

# The use of instrumented gait analysis in interdisciplinary interventions for children with cerebral palsy

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# Thesis & papers



- I Rasmussen HM, Nielsen DB, Pedersen NW, Overgaard S, Holsgaard-Larsen A. Gait Deviation Index, Gait Profile Score and Gait Variable Score in children with spastic cerebral palsy: Intra-rater reliability and agreement across two repeated sessions. **Gait & Posture. 2015;42(2):133-7.**
- IIa Rasmussen HM, Pedersen NW, Overgaard S, Hansen LK, Dunkhase-Heinl U, Petkov Y, Engell V, Baker R, and Holsgaard-Larsen A. The use of instrumented gait analysis for individually tailored interdisciplinary interventions in children with cerebral palsy: a randomised controlled trial protocol. **BMC Pediatrics. 2015;15(1):202.**
- IIb Rasmussen HM, Pedersen NW, Overgaard S, Hansen LK, Dunkhase-Heinl U, Petkov Y, Engell V and Holsgaard-Larsen A. The use of instrumented gait analysis for individually tailored interdisciplinary interventions in children with cerebral palsy: a randomised controlled trial. **[Re-submitted to Dev Med Child Neurol, Feb 2018].**
- III Rasmussen HM, Svensson J, Christensen MT, Pedersen NW, Overgaard S, Holsgaard-Larsen A. Threshold values of ankle dorsiflexion and gross motor function in 60 children with cerebral palsy – a cross-sectional study **[Acta Orthop, 2018 Mar 28:1-6 Epub ahead of print].**

# Content

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Introduction

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Results

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# Cerebral palsy

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## Definition

“a group of permanent but not unchanging disorders of movement and/or posture and motor function, which are due to a non-progressive interference, lesion or abnormality of the developing/immature brain.”

Surveillance of cerebral palsy in Europe (2000)

# Cerebral palsy subtypes

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Spastic (66%)

Ataxic (9%)

Dyskinetic (15%)

Unclassified or mixed (10%)

Surveillance of cerebral palsy in Europe (2000)

Rodby-Bousquet & Hägglund (2012)



[www.cpguiden.dk](http://www.cpguiden.dk)

## Spastic CP

- unilateral (44%)

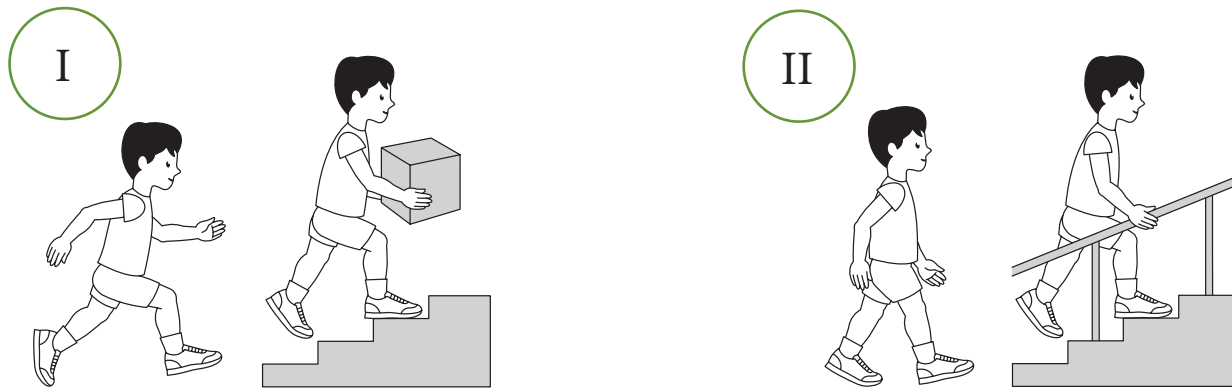
- bilateral (56%)

Surveillance of cerebral palsy in Europe (2000)

Rodby-Bousquet & Hägglund (2012)

# GMFCS

## Gross Motor Function Classification System



60% of children with CP  
Rodby-Bousquet & Hägglund (2012)

Rosenbaum PL et al (2008)  
[www.canchild.ca](http://www.canchild.ca)



