The association between lower leg impairments and RaceRunning performance
Towards a classification system of RaceRunning as a Paralympic event
Nicola Tennant, Physiotherapist RaceRunning Scotland
Sadaf Jahed, MSc Physiotherapy 2015/16, QMU
Martine Verheul, University of Edinburgh
Marietta van der Linden, Queen Margaret University, Edinburgh
The association between lower leg impairments and RaceRunning performance
Towards an evidence based classification system of RaceRunning as a Paralympic event

Marietta van der Linden
Nicola Tennant
Sadaf Jahed
Martine Verheul
What is RaceRunning?

- Light weight ‘trike’ with chest support and without pedals
- Allows athletes with limited or no walking ability to propel themselves independently
- Expected health benefits which the majority would not experience from any other sport: bone health & cardiovascular health
RaceRunning propulsion styles

Because of the design of the running bike and the range of abilities of the athletes, a range of propulsion techniques is used.
RaceRunning propulsion styles

Because of the design of the running bike and the range of abilities of the athletes, a range of propulsion techniques is used.
Current Para-athletics classification for track athletes with hypertonia, ataxia or athetosis

- Ambulant athletes (T35-T38)
- Wheelchair athletes (T31-T34)

RaceRunning as a future para-athletic event?
Evidence based IPC classification

Step 1: Eligible impairment types

Step 2a: Valid measures of impairments

Step 2b: Sports specific measure of performance

Step 3: Association between valid measures of impairment and sports specific measure of performance
## Step2a: Valid measures of impairments

<table>
<thead>
<tr>
<th>ICF ¹</th>
<th>CPISRA RR classification</th>
<th>CP literature²</th>
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</thead>
<tbody>
<tr>
<td>b735 Muscle tone functions</td>
<td>Spasticity: ASAS</td>
<td>MAS, ASAS, instrumented spasticity measures</td>
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<tr>
<td>b760 Control of voluntary movement functions</td>
<td>Ability to control individual joint movements</td>
<td>Selective motor control: SCALE/SMC</td>
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<td>Trunk control</td>
<td>TCMS/TIS</td>
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<tr>
<td>b710 Mobility of joint functions</td>
<td>Range of motion (manual goniometry)</td>
<td>Range of motion (manual goniometry)</td>
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<tr>
<td>b730 Muscle power functions</td>
<td>Propulsion power</td>
<td>MMT &amp; isokinetics</td>
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¹Schiarti et al. (2015) iCF Body structures and Functions for children and youth with CP
Evidence based IPC classification

Step 1: Eligible impairment types

Step 2a: Valid measures of impairments: ASAS/MAS, SCALE, ROM, MMT

Step 2b: Sports specific measure of performance
- Running speed

Step 3: Association between valid measures of impairment and sports specific measure of performance
Sports specific measure

• Maximum Static Step length

Step with right foot
Participating athletes (2016)

- 16 males, 15 females
- Average age: 23(±7), range 14-42
- CP (29) TBI (1), Brain Tumour (1)
- Hypertonia (17), ataxia (3), athetosis (1) mixed (8), NA (2)
- RR1 (11) RR2(12) RR3(8)
- GMFCS II (9), III (9), IV (11), V (2)
- Years RR : 4.3(2.9) years (1.5-11)
RESULTS...

• Lower limb spasticity (ASAS\textsubscript{tot})
• Lower limb spasticity (MA\textsubscript{tot})
• Lower limb Muscle strength (MMT\textsubscript{tot})
• Selective Voluntary Motor Control (SCALE)
• Passive knee extension
• Maximum static step length
Australian Spasticity Assessment Score

Total ASAS score vs. DL speed

- Top 7 & more than 2 yrs RR experience
- $\rho = 0.48$
RESULTS...

- Lower limb spasticity (ASAS\textsuperscript{tot})
- Lower limb spasticity (MA\textsuperscript{Stot})
- Lower limb Muscle strength (MM\textsuperscript{MStot})
- Selective Voluntary Motor Control (SCALE)
- Passive knee extension
- Maximum static step length
Modified Ashworth Scale

![Graph showing the relationship between DL speed and Total MAS score with a rho value of 0.47. The graph includes a line of best fit and data points.

- Top 7 & more than 2 yrs RR experience

 rho=0.47

Queen Margaret University
Centre for Health, Activity and Rehabilitation Research

CPIsRA: Access to Sport

School of the University of Edinburgh]
RESULTS...

- Lower limb spasticity (ASAS\text{tot})
- Lower limb spasticity (MA\text{S}\text{tot})
- Lower limb Muscle strength (MMT\text{tot})
- Selective Voluntary Motor Control (SCALE)
- Passive knee extension
- Maximum static step length
Manual Muscle Test

Top 7 & more than 2 yrs RR experience

rho=0.43

Total MMT score (no impairment = zero)
RESULTS...

• Lower limb spasticity (ASAS\textsubscript{tot})
• Lower limb spasticity (MAStot)
• Lower limb Muscle strength (MMT\textsubscript{tot})
• Selective Voluntary Motor Control (SCALE)
• Passive knee extension
• Maximum static step length
Top 7 & more than 2 yrs RR experience

rho = 0.40

Total SCALE
no impairment of selective motor control = 20
RESULTS...

- Lower limb spasticity (ASAS\textsubscript{Stot})
- Lower limb spasticity (MA\textsubscript{Stot})
- Lower limb Muscle strength (MMT\textsubscript{tot})
- Selective Voluntary Motor Control (SCALE)
- Passive knee extension
- Maximum static step length
Passive knee extension

Top 7 & more than 2 yrs RR experience
RESULTS...

• Lower limb spasticity (ASAS\text{tot})
• Lower limb spasticity (MA\text{Stot})
• Lower limb Muscle strength (MMT\text{tot})
• Selective Voluntary Motor Control (SCALE)
• Passive knee extension
• Maximum static step length
Maximum static step length

- Top 7 & more than 2 yrs RR experience

\[ \rho = 0.48 \]
So what do we know now?

• Spasticity, lack of muscle strength, lack of selective motor control and a knee flexion contracture of $\geq 20^\circ$ are negatively associated with 100 m race speed.

• Experience of the athlete may need to be considered when interpreting results.
• Trunk Control Measurement Scale
• Multi joint co-ordination test
Total score with beta coefficients for SCALE, ASAS & TCMS

- Ataxia, athetosis

- Impairment score (higher score, less impaired)
Ongoing & future research

• Expert consensus (Delphi)
• Performance measures (motion analysis)
• Ratio scale measures
THANK YOU!
Manual Muscle Testing

Divide passive range in three equal sections:
Inner, Mid and Outer range

Daniels and Worthingham Scale

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<tr>
<td>1</td>
<td>Trace</td>
<td>Visible or palpable contraction with no motion</td>
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<tr>
<td>2</td>
<td>Poor</td>
<td>Full ROM gravity eliminated</td>
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<tr>
<td>3</td>
<td>Fair</td>
<td>Full ROM against gravity</td>
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<td>Good</td>
<td>Full ROM against gravity, moderate resistance</td>
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<td>normal</td>
<td>Full ROM against gravity, maximal resistance</td>
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</table>
METHODS:
Selected impairment measures

- Spasticity (MAS, ASAS¹)
  (hip flexors, hip adductors, knee extensors, plantar flexors)
- Muscle strength (MMT)
  (hip extensors, hip abductors, hip flexors, knee extensors)
- Selective voluntary motor control (SCALE²)
- Passive Range of Motion (goniometry)

¹Love et al
²Fowler et al, Balzer et al