD) z-score boys -4.1 (1.9); girls -4.3 (1.9)

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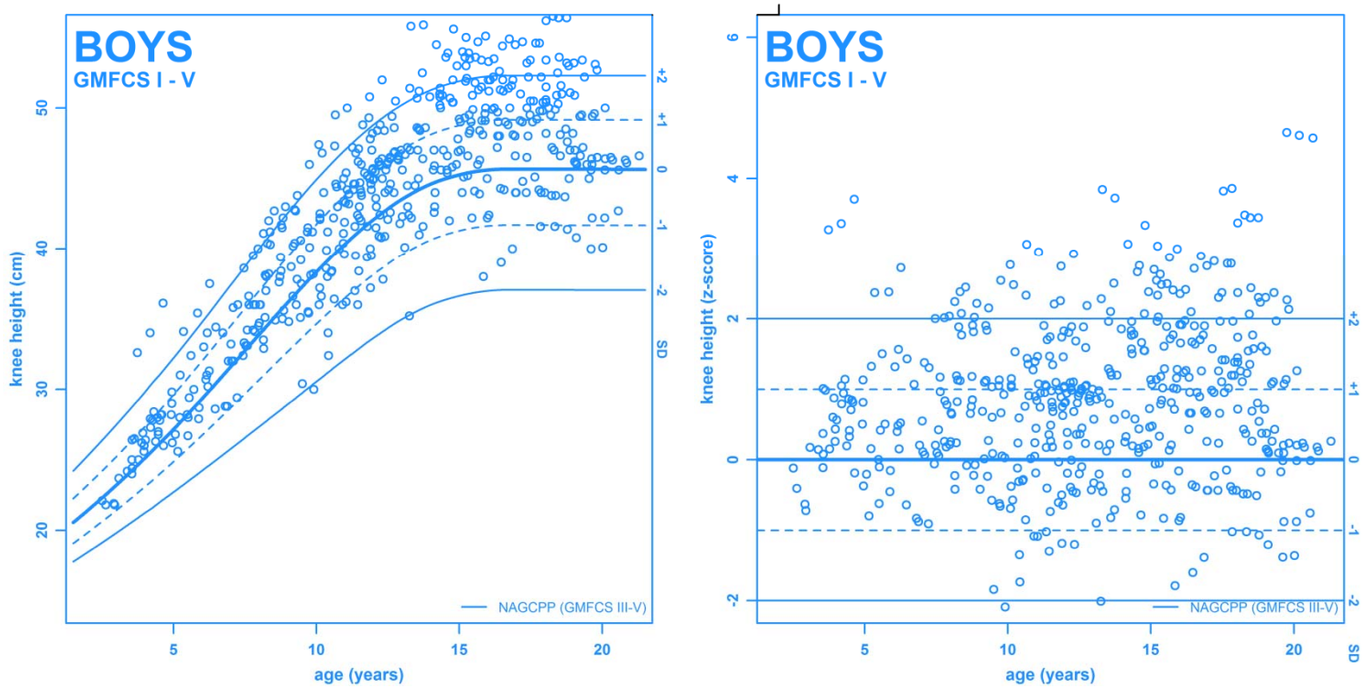
Results (2)

Compare with existing reference for knee height (NAGCPP)



- NAGCPP reference based on GMFCS III – V
- Mean (SD) z-score boys 0.9 (1.1); girls 1.2 (1.3)
- Too tall!

