Validation of a class allocation method for wheelchair track athletes with impaired strength – a proof of concept study

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Photo by Simon Bruty
EVIDENCE-BASED DECISION MAKING

- Similarities with evidence-based medicine?
- Central tenets?
- How should we proceed?

DECISION-MAKING IN THE CURRENT SYSTEM
BASED ON CLINICAL REASONING
SCIENTIFIC BASIS?
Performance EVIDENCE-BASED SYSTEM – TRANSPARENT, VALIDATED DECISIONS
## IDENTIFICATION OF IMPAIRMENT TESTS

<table>
<thead>
<tr>
<th>Isometric strength measure</th>
<th>Performance Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top-Speed (0-15m) correlation</td>
</tr>
<tr>
<td>Strongest Forearm Pronation</td>
<td>0.70*</td>
</tr>
<tr>
<td>Weakest Forearm Pronation</td>
<td>0.70*</td>
</tr>
<tr>
<td>Strongest Arm Extension</td>
<td>0.83*</td>
</tr>
<tr>
<td>Weakest Arm Extension</td>
<td>0.81*</td>
</tr>
<tr>
<td>Isolated Trunk</td>
<td>0.54*</td>
</tr>
<tr>
<td>Arm+Trunk</td>
<td>0.73*</td>
</tr>
</tbody>
</table>

- 32 International-level wheelchair track racers
- Classes T54-T51
- Six isometric strength tests

IDENTIFICATION OF A CLASS STRUCTURE

- 4 clusters
- Differences found in the 6 strength tests and 2 performance-related outcomes
AIM

To evaluate the validity of statistical recommender systems for allocating class in wheelchair track racing athletes.
METHODS

Original Data

Sampling \( n = 1200 \) (Gaussian Copula)

Cluster analysis \((k = 4)\)

Evaluate recommender systems (10-fold cross validation)

- K-nearest neighbour
- Discriminant analysis
- Artificial Neural Network
- Naive Bayes
- Classification Decision Tree

Recommender system

Final Prediction
**RESULTS**

<table>
<thead>
<tr>
<th>Classification method</th>
<th>Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>k-nearest neighbour</td>
<td>4.0 ± 0.5</td>
</tr>
<tr>
<td>discriminant analysis</td>
<td>4.0 ± 0.5</td>
</tr>
<tr>
<td>artificial neural network</td>
<td>4.0 ± 0.5</td>
</tr>
<tr>
<td>classification tree</td>
<td>14.0 ± 2.0</td>
</tr>
<tr>
<td>naïve bayes</td>
<td>8.0 ± 2.0</td>
</tr>
</tbody>
</table>
METHOD

Original Data

Sampling \( n = 1200 \) (Gaussian Copula)

Cluster analysis (\( k = 4 \))

Evaluate recommender systems

Recommender 1

Recommender 2

Recommender 3

Majority vote

Final predictions

Final Prediction
RESULTS

<table>
<thead>
<tr>
<th>Classification method</th>
<th>Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>k-nearest neighbour</td>
<td>4.5 ± 0.2</td>
</tr>
<tr>
<td>discriminant analysis</td>
<td>3.8 ± 0.3</td>
</tr>
<tr>
<td>artificial neural network</td>
<td>3.2 ± 0.1</td>
</tr>
<tr>
<td>ensemble</td>
<td>2.0 ± 0.1</td>
</tr>
</tbody>
</table>
DISCUSSION

• In this population, statistical recommender systems provide valid tools that classifiers can use to allocate class.

• However, this was proof-of-concept and philosophical discussions are needed
  – Potential translation of these methods

• Precise parameters must be calculated in a large-scale study (i.e. test close to 100% of the population)

• Influence of training and intentional misrepresentation

• Remember, retain expert opinion and athlete context
THANK YOU

Acknowledgments:

• International Paralympic Committee
• The Zayhed Higher Organisation for Humanitarian Care and Special Needs
• Ergotest
• The athletes

• Sean Tweedy, Mark Connick and Emma Beckman are members of the IPC Classification Research and Development Centre (Physical Impairments), which is supported by the International Paralympic Committee.