Background: Gait deficits are common in Multiple Sclerosis (MS) but poorly captured by stopwatch-timed tests or rating scales. Body-worn inertial sensors can detect precise gait abnormalities in people with MS who have normal walking speed but the most discriminative measures of gait for MS are unknown.

Aim: This study aimed to determine the best combination of gait measures to discriminate MS from healthy control (HC) subjects.

Methods

Protocol

- Participants wore 6 inertial sensors (2 feet, 2 wrists, 1 sternum and 1 lumbar; Opal by APDM Wearable Technologies, a Clario company)
- 6 min-walk test: Participants were instructed to walk at a comfortable and natural pace back and forth continuously over two lines of tape placed 30 meters apart (Study I) and 15 meters apart (Study II).

Development dataset [Study I: Walkway length=30 meters] (MS=14 and HC=17)

Test dataset [Study II: Walkway length=15 meters] (MS=9 and HC=7)

Six precise gait measures, captured with body-worn inertial sensors during a 6-minute walk test, discriminate Multiple Sclerosis from healthy controls while gait speed does not.

Digital Measures from 6-minute Walk Test

<table>
<thead>
<tr>
<th>Lower Body</th>
<th>Transverse Range of Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait Speed</td>
<td>Sagittal Range of Motion</td>
</tr>
<tr>
<td>Step Length</td>
<td>Coronal Range of Motion</td>
</tr>
<tr>
<td>Step Duration</td>
<td>Turn Angle</td>
</tr>
<tr>
<td>Double Support</td>
<td>Turn Duration</td>
</tr>
<tr>
<td>% Swing of Gait Cycle</td>
<td>Turn Rate Average</td>
</tr>
<tr>
<td>Step Height</td>
<td>Number of Steps in Turn</td>
</tr>
<tr>
<td>Pitch at Toe OFF</td>
<td>Turn Jerk</td>
</tr>
<tr>
<td>Pitch at Initial Contact</td>
<td>Medio-lateral Turn Range</td>
</tr>
</tbody>
</table>

Result

Feature Selection Method

- Least Absolute Shrinkage and Selection Operator (LASSO)
- 5-fold, cross-validated LASSO
- Selected features are used to train 70% of the dataset of Study I using logistic regression

Conclusions

- From 36 gait measures, LASSO selected 6 measures from the training dataset:
  1. Stride time
  2. Variability of double support time
  3. Turn duration
  4. Total number of steps in a turn
  5. Elevation at mid-swing
  6. Toe-out angle standard deviation

- Logistic regression trained with the 6 gait measures on 70% of Study I resulted in AUC=1 (sensitivity=1 and specificity=1) when applied on the validation dataset (30% of Study I)

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Conflict of Interest

Drs. Shah, and Horak are employees of APDM Wearable Technologies, a Clario company that may have a commercial interest in the results of this research and technology. This potential conflict of interest has been reviewed and managed by OHSU.