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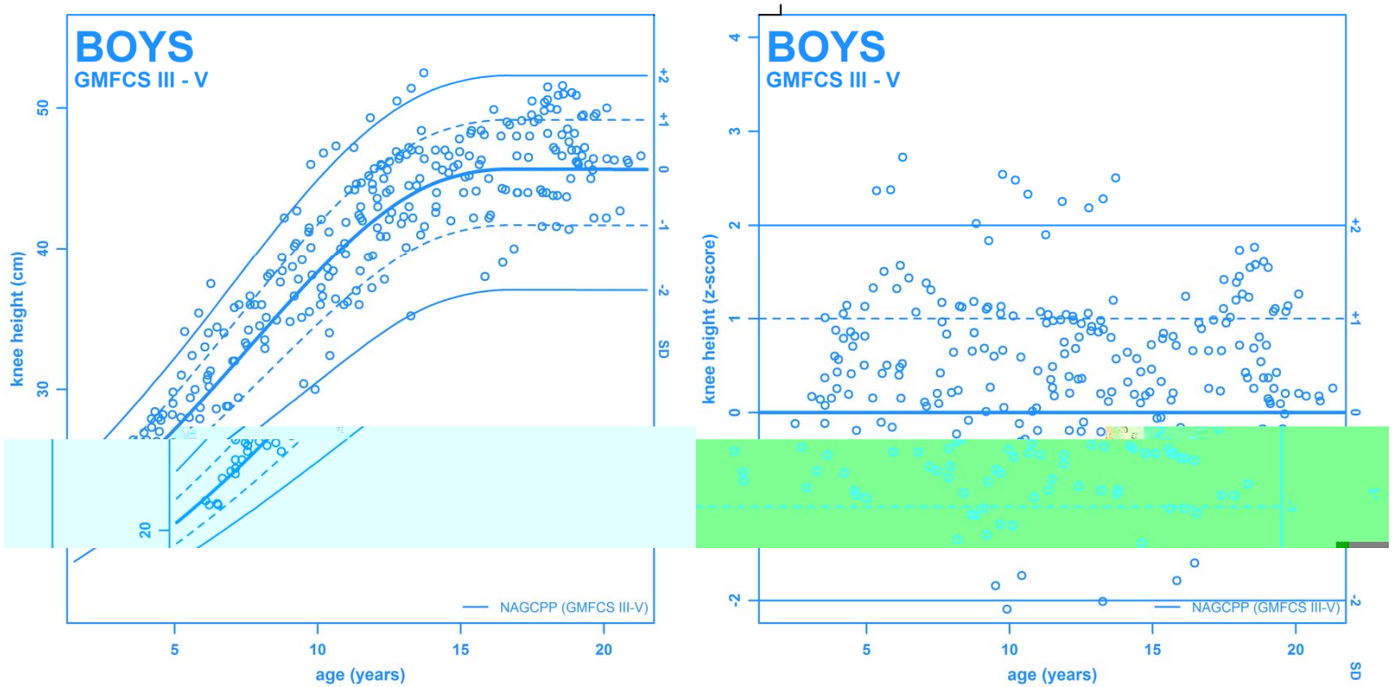
Results (2)

Compare with existing reference for knee height (NAGCPP)



- NAGCPP reference based on GMFCS III – V; data also
- Mean (SD) z-score boys 0.3 (0.9); girls 0.8 (1.0)
- What about GMFCS I and II?

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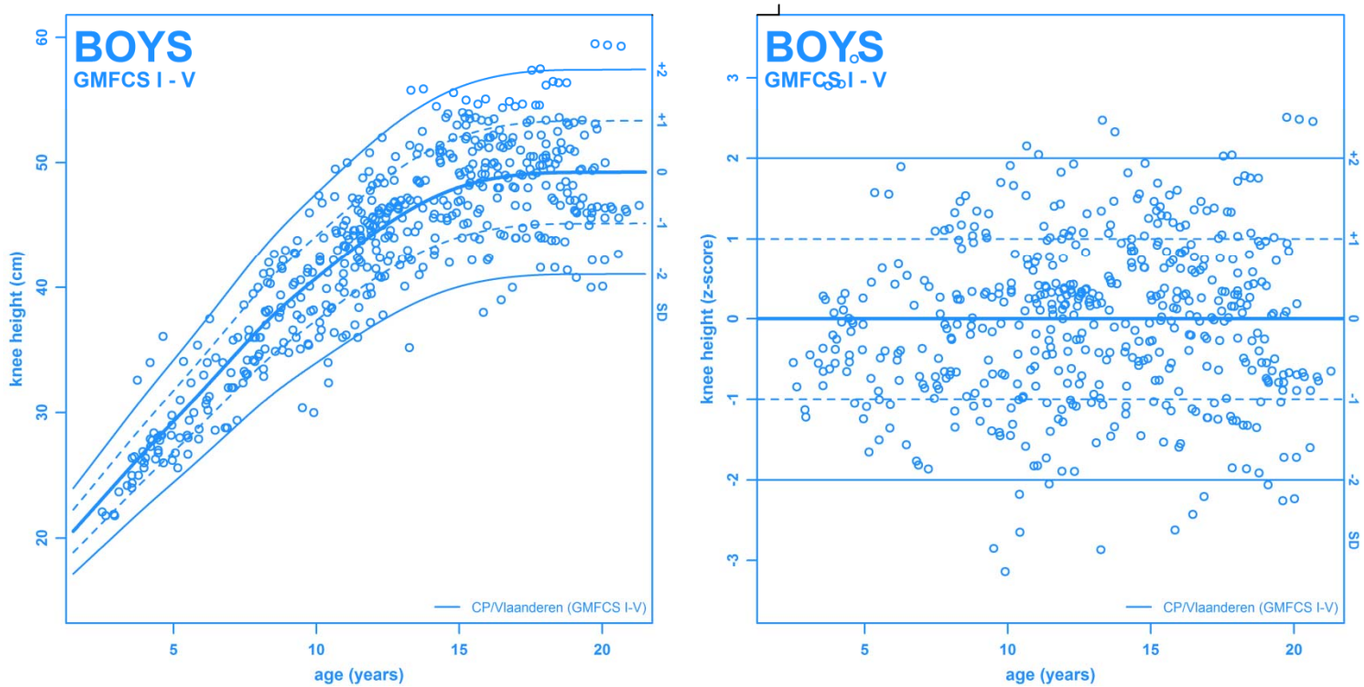
Results (3)

