Visual Acuity, Balance Control, and Walking Automaticity in Older Women

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Introduction

• Gait changes in older adults are associated with falls, functional disability and death (Guralnik et al., 1994).

• Gait variability

  • not well studied with inconsistent findings

    – Step length and stride time are more variable in fallers than non-fallers (Hausdorff et al., 1997, Maki et al. 1997).

    – Individuals who had reported a fall in the past year did not differ on any of the measures of gait variability when compared to individuals who had not reported a fall (Brach et al., 2005).
Introduction

• Vision and fall risk inconsistencies
  
  • Poor vision reduces postural stability and significantly increases the risk of falls and fractures in older people (Klein et al., 2003).
  
  • Subjects with good vision in both eyes had the lowest rate of falls, whereas subjects moderate or poor vision had elevated falling rates. (Ivers et al., 1998)
  
  • Visual acuity and contrast sensitivity were not associated with body sway when subjects were standing on a firm base (Lord et al., 1991).
Background

- **Components of Gait** (Gabell et al., 1984)
  - Walking Automaticity
    - Stride Time
    - Step Length
  - Balance Control
    - Double-Support Time
    - Step Width
- **Vision and Balance**
Purpose

To determine the extent to which visual acuity influences balance control and walking automaticity in older adult women

Hypothesis

A decrease in visual acuity increases the variability of gait characteristics associated with walking automaticity and balance control
Measures

Snellen Eye Chart Visual Acuity

**Step Length**
- The distance from heel strike of one foot to the following heel strike of the opposite foot measured in centimeters.

**Stride Time**
- The time elapsed between the heel strikes of two consecutive footfalls of the same foot measured in seconds.

**Step Width**
- The perpendicular distance from heel strike of one footfall to the line of progression of the opposite foot measured in centimeters.

**Double-Support Time**
- The time during which both feet are in contact with the ground measured in seconds.
Methodology

• Study:
  • Visual Acuity Test ➔ Habituation ➔ Treadmill Walking
    – Women ages 65-80 yr (n = 16)
    – High visual acuity (VA) (n = 10) and low VA (n = 6) groups

• RAPA (0-10) and SPPB (0-12) performance
  – Physical activity and mobility evaluation

• Visual acuity exam
  – Snellen measurements converted to Minimum Angle of Resolution (logMAR) for analysis
  – Divided into high and low visual acuity groups using the median 0.48 logMAR ≈ 20/70
Methodology

• Instrumented treadmill walking at 50 m\(\cdot\)min\(^{-1}\) recording ground reaction force and center of pressure using Kistler Gaitway software
  – Step length, step width, stride time, and double-support time were determined

• Standard Deviation of parameters over 10 subsequent strides were calculated
Data Analysis

• Independent T-Tests were used to analyze all gait characteristic means and standard deviations between the high visual acuity and low visual acuity groups.
<table>
<thead>
<tr>
<th></th>
<th>High VA n=10</th>
<th>Low VA n=6</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>72.6 ± 4.2</td>
<td>69.5 ± 3.9</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>63.4 ± 11.2</td>
<td>66.8 ± 7.7</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161.1 ± 6.5</td>
<td>159.7 ± 3.9</td>
</tr>
<tr>
<td>Body Mass Index (kg·m⁻²)</td>
<td>24.5 ± 4.4</td>
<td>26.2 ± 2.6</td>
</tr>
<tr>
<td>Short Physical Performance</td>
<td>11.3 ± 0.9</td>
<td>10.8 ± 1.2</td>
</tr>
<tr>
<td>Battery Score</td>
<td></td>
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<tr>
<td>Rapid Assessment of Physical</td>
<td>7.4 ± 2.6</td>
<td>6.7 ± 1.6</td>
</tr>
<tr>
<td>Activity Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Acuity (logMAR)</td>
<td>0.252 ± 0.122</td>
<td>0.722 ± 0.223 *</td>
</tr>
<tr>
<td>Visual Acuity (Snellen Eye</td>
<td>20/35</td>
<td>20/105 *</td>
</tr>
<tr>
<td>Chart)</td>
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</tbody>
</table>

* = significant difference between high VA and low VA (P < 0.05)
Figure 1. and 2. Mean stride time, double-support time, step length and step width values between high visual acuity and low visual acuity over 10 consecutive steps.

* = significant difference between high VA and low VA (P < 0.05)
Figure 3. and 4. Mean standard deviation values for step length, step width, stride time, and double-support time between high visual acuity and low visual acuity over 10 consecutive steps.

* = significant difference between high VA and low VA (P < 0.05)
Figure 5. Coefficients of Variation values for step length, step width, stride time, and double-support time between high visual acuity and low visual acuity over 10 consecutive steps

* = significant difference between high VA and low VA, \( P < 0.05 \)
Conclusions

• As visual acuity decreased:
  • Double-support time increased
    – Less capable of single-limb support during walking
    – Indication of a more cautious gait to increase postural stability
  • Variability of double-support time increased
    – Decrease in temporal gait symmetry
    – Indication of an attempt to adapt gait in order to maintain stability
• Visual acuity and walking automaticity were not shown to be related in this study
Limitations

- Non-challenging both visually and terrain-wise
- Small sample size
- Number of steps
- Healthy sample
- Use of treadmill
- Edge contrast sensitivity
Thank You