# The Danish Cerebral Palsy Follow-up Program (CPOP)

National clinical quality database & Follow-up program

## Standardized examinations

Gross motor function

Muscle tone

**Passive range of motion**

Orthotics and assistive devices



[www.cpguiden.dk](http://www.cpguiden.dk)

Rasmussen et al (2016)

# Passive Range of Motion



Dorsiflexion with extended knee

Alriksson-Schmidt AI et al (2016)



# Passive Range of Motion



Dorsiflexion with extended knee

Alriksson-Schmidt AI et al (2016)

# Interpretation

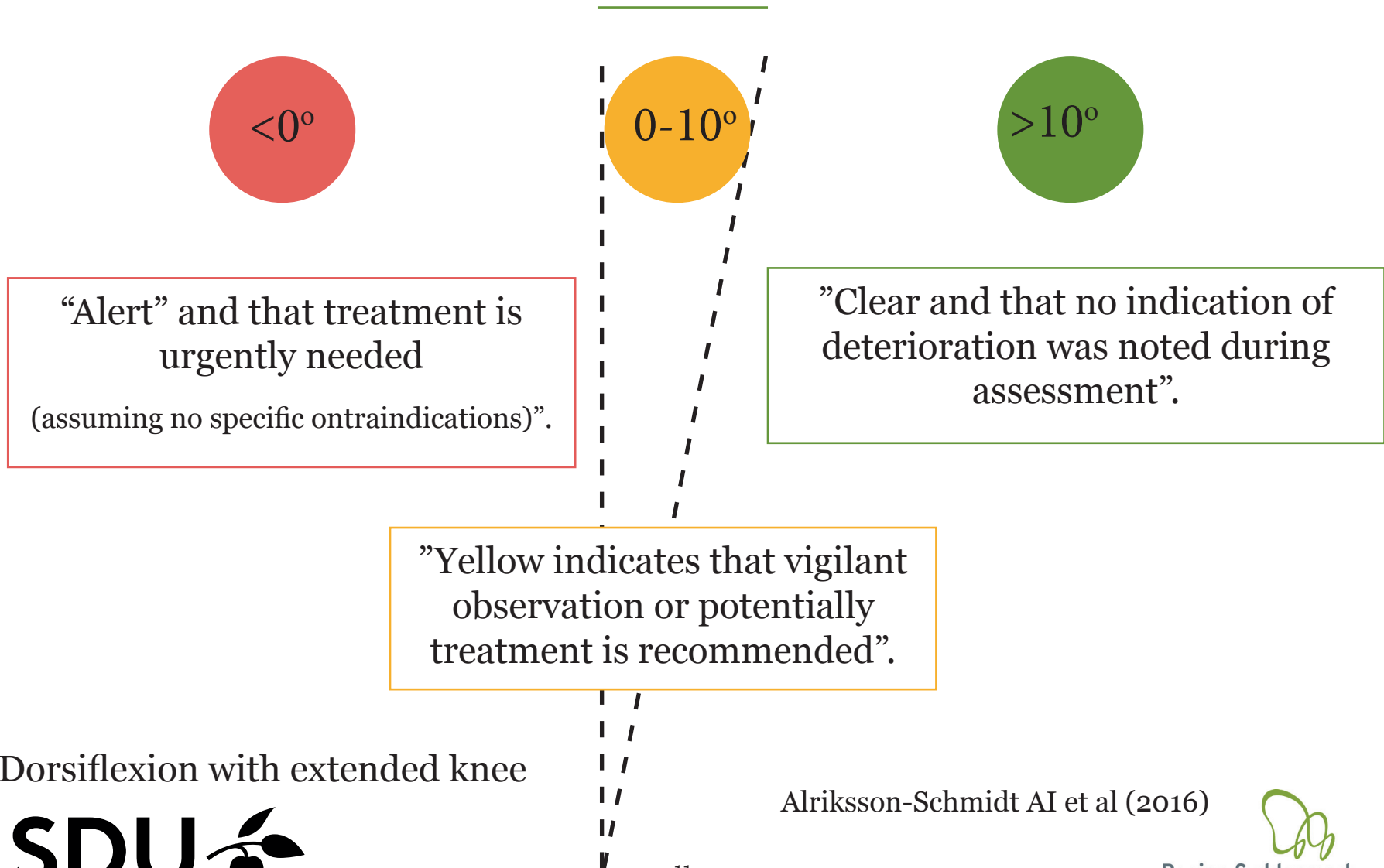
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## Threshold values

”For children on GMFCS levels I to III, the threshold values of passive range of motion are set to ensure that the patient is able to dorsiflex adequately in the stance and swing of walking.”