Estimate a single reference curve (LMS)



- L=1; M 4 (b) or 5 (g) edf; S=0.083 (b) or 0.081 (g) [1(!) edf]

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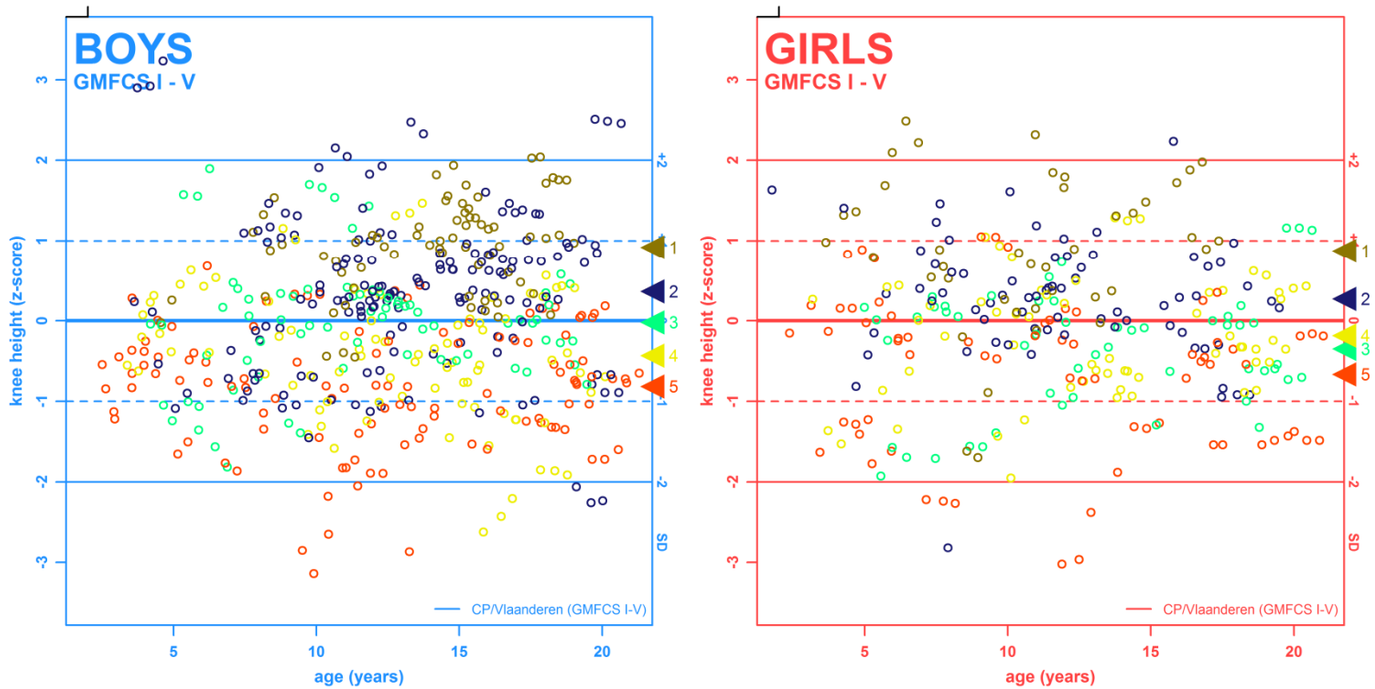
Results (3)

Estimate a single reference curve (LMS)



