Exploration of the Minimum Visual Impairment Criteria for Para Alpine Skiing using Simulated Vision Impairments

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INTRODUCTION

- Classification
  - 1) Minimum impairment criteria
  - 2) Sport classes for competition
  - Evidence-based and sport-specific

- The purpose of this project was to investigate the minimum vision impairment criteria for Para Alpine Skiing

1. IPC Athlete Classification Code: Rules, Policies and Procedures for Athlete Classification, July 2015
METHODS

- Within-subjects repeated measures study design
  - Experienced skiers with normal sight were asked to ski with simulated vision impairments
  - Visual Acuity + Contrast Sensitivity Impairments
    - Cambridge Sim Specs
  - Visual Field Impairments
    - Bespoke goggles
  - Visit 1: Visual function assessment + skiing experience questionnaire
    - Static Visual Acuity, Contrast Sensitivity, Visual Field Extent
      - Habitual vision and simulated impairments
  - Visit 2: On snow assessment
    - National Sports Center for the Disabled, Winter Park, USA
VISIT 1

- Visual Acuity
  - ETDRS and BRVT charts (logMAR)
  - 0.1 logMAR to 1.6 logMAR
- Contrast Sensitivity
  - MARS charts (logCS)
  - 1.7 logCS to 0.1 logCS
- Visual Fields
  - Arc Perimetry with an Esterman Scoring Grid
  - 85% to 20% visual field extent
VISIT 2

- 20 skiing trials total
  - 2 x 10 gate GS courses; 10 trials per course
    - Goal: maintain consistent 70 to 80% pace across trials
  - First and last trials on each course were always with clear goggles
    - 4 trials total; minimum 2 clear trials per course
  - Middle 16 trials total (8 per course) included:
    - 2 clear goggle trials
    - 8 visual acuity + contrast sensitivity impairments
    - 6 visual field binocular visual field impairments
      - All randomly assigned across both courses
STATISTICAL ANALYSIS

- Shapiro Wilk test, Q-Q plots to check normality
- Friedman’s 2-way Analysis of Variance (p<0.05) with Dunn post-hoc test
  - Fatigue effects, order effects, simulated impairment effects
    - Dependent variable: Time to complete each run compared to baseline (per course)
- Receiver operator analysis (ROC) was used to identify optimal impairment level
  - Youden’s J: maximum sensitivity and specificity overall (optimum criteria)
    - Sensitivity: correctly identify skiers with vision impairments
    - Specificity: correctly identify skiers without vision impairments
POPULATION

- 11 male sighted, experienced Alpine skiers
  - Age: $37.91 \pm 18.9$ years (17 to 64 years)
  - Years of Experience: $29.91 \pm 14.88$ years (15 to 58 years)
  - Skiing Hours per Week: $22.45 \pm 13.62$ hours (6 to 42.5 hours)
  - Ski club racers (n=5), Masters ski racers (n=3), coaches (n=3)
No difference in race time was found across the clear goggle trials on either course

- Skiers could maintain a consistent race pace
- Average race time of clear goggle trials = BASELINE
  - Calculated for each course
- All simulated impairment trials compared to baseline time (per course)
There was a significant order effect found on Course 2 only

- Fifth and ninth runs on course 2 were significantly slower than other trials ($p<0.01$)
  - Proportion of severe impairments was much higher on these two runs (64% vs. ≤46%)
Skiing performance decreased gradually with increasing impairment

- Significant decrease in performance (p<0.05) from Level 5
  - VA: 1.20 logMAR
  - CS: 0.60 logCS
VISUAL ACUITY

- Max Youden’s J = \textit{0.81} at \textit{0.59 logMAR}
  - Sensitivity = 0.93, Specificity = 0.88
- Youden’s J = \textit{0.70} @ B3 (1.0 logMAR)
  - Sensitivity = 0.73, Specificity = 0.98
CONTRAST SENSITIVITY

- Max Youden’s $J = 0.78$ at $1.14 \log CS$
  - Sensitivity: $0.81$, Specificity: $0.74$
- Skiing performance decreased gradually increasing impairment
  - Significant decrease in performance (p<0.05) from Level 5
    - VF: 30.8% extent
**VISUAL FIELD**

- Max Youden’s J = **0.59** at **54.2%** extent
  - Sensitivity: 0.88, Specificity: 0.71
- Youden’s J = **0.22** at B3 (21.7% extent)
  - Sensitivity: 0.29, Specificity: 0.93
Mild reductions in visual acuity, and moderate reductions in contrast sensitivity and visual field appear to affect skiing performance

- Visual Acuity: 0.6 logMAR
- Contrast Sensitivity: 1.1 logCS
- Visual Field: 54% extent

The results of this study will help to inform the minimum visual impairment criteria for Para Alpine Skiing.
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