Visual Function of Para Nordic Skiers with Visual Impairment

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Research Goal

- The purpose of this study is to develop new, evidence based classification systems for Alpine and Nordic VI skiers
- Need tests of visual function that accurately reflect skiers’ visual demands
Methods

• Cross-sectional exploratory study
• Para Alpine skiers
  • IPCAS Landgraaf Competition, Landgraaf, Netherlands, November 2015
• Para Nordic skiers
  • International Para Nordic World Cup, Finsterau, Germany, February 2016
• Comparison of skiers’ performance with visual function
Visual Function Measures

- **Static visual acuity**
  - ETDRS, Berkeley Rudimentary Vision Test
- **Dynamic visual acuity and Low contrast visual acuity**
  - mov&, V&mp Vision Suite
- **Contrast sensitivity**
  - 2015/16: Pelli-Robson
- **Colour Vision**
  - Large D-15
- **Glare Sensitivity and Glare Recovery**
  - Mars chart and transilluminator
## Participants

<table>
<thead>
<tr>
<th>Visual Function Tests</th>
<th>n</th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static Visual Acuity (logMAR)</td>
<td>55</td>
<td>1.54 ± 0.72</td>
<td>0.14 – 3.50</td>
</tr>
<tr>
<td>Contrast Sensitivity (logCS)</td>
<td>50</td>
<td>0.64 ± 0.50</td>
<td>0.00 – 1.55</td>
</tr>
<tr>
<td>Dynamic Visual Acuity (logMAR)</td>
<td>51</td>
<td>1.92 ± 0.57</td>
<td>0.48 – 2.72</td>
</tr>
<tr>
<td>Low Contrast Visual Acuity (logMAR)</td>
<td>48</td>
<td>1.77 ± 0.66</td>
<td>0.38 – 2.70</td>
</tr>
<tr>
<td>Glare Sensitivity (change in logCS)</td>
<td>48</td>
<td>0.12 ± 0.19</td>
<td>-0.36 – 0.72</td>
</tr>
<tr>
<td>Glare Recovery (change in logCS)</td>
<td>47</td>
<td>-0.04 ± 0.15</td>
<td>-0.44 – 0.24</td>
</tr>
<tr>
<td>Colour Vision</td>
<td>53</td>
<td>33 with defect</td>
<td>20 without defect</td>
</tr>
</tbody>
</table>
Significant Correlations

Visual Acuity ———————————— Low Contrast

Visual Acuity

Dynamic Visual Acuity ———————————— Contrast Sensitivity

Glare Sensitivity ———————————— Glare Recovery
Performance Measure

• IPC Alpine Skiing Points and IPC Nordic Skiing Points
  • Points given for finishing a race
  • First place competitor: 0 points
    • Other competitors assigned points based on time difference in relation to first place
    • Points = penalty
  • IPCAS/IPCNS points averaged over a season
Visual Acuity vs. Performance

Performance Points vs. Visual Acuity (logMAR)

- Nordic
- Alpine
- Linear (Nordic)
- Linear (Alpine)

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Contrast Sensitivity vs. Performance

- Nordic
- Alpine
- Linear (Nordic)
- Linear (Alpine)

Performance Points vs. Contrast Sensitivity (logCS)
Dynamic Visual Acuity vs. Performance

Performance Points vs. Dynamic Visual Acuity (logMAR)

- Nordic
- Alpine
- Linear (Nordic)
- Linear (Alpine)

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Low Contrast Visual Acuity vs. Performance

Performance Points vs. Low Contrast Visual Acuity (logMAR)

- Nordic
- Alpine
- Linear (Nordic)
- Linear (Alpine)
Glare Sensitivity vs. Performance

Performance Points vs. Glare Sensitivity (change in logCS from baseline)

- Nordic
- Alpine
- Linear (Nordic)
- Linear (Alpine)

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Glare Recovery vs. Performance

Performance Points vs. Glare Recovery (change in logCS from baseline)

- **Nordic**
- **Alpine**
- **Linear (Nordic)**
- **Linear (Alpine)**

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Colour Vision vs. Performance

Performance Points vs. Colour Vision (no. crossings)

Nordic
Alpine
Linear (Nordic)
Linear (Alpine)

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Summary

• A wide range of visual function was measurable
  • Measures of visual acuity were well correlated
  • Contrast sensitivity was correlated with visual acuity
  • Glare sensitivity and glare recovery were well correlated

• Some tests did not work well in this population
  • Pelli-Robson contrast sensitivity
  • Monocular glare testing

• Poor correlations between individual factors and skiing performance

• No single factor predicts Nordic skiing performance
  • Visual Acuity appears to be predictive of Alpine skiing performance
Performance Measure

• International Paralympic Committee Nordic Skiing Points
  • Single race points
    • Athlete A race points
      \[ = \left( \frac{\text{time}_{\text{athlete A}}}{\text{time}_{\text{first place}}} \right) \times \text{race factor} \]
  • International Ranking
    • 5 best race points averaged over two seasons
  • Normalization of race conditions, race distances, gender
Classification Criteria

- Classification category is determined by visual acuity of visual field of the better eye only
- B1: VA worse than 2.6 logMAR
- B2: VA between 1.5 and 2.6 logMAR or VF radius less than 5 degrees
- B3: VA between 1.0 and 1.4 logMAR or VF radius less than 20 degrees
Static Visual Acuity
Dynamic Visual Acuity and Low Contrast Visual Acuity
Contrast Sensitivity and Glare (Sensitivity and Recovery)
Figure 3: Visual Acuity and Dynamic Visual

$r_s = 0.773$, $p<0.01$
Figure 5: Visual Acuity and Low Contrast Visual Acuity

$\text{LCVA (logMAR)}$

$\text{VA (logMAR)}$

$r_s = 0.863, p < 0.01$
Figure 7: Dynamic Visual Acuity and Low Contrast Visual Acuity

$r_s = 0.899, \ p<0.01$
Figure 2: Visual Acuity and Contrast Sensitivity

$r_s = -0.749, p<0.01$
Visual Acuity and Contrast Sensitivity
Figure 6: Dynamic Visual Acuity and Contrast Sensitivity

\[ r_s = -0.565, \quad p<0.01 \]
Figure 4: Low Contrast Visual Acuity and Contrast Sensitivity

$\rho_s = -0.641, p<0.01$
Glare Recovery (change in logCS)

Glare Sensitivity (change in logCS)

Figure 1: Glare Sensitivity and Glare Recovery

$r_s = -0.477, p < 0.01$