Cerebral Parese Oppfølgingsprogram (CPOP)  
Alarmverdier for passive bevegeutslag 2014

# CPOP - Traffic light

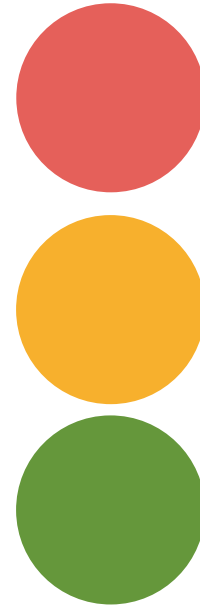


Dorsiflexion with extended knee

# Study aim

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The aim of the study was to investigate the threshold values used by the CPUP by testing the hypothesis that passive range of motion in ankle dorsiflexion is associated with gross motor function and that gross motor function differs between the groups of participants in each category.



# Materials and Methods

RCT (CPinMotion) baseline data  
ClinicalTrials.gov (NCT02160457)

	Reference		Study II-III	
Number, n	<b>15</b>		<b>60</b>	
Age, mean (SD)	<b>6 y 10 m</b>	(1 y 8 m)	<b>6 y 10 m</b>	(1 y 3 m)
Sex, boys/girls, n (%)	<b>7/8</b>	(47/53)	<b>21/39</b>	(35/65)
CP subtype, UL/BL, n (%)		-	<b>43/17</b>	(72/28)
GMFCS I / II, n (%)		-	<b>42/18</b>	(70/30)

Abbreviations: BL: Bilateral spastic cerebral palsy; CP: Cerebral palsy; GMFCS: Gross Motor Function Classification System; SD: Standard deviation; UL: Unilateral spastic cerebral palsy (UL).

# Methods

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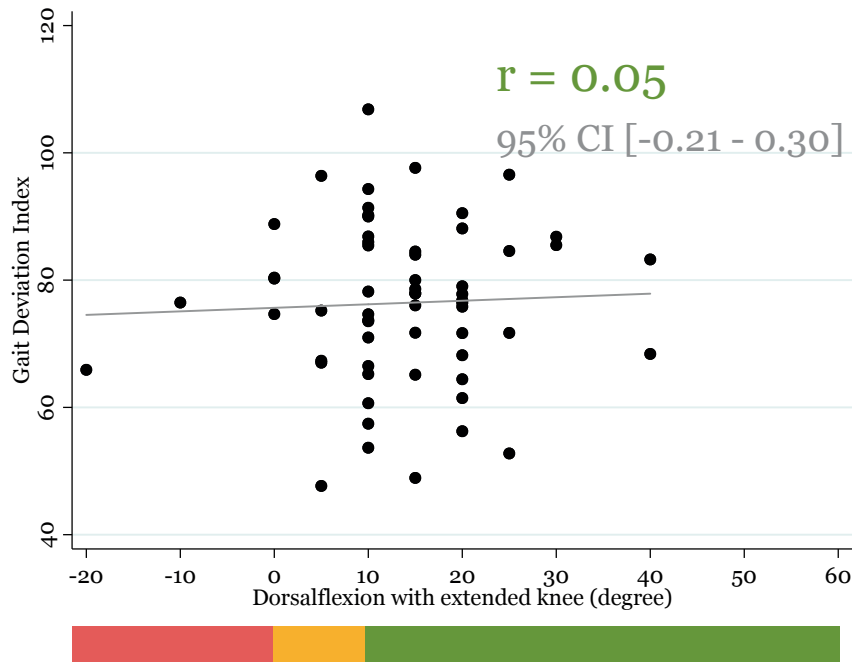
- Passive range of motion
- Overall gross motor capacity
- Ankle-specific gait capacity
- Gross motor skills in everyday life.

