Comparison of race parameters in swimmers with visual impairment

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Classification:

3 S, SB, SM classes

• **S11**: No light perception up to light perception but inability to recognise the shape of hand at any distance

• **S12**: Ability to recognize shape of hand up to visual acuity of 2/60 and/or visual field of less than 5 degrees.

• **S13**: Visual acuity above 2/60 up to 6/60 and/or visual field of 5 – 20 degrees.
Introduction

Determined by IPC 2 approved ophthalmologists
# Introduction

- Visual Acuity
- Contrast Sensitivity
- Visual Field
- Peripheral Awareness
- Colour Vision
- Motion Perception

<table>
<thead>
<tr>
<th></th>
<th>VA</th>
<th>VF</th>
<th>MP</th>
<th>PA</th>
<th>CV</th>
<th>CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletics</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Swimming</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Alpine Ski</td>
<td>++</td>
<td>+++</td>
<td>++++</td>
<td>+++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Nordic Ski</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
</tbody>
</table>
Previous studies:

- 2001, Malone: Based on 1996 Paralympics freestyle and backstroke finals
  
  “Performance and competitiveness decrease in all aspects of race with increasing visual impairment.”

- 2009, Daly: Based on 2000 Paralympic freestyle finals
  
  “S11 class swam slowest and was least competitive. Classes S12 and S13 did not differ in this respect.”

Aim of this study:

Compare race parameters between VI classes at 2009 European Championships on 100 freestyle and breaststroke
Race results =
Time (Start + Swimming + Turning + Finish)
Methods

Speed = time over 10m
(reference = head)

Rate = time for 4 arm cycles
(e.g. crawl = right hand – right hand)
Methods

• **Subjects**
  - All visually impaired swimmers at 2009 European Championships in Reykjavík
    - 100 freestyle: 26 male, 23 female
    - 100 breaststroke: 18 male, 13 female

• **Race parameters determined**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Time</td>
<td>Official competition results</td>
</tr>
<tr>
<td>Stroke Rate (= strokes per minute)</td>
<td>60/(time for 4 cycles/4)</td>
</tr>
<tr>
<td>Stroke Length</td>
<td>= speed / (stroke rate/60)</td>
</tr>
<tr>
<td>Clean Swimming Speed</td>
<td>Speed over 10m in middle of pool</td>
</tr>
<tr>
<td>Start Time</td>
<td>0 – 15m</td>
</tr>
<tr>
<td>Turn Time</td>
<td>5m before wall, 10m after wall</td>
</tr>
</tbody>
</table>
## Results

### 100m freestyle men

<table>
<thead>
<tr>
<th></th>
<th>S11 (n=11)</th>
<th>S12 (n=7)</th>
<th>S13 (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start time 15m (s)</td>
<td>7,98 (0,65)</td>
<td>6,61 (0,51)</td>
<td>6,72 (0,48)</td>
</tr>
<tr>
<td>Clean swimming speed (m/s)</td>
<td>1,35 (0,25)</td>
<td>1,63 (0,34)</td>
<td>1,62 (0,31)</td>
</tr>
<tr>
<td>Stroke rate (str/min)</td>
<td>51,3 (2,9)</td>
<td>49,7 (2,1)</td>
<td>49 (4,8)</td>
</tr>
<tr>
<td>Stroke length (m)</td>
<td>1,57 (0,15)</td>
<td>1,97 (0,29)</td>
<td>1,99 (0,21)</td>
</tr>
<tr>
<td>Turn time (s)</td>
<td>9,77 (0,74)</td>
<td>8,04 (0,49)</td>
<td>8,04 (0,44)</td>
</tr>
<tr>
<td>Final time (s)</td>
<td>69,57 (2,91)</td>
<td>57,74 (0,65)</td>
<td>57,74 (0,61)</td>
</tr>
</tbody>
</table>

Significant difference between S11 and S12 + S13 (95% CI)
## Results

### 100m freestyle women

<table>
<thead>
<tr>
<th></th>
<th>S11 (n=7)</th>
<th>S12 (n=12)</th>
<th>S13 (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start time 15m (s)</td>
<td><strong>9,34</strong> (0,81)</td>
<td>6,61 (0,42)</td>
<td>6,72 (0,53)</td>
</tr>
<tr>
<td>Clean swimming speed (m/s)</td>
<td><strong>1,23</strong> (0,22)</td>
<td><strong>1,63</strong> (0,15)</td>
<td><strong>1,62</strong> (0,11)</td>
</tr>
<tr>
<td>Stroke rate (str/min)</td>
<td>50,1 (4,1)</td>
<td>49,7 (5,8)</td>
<td>49 (3,5)</td>
</tr>
<tr>
<td>Stroke length (m)</td>
<td><strong>1,48</strong> (0,19)</td>
<td><strong>1,97</strong> (0,32)</td>
<td><strong>1,99</strong> (0,24)</td>
</tr>
<tr>
<td>Turn time (s)</td>
<td><strong>11,18</strong> (0,41)</td>
<td>8,04 (1,11)</td>
<td>8,04 (0,45)</td>
</tr>
<tr>
<td>Final time (s)</td>
<td><strong>77,2</strong> (2,47)</td>
<td>66,5 (0,66)</td>
<td>66,57 (0,34)</td>
</tr>
</tbody>
</table>

