Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

Dra. Beatriz Crespo Ruiz, Ph.D

Gil-Agudo A, De los Reyes J, Oliviero A, Mordillo L, Aguado R.

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European Research Group in Disability Sports (ERGids)
01. INTRODUCTION

FATIGUE vs SPINAL CORD INJURY

Hay imposibilidad de conectar con algunas regiones corporales, y se recurre a otras estrategias motoras. Bigland-Ritchie B et al. (1984); Edwards RHT (1986); Mosso A (1904)

The fatigue is a complex physiologic phenomenon which limits the individual's capacity to maintain the physical exercise. Modified from Bigland-Ritchie B et al. (1981); Gandevia SC (2001)
Inside the Spinal Cord is where the output of the brain is ordered to stimulate the muscle with how and when it has to move giving us what we know as a coordinated movement.

Staas WE et al. (1998); Sapru HN (2002); Steeves JD (2007); Alcobendas Maestro M (2010)
01. INTRODUCTION

FATIGUE vs SPINAL CORD INJURY
02. HYPOTHESIS

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

**Hypothesis 1**

In trained people with spinal cord injury (SCI) the behaviour of the mechanisms where fatigue is developed they are unchained in a different way than a controled group (CG) of trained athletes.

**Hypothesis 2**

The people that have SCI that have been trained will get tired a lot later in the proposed exercise than a CG of trained athletes, without the importance of the SCI that they suffer.
To study the behavior of the mechanisms of development of fatigue during manual wheelchair propulsion in athletes with SCI.

To compare the physiological, metabolic and biomechanical aspects

**Study 1: Study of Fatigue during a Short –Term Test**

**Study 2: Study of Fatigue during a Long-Term Test**
04. PARTICIPANTS. INCLUSION CRITERIAS

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

Athletes with Spinal Cord Injury (SCI)

- Athletes with lower than the T6 SCI level.
- Ages from 18 to 45 years old.
- Aerobic training 3-6 h/week.
- Daily life dependent on the use of the wheelchair.
- To have at least 6 months of injury evolution.

Control Group (CG)

- Athletes without sensori-motors alterations.
- Ages from 18 to 45 years old.
- Aerobic training 3-6 h/week

Study 2. Long-Term Fatigue Test

It was established that they had aerobic training at least 6h/week to be equal to the sample of elite athletes with SCI.

04. PARTICIPANTS. EXCLUSION CRITERIAS

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### Study 1 and Study 2

- **Illness or injury** at the moment of doing the test.
- Participants with **cardiovascular disease** or which had suffered **hyperthermia or hypothermia** in the last 48h.
- Those who indicated shoulder pain or history of **trauma the last 4 weeks**.
- Was also excluded any subject who refused to sign the consent form.

### Study 2

- Participants who showed **poor adaptation** to exercise on wheelchair during **Study 1**.
- Those not meeting the inclusion criteria specific to the CG for the realization of Study 2.
### Study 1: Short-term Fatigue Test

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Weight (kg)</th>
<th>Aerobic Training (h/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean SCI ± SD (n=9)</td>
<td>30 ± 8</td>
<td>63 ± 10</td>
<td>8 ± 2</td>
</tr>
<tr>
<td>Mean CG ± SD (n=9)</td>
<td>29 ± 6</td>
<td>77 ± 8</td>
<td>6 ± 2</td>
</tr>
</tbody>
</table>

### Study 2: Long-term Fatigue Test

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Weight (kg)</th>
<th>Aerobic training (h/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean SCI ± SD (n=5)</td>
<td>28,6 ± 2</td>
<td>63,2 ± 12</td>
<td>&gt; 8</td>
</tr>
<tr>
<td>Mean CG ± SD (n=5)</td>
<td>27 ± 4</td>
<td>76,8 ± 7</td>
<td>&gt; 8</td>
</tr>
</tbody>
</table>

Descriptive Statistic (Mean+/− Standard Deviation (SD))
05. INSTRUMENTATION

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

Laboratory Setting. Wheelchair Treadmill.

05. INSTRUMENTATION

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

Crespo-Ruiz B (2008); Solís-Mozos et al. (2009)
06. METHOD

Study 1: Maximal Incremental Aerobic Test
(Short-term Test)

Study 2: Anaerobic Threshold Test
(Long-Term Test) (75 min max)

Study 1: Study of Fatigue during short-term test

Maximal Incremental Aerobic Test

1º Inclination

06. METHOD

AT : 6 km·h⁻¹

Jones A et al. (1996); Cálculo UA: Coyle et al. (1983); Criterios Test Máximo: ACSM (2006)
06. METHOD

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

Anabolic Threshold Test

AT: 6 km · h⁻¹

Fatigue

Billat V et al. (1996) a 1 ° Inclination on a Treadmill
06. METHOD

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion
Cardiorespiratory Parameters

- Oxygen consumption \((\text{VO}_2)\) absolute (l / min) and relative (ml · kg\(^{-1}\) · min\(^{-1}\)).
- CO\(_2\) production \((\text{VCO}_2)\) (l / min).
- Respiratory exchange ratio \((\text{RER} = \text{VCO}_2 / \text{VO}_2)\).
- CO\(_2\) Ventilatory equivalent \((\text{VE/VCO}_2)\).
- Basal heart rate \((\text{Fcbasal})\) (beats / min) and maximum (HR\(_{\text{max}}\)) (beats / min).

Metabolic Parameters

- Blood Lactate \((\text{La})\) (mmol)
- Tympanic Temperature (Temp.) (\(\circ\))
- RPE (6-20)
- % Gross Mechanical Efficiency (GME)
08. RESULTS

Incremental Test

Anaerobic Threshold (AT) Test

Lactate

Results - Fatigue in Wheelchair Athletes

Incremental Test

Anaerobic Threshold (AT) Test
RESULTS – FATIGUE IN WHEELCHAIR ATHLETES

INCREMENTAL TEST

<table>
<thead>
<tr>
<th>Speed (Km · h⁻¹)</th>
<th>VO2 (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
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<td>12</td>
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<tr>
<td>13</td>
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<tr>
<td>MAX</td>
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</tbody>
</table>

Fatigue

AT TEST

<table>
<thead>
<tr>
<th>Duration (min)</th>
<th>VO2 (mL/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>30</td>
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<tr>
<td>45</td>
<td></td>
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<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>75</td>
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</tr>
<tr>
<td>Fatiga</td>
<td></td>
</tr>
</tbody>
</table>
08. RESULTS

INCREMENTS TEST

RER

Duration (min)

VE/VCO2

Duration (min)

AT TEST

Duration (min)

RER

VE/VCO2
Gross Mechanical Efficiency

Borg Scale

% GME

Incremental Test

AT Test

Efficiencia (%)

RPE

Duration (min)

Speed (Km · h⁻¹)

Duration (min)

Speed (Km · h⁻¹)
08. CONCLUSIONS
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1. The SCI athletes show a better physiological adaptation to the high intensity and short duration physical exercise during manual wheelchair propulsion in comparison with the CG.

2. In a long-term duration exercise, the SCI had indicated an increased level of fatigue. This increased fatigue could not be detected through the study of the physiological, metabolic and biomechanical parameters, but it was detected by the perception of the subjective individual effort.
08. CONCLUSIONS

Assessment of Fatigue in Athletes During Manual Wheelchair Propulsion

- There are some other possible factors beyond the metabolic and cardiorrespiratory parameters through which it is triggering fatigue in the SCI group during a long-term test, and it could be related to a central fatigue that comes from their pathology (i.e. pain).

Hence it follows that what triggers fatigue in both groups must be different.
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