Instrumented gait analysis	
Passive range of motion in dorsiflexion	x
Gait Deviation Index	x
Gait Variable Score, ankle	x
Peak dorsiflexion during gait	x
1-minute walk	x
Gross Motor Function Measure (selected items)	x
Patient reported outcome measures	
Pediatric Outcome Data Collection Instrument	x
The Pediatric Quality of Life Inventory Cerebral Palsy Module	x

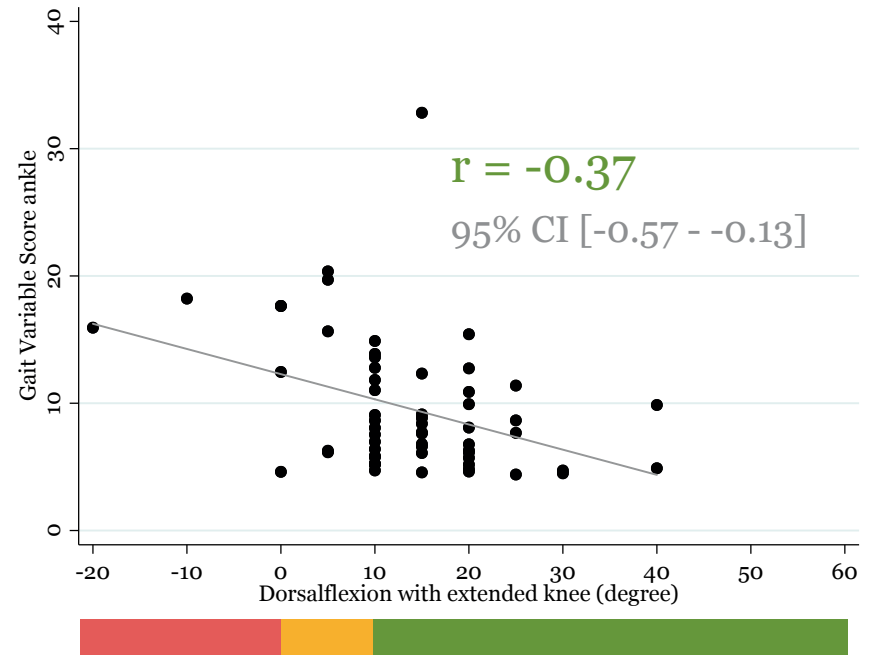
# Results

## Range of Motion i ankle dorsiflexion (Extended knee)

### Gait Deviation Index



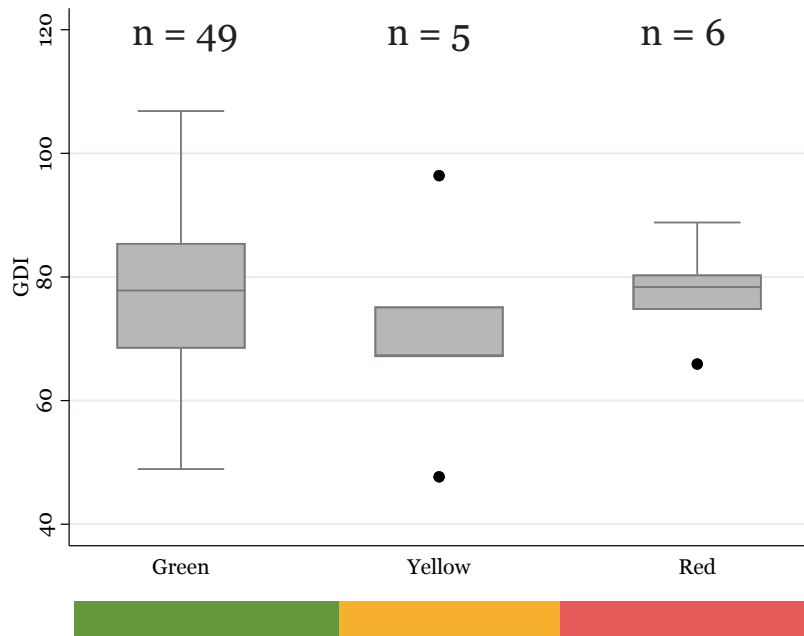
### Gait variable score



# Results

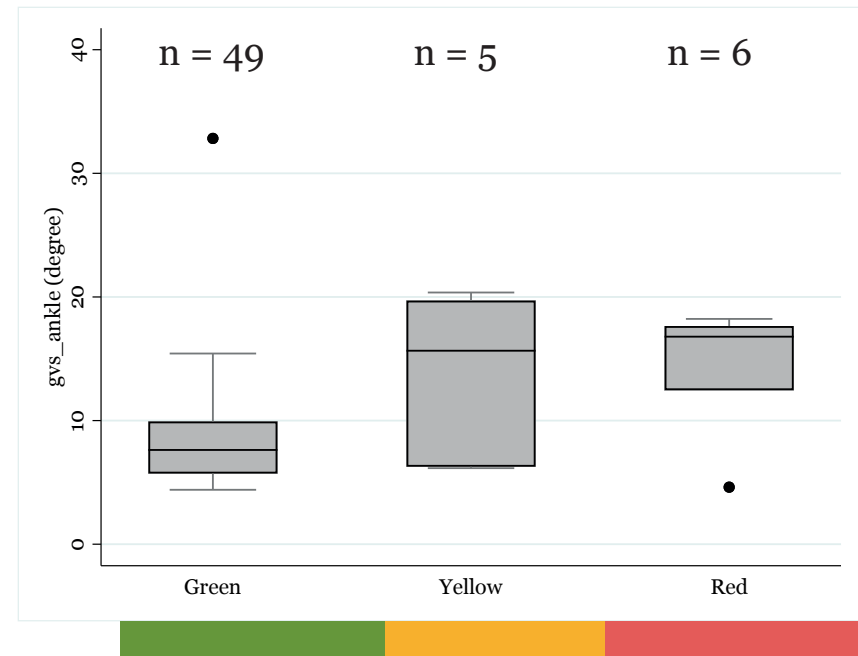