Significant difference between S11 and S12 + S13 (95% CI)
Significant difference between S11 and S12 (95% CI)
## Results

### 100m breaststroke men

<table>
<thead>
<tr>
<th></th>
<th>S11 (n=4)</th>
<th>S12 (n=4)</th>
<th>S13 (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start time 15m (s)</strong></td>
<td>9.17 (0.39)</td>
<td>8.55 (0.54)</td>
<td>8.24 (0.51)</td>
</tr>
<tr>
<td><strong>Clean swimming speed (m/s)</strong></td>
<td>1.15 (0.19)</td>
<td>1.25 (0.21)</td>
<td>1.26 (0.25)</td>
</tr>
<tr>
<td><strong>Stroke rate (str/min)</strong></td>
<td>47.4 (4.8)</td>
<td>46.6 (3.8)</td>
<td>44.4 (2.9)</td>
</tr>
<tr>
<td><strong>Stroke length (m)</strong></td>
<td>1.46 (0.17)</td>
<td>1.61 (0.16)</td>
<td>1.71 (0.09)</td>
</tr>
<tr>
<td><strong>Turn time (s)</strong></td>
<td>11.75 (2.4)</td>
<td>9.68 (1.9)</td>
<td>9.58 (2)</td>
</tr>
<tr>
<td><strong>Final time (s)</strong></td>
<td>81.83 (3.1)</td>
<td>74.04 (3.9)</td>
<td>73.01 (3.4)</td>
</tr>
</tbody>
</table>

**Significant difference between S11 and S12 + S13 (95% CI)**  
**Significant difference between S11 and S13**  
(95% CI)
## Results

### 100m breaststroke women

<table>
<thead>
<tr>
<th></th>
<th>S11 (n=8)</th>
<th>S12 (n=3)</th>
<th>S13 (n=2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start time 15m (s)</td>
<td>10.68 (0.74)</td>
<td>10.23 (0.65)</td>
<td>10.41 (0.55)</td>
</tr>
<tr>
<td>Clean swimming speed (m/s)</td>
<td>1.03 (0.15)</td>
<td>1.12 (0.23)</td>
<td>1.11 (0.14)</td>
</tr>
<tr>
<td>Stroke rate (str/min)</td>
<td>44.2 (5.1)</td>
<td>44.3 (2.9)</td>
<td>45.1 (2.7)</td>
</tr>
<tr>
<td>Stroke length (m)</td>
<td>1.39 (0.24)</td>
<td>1.51 (0.34)</td>
<td>1.47 (0.18)</td>
</tr>
<tr>
<td>Turn time (s)</td>
<td>12.42 (1.5)</td>
<td>11.58 (1.2)</td>
<td>14.97 (2.9)</td>
</tr>
<tr>
<td>Final time (s)</td>
<td>90.86 (8.1)</td>
<td>84.33 (5.1)</td>
<td>88.51 (4.1)</td>
</tr>
</tbody>
</table>

No significant differences (95% CI)
Discussion

• No statistical differences on any parameter in freestyle or breaststroke, men or women between S12 and S13

  the current classification system however assumes decreased performance with decreased visual function

• Differences found between S11 on one hand, and S12/S13 on the other hand in some parameters

  - seeing nothing affects race patterns and outcome
  - seeing only a little bit is enough to swim the race in an optimal manner
• Less or no statistical differences found in breaststroke, especially in women

low number of participants
Future

• From a medical system...

... to an evidence based system

• Philosophy of classification:

  minimizing the impact of impairment on the outcome of competition by classifying impairments by the activity limitations they cause
Medical classification: Spinal Cord Injury

C4 - T1 - T5 - T10 - Below L2
C8 - T5 - T10 - L2

One class for all sports
One impairment type per class
Medical classification

Example competition outcome = performance
e.g. End race time

Normal vision

blind

impairment

Medical classification

AB S13 S12 S11

Normal vision blind impairment
Aspects of visual functioning

THE ORGAN

THE PERSON

Cause → Structure → Function → Abilities → Consequences

Scar
Atrophy
Loss

Acuity
Field
Contrast
...

Dive
Swim straight
Estimate
distance to wall
...

End race result

VISUAL FUNCTIONS
how the EYE functions

FUNCTIONAL VISION
how the PERSON functions

Colenbrander, 2010
Evidence based classification

Major determinant of performance: Ability to estimate distance to wall

Sport-specific classification

e.g. visual acuity

impairment
Thanks to…

• Ásbjörg Gústafsdóttir for doing all the hard work on the race analysis

• Prof. D. Daly, prof. Y. Vanlandewijck and IPC for providing some of the slides

• … and you for your attention