- Z-scores (model residuals); color coded (GMFCS)
- GMFCS gradient 1 > 2 > 3 > …

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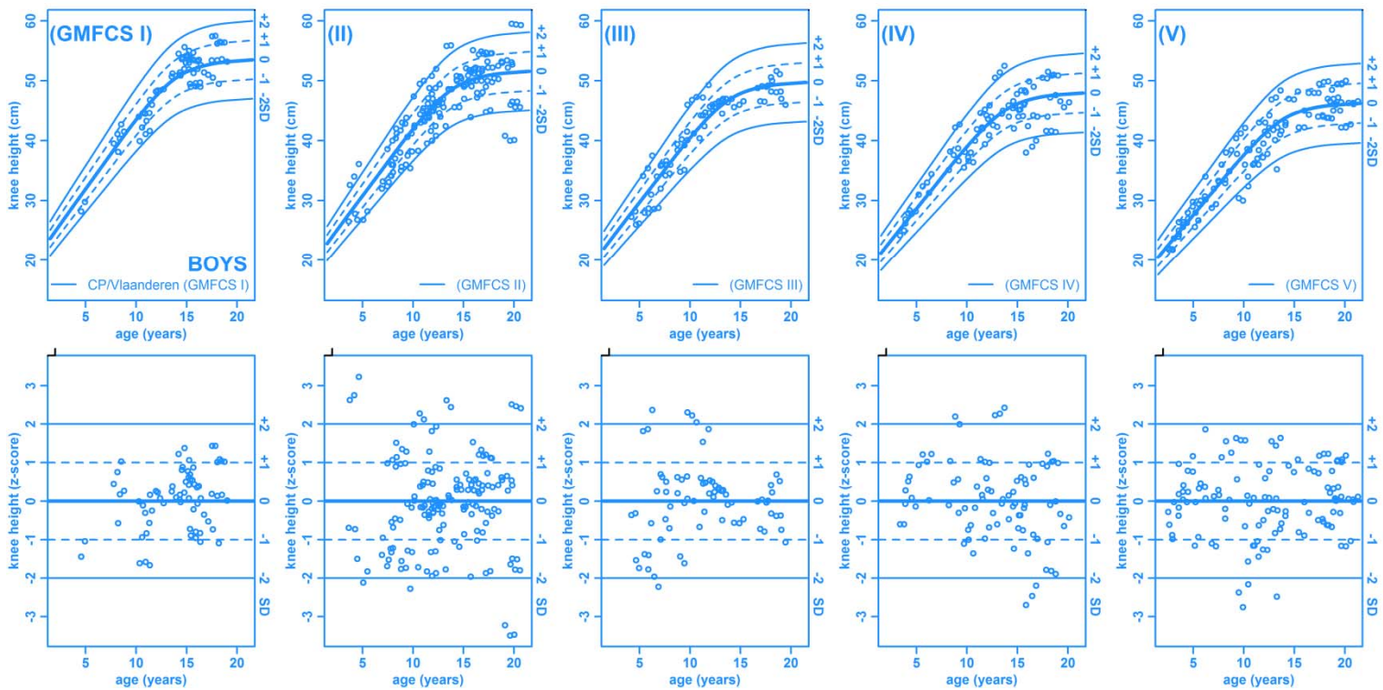
Results (4)

Estimate a GMFCS specific reference curve (GAMLSS)



- GMFCS gradient incorporated in the model
- Lambda = 1 (normal distribution)
- Log(mu) = cs(age, 3 edf) + GMFCS (constant ratio)
- Log (sigma) = GMFCS (constant ratio) ≈ same SD