Threshold values - ankle dorsiflexion  
(Extended knee)

## Gait Deviation Index



$p = 0.6$

## Gait variable score



$p = 0.02$



# Results

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Passive Range of Motion in ankle dorsiflexion  
(Extended knee & Flexion knee)

Association and difference between

Gait Variable Score, ankle  
Peak dorsiflexion during gait

NO associatio and NO difference

Gait Deviation Index  
1-minute walk

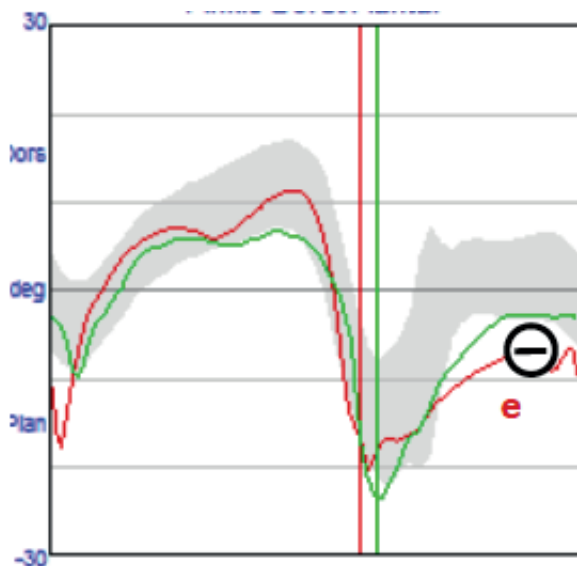
Gross Motor Function Measure (selected items)  
The Pediatric Quality of Life Inventory CP Module  
Pediatric Outcome Data Collection Instrument