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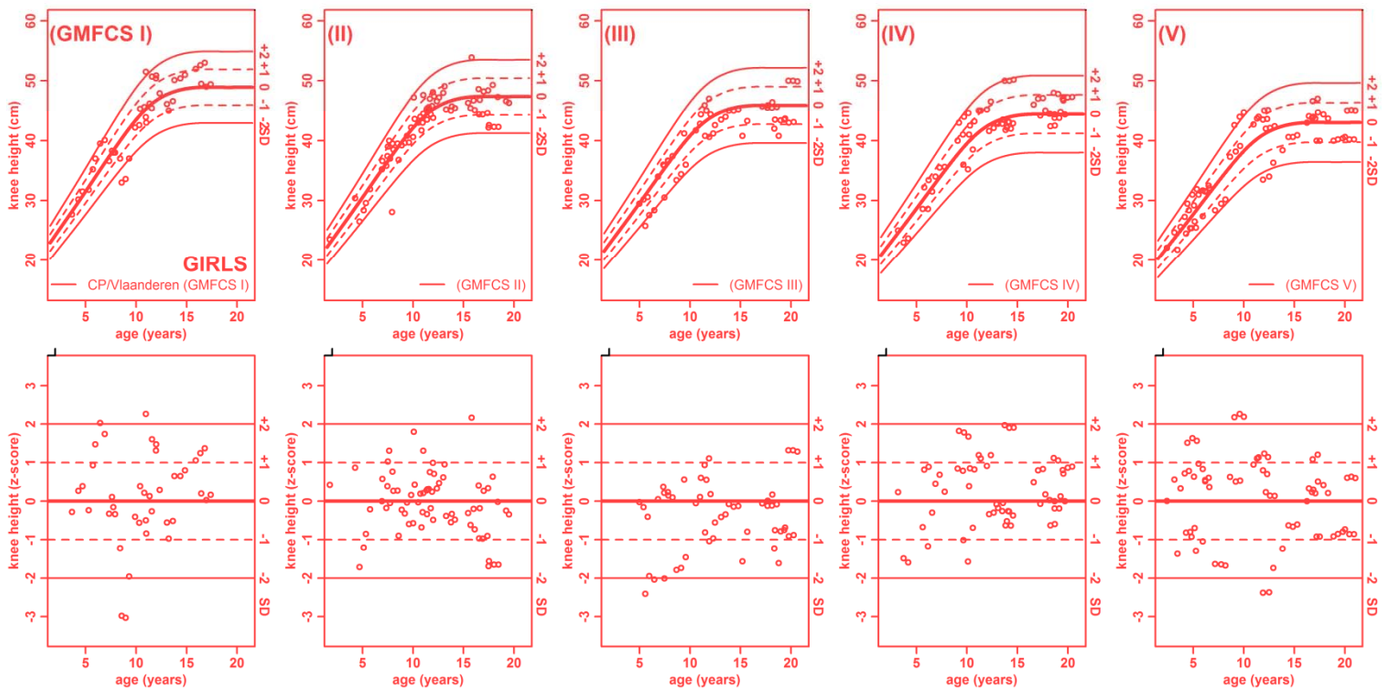
Results (4)

Estimate a GMFCS specific reference curve



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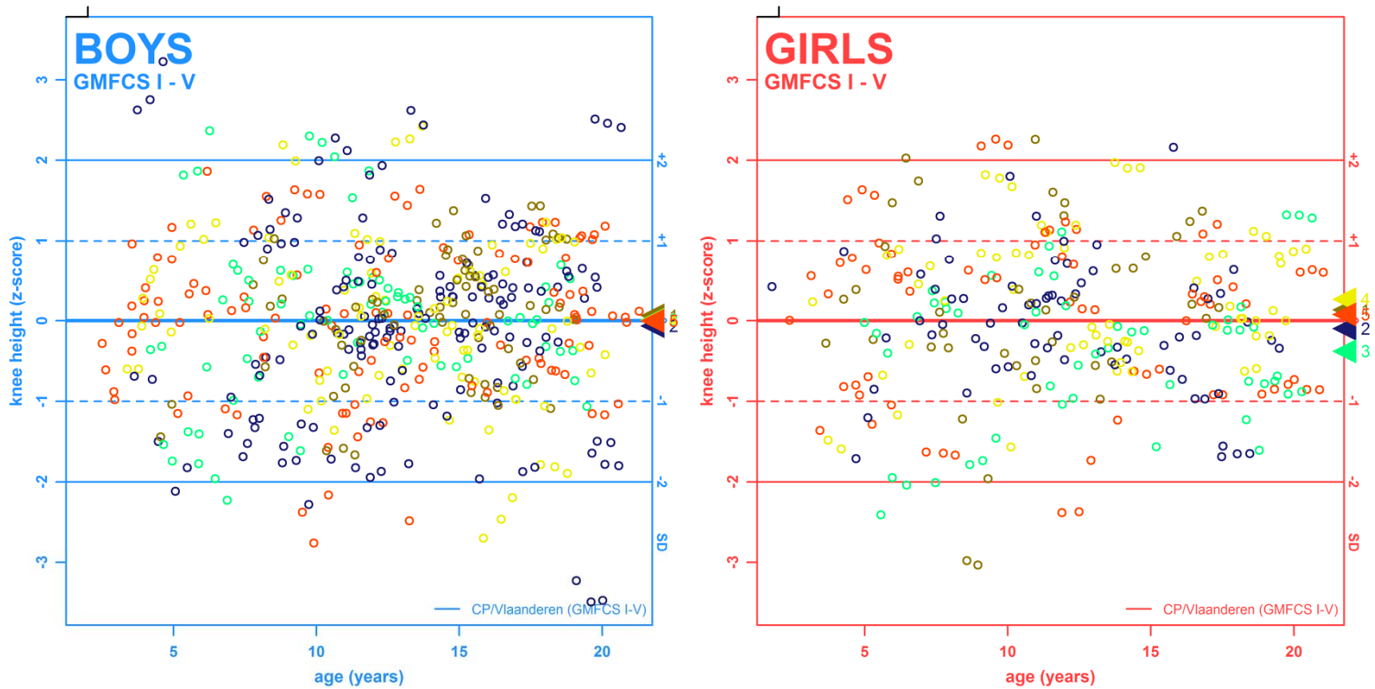
Results (4)