# Examples - "traffic light"

High GDI - **red** values

GDI: 88.8

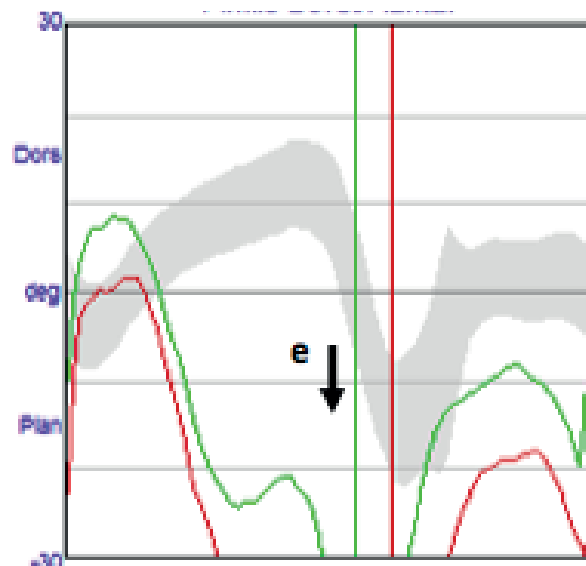
Dorsiflexion:  $5^{\circ}$  /  $0^{\circ}$



Low GDI - **green** values

GDI: 48.9 - GVS:  $33.5^{\circ}$

Dorsiflexion:  $20^{\circ}$  /  $15^{\circ}$



# Study III - Conclusion

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## Study aim

The aim of this study was to investigate the threshold values used by the CPUP by testing the hypothesis that passive range of motion in ankle dorsiflexion is associated with gross motor function and that gross motor function differs between the groups of participants in each category.

## Conclusion

Passive range of motion in ankle dorsiflexion is moderately associated with ankle-specific measures of gross motor function, and the mean scores of the ankle-specific measures were different in the three categorical groups.

In contrast to our hypothesis, we did not find an important relationship between passive range of motion in ankle dorsiflexion or the three related categories and overall measures of gross motor capacity or the use of gross motor skills in everyday life.

# Perspective

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Example:

Hip surveillance and CPUP hip score

- inter- and intra-rater reliability
- odds ratio for hip displacement
- risk score for hip displacement

The screenshot shows a mobile app interface titled "Kalkylator" with a back arrow labeled "Tillbaka". The status bar at the top shows "Sög", signal strength, Wi-Fi, time "16.00", and battery "88 %". The form contains four input fields, each with a green question mark icon to its right:

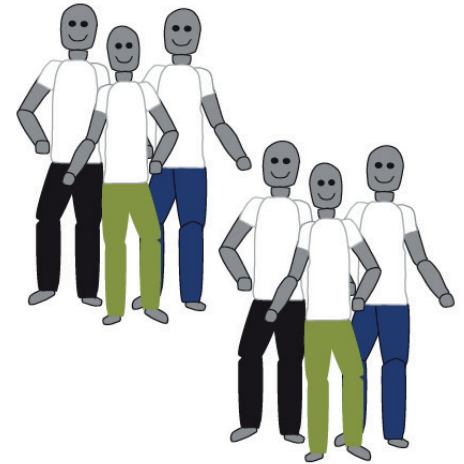
- GMFCS: A row of three buttons labeled "III", "IV", and "V", with "V" selected.
- HSA: A text box containing "180".
- MP: A text box containing "30".
- Ålder: A text box containing "3".

Below the input fields, a horizontal line separates them from the result: "Risk: 80 - 90 %". At the bottom is the CPUP logo, which features a green stylized figure jumping over a bar, with the text "CPUP" in bold black letters below it.

# Thanks!

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Participants and their parents  
The local teams and healthcare professionals  
Research assistants & colleagues



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The Linex Foundation and  
The Danish Physiotherapy Research Fund.

# Physical examination

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	<b>Muscle function</b> <i>Kendall 0-5</i>	<b>Muscle tone</b> <i>Modified Ashworth Tardieu</i>	<b>Range of motion</b> <i>Goniometer</i>	<b>Deformities</b> <i>Goniometer Observation</i>
<b>Hip</b>	Hip flexion Hip extension		Extension Abduction Internal rotation External rotation	
<b>Knee and tibia</b>	Knee extension Knee flexion Quadriceps lag	Hamstring Rectus femoris	Popliteal angle Hamstring shift Knee extension Quadriceps lag Rectus femoris length	Tibial torsion Knee (valgus / varus)
<b>Ankle and feet</b>	Plantar flexion Dorsiflexion Inversion Eversion Confusion test	Plantar flexor	Dorsiflexion (knee 90° and 0°)	Posture of feet