Estimate a GMFCS specific reference curve



- Mission accomplished?

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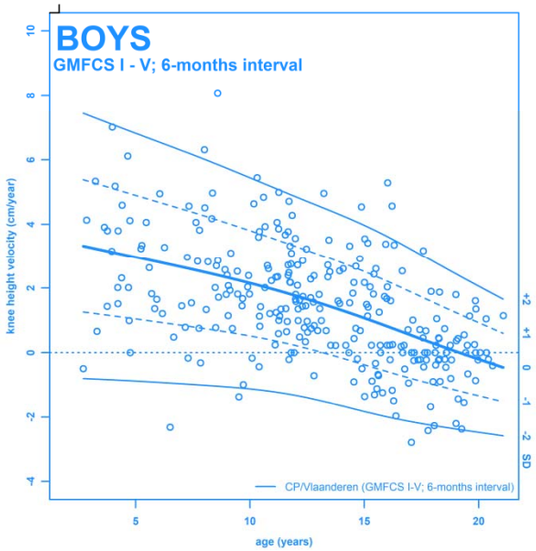
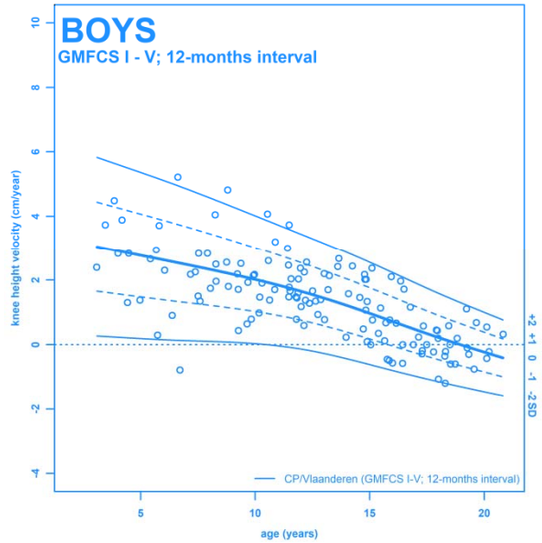
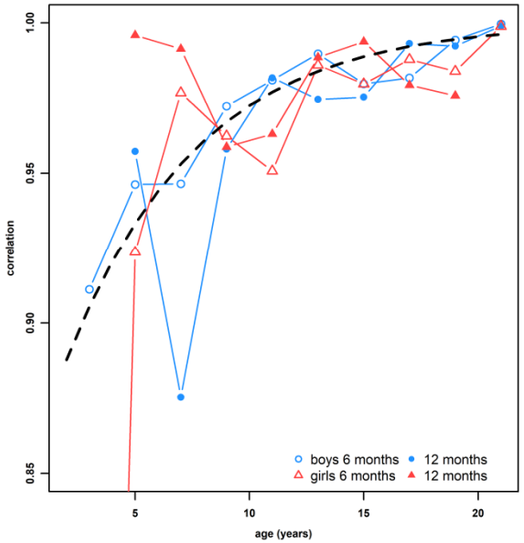
Results (suppl)

Velocity & conditional growth







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Conclusions

- Knee height reference avoids additional prediction error
- Do we need a CP specific reference?
- Should we condition on the GMFCS level?
- → test against clinical outcome! (further research …)

- 10 reference curves based on n = 799 (GAMLSS)
- Parsimonious models (no overfitting, but bias is possible)
- More data needed to model S-curve

- Other parameters, e.g. weight, ‘BMI’, skinfolds, …

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