The Effect of Virtual Reality Training on Balance and Mobility in Adults with Moderate to Severe Traumatic Brain Injury: A Systematic Review

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Overview

- Purpose
- Definitions
- Methods
- PRISMA
- PEDro scoring
- Results

- Conclusion
- Limitations
- Clinical Relevance
- Recommendations
- Acknowledgements
The purpose of this systematic review was to determine if virtual reality training was effective at improving balance and mobility scores in adults with moderate to severe traumatic brain injuries (TBI).
Definitions

- Traumatic brain injury (TBI)\(^1\)
  - Brain tissue damage caused by compression, shearing or a combination of both following acceleration, deceleration or rotational forces on the head due to an outside impact
Definitions

- Virtual reality (VR)\(^2\)
  - Computer based processes providing a simulated environment that can be used for real-time interaction and reactions to changes in the environment
  - i.e. Xbox Kinect, PlayStation and Wii\(^2,4,6\)
Definitions cont.

- eBaVIR - easy Balance Virtual Rehabilitation
  - Based on the Nintendo Wii Balance Board System
  - Does not use traditional commercial software
  - Weight transfers in seated and standing that actively involve the patient
  - Calibrates and adapts to the subjects range and impairments
Definitions cont.

- **CAREN** - computer assisted rehabilitation environment
  - Consists of a motion platform surrounded by a 10-ft tall screen and dual-belt treadmill that measures the ground reaction forces
  - Platform that challenges subjects physically and cognitively by being fully immersed
  - Programmed to move in synchronization with the treadmill and platform
Methods

- A literature search was conducted including:
  - CINAHL
  - HealthSource: Nursing/Academic Edition
  - Medline/PubMed
  - ProQuest Central

- Two reviewers independently assessed each study using the PEDro scoring system
Methods cont.

- Search terms
  - ("brain injury" OR "traumatic brain injury") AND ("virtual reality" OR gaming OR wii OR kinect) NOT concussion
Methods cont.

- **Search limits**
  - Peer-reviewed
  - Published between 2008-2018
  - Adults aged > 18 years

- **Selection Criteria**
  - Virtual reality
  - Moderate to severe TBI
  - Randomized control trials
Records identified through database searching (n= 326)

Records identified through other sources (n=0)

Records after duplicates removed (n= 248)

Records screened by title and abstract (n= 248)

Full-text articles assessed for eligibility (n=19)

Studies included (n=5)

Records excluded (n= 229)
- Not adults (n= 52)
- Not TBI (n= 78)
- Not balance/mobility (n= 99)

Full-text articles excluded, with reasons (n=14)
- Not randomized control trials
## PEDro Scores

<table>
<thead>
<tr>
<th>Study</th>
<th>Random Allocation</th>
<th>Concealed Allocation</th>
<th>Baseline Comparison</th>
<th>Blind Subjects</th>
<th>Blind Therapists</th>
<th>Blind Assessors</th>
<th>Adequate Follow Up</th>
<th>Intention to Treat</th>
<th>Between Group Comparison</th>
<th>Point Estimate Variability</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straudi et al</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>6/10</td>
</tr>
<tr>
<td>Sessoms et al</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>6/10</td>
</tr>
<tr>
<td>Gil-Gomez et al</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8/10</td>
</tr>
<tr>
<td>Cuthbert et al</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>9/10</td>
</tr>
<tr>
<td>McClanachan et al</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8/10</td>
</tr>
</tbody>
</table>
Results

- 326 articles were screened for eligibility
  - 5 met the criteria for final inclusion\(^2-6\)
- Average PEDro score of 7.4
- Sample sizes ranged from 11-26 subjects
- Subjects range from 19-75 years old
- Studies occurred over 4-6 week time period
- Treatment sessions ranged from 15-60 minutes
Results cont.

- All five studies found improvements in balance and mobility scores\(^2-6\)
- Statistically significant improvements across studies included:
  - TUG score: average change of 2 seconds\(^3,6\)
  - Berg Balance Score: average change of 4.22 points\(^3\)
  - 30 Second Sit to Stand: average change of 1.44 repetitions\(^3\)
  - Community Balance and Mobility Scale: average change of 8 points\(^6\)
# Interventions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 minutes of balance therapy (8 minutes balance board and 7 minutes WiiSports) in addition to standard therapy</td>
<td>4 times/week 4 weeks</td>
</tr>
<tr>
<td>1 hour of eBaViR therapy (virtual rehabilitation system for balance recovery) with 3 different games</td>
<td>3-5 times/week 20 sessions total</td>
</tr>
<tr>
<td>30 to 60 minutes of either usual therapy or usual therapy plus WiiFit balance therapy</td>
<td>3 times/week 4 weeks</td>
</tr>
<tr>
<td>20 to 30 minutes of either half traditional therapy/half CAREN or all CAREN therapy</td>
<td>2 times/week 6 weeks</td>
</tr>
<tr>
<td>1 hour of either standard balance therapy or video game therapy</td>
<td>3 times/week 6 weeks</td>
</tr>
</tbody>
</table>
Conclusion

- There is moderate to strong evidence that the use of VR as an adjunct intervention can improve balance and mobility in patients with TBI.
- The most clinically significant findings were found in the TUG and CB&M scores using eBaViR and WiiFit systems.
- Most effective outcomes were found with sessions greater than 20 minutes over the course of 6 weeks.
Limitations

- Small sample size
- Varied use of outcome measures and protocols for balance and mobility
- Not all of the subjects were exclusively patients with TBI
- Of the 5 studies, 3 used commercially available equipment and 2 used custom VR technology
Clinical Relevance

- Commercial VR systems (i.e. Wii and Xbox Kinect) are readily available to clinicians
- VR can be an effective adjunct intervention to improve balance and mobility performance in patients with TBI
- Promote adherence to patient’s plan of care and increased patient enjoyment
Recommendations

- Future research should consider:
  - Larger sample sizes
  - Patients with exclusively TBI
  - More uniform tests and measures to determine optimum VR protocols
Acknowledgements

- Dr. Renee Hakim PT, PhD, Board-Certified Neurologic Specialist in Physical Therapy
- Dr. Tracey Collins, PT, PhD, MBA, Board-Certified Geriatric Specialist in Physical Therapy
- Dr. John Sanko, PT, EdD
- DPT Faculty and Students
References


Thank You!
Questions?
Appendix
## Psychometrics

<table>
<thead>
<tr>
<th>Outcome Measure&lt;sup&gt;7&lt;/sup&gt;</th>
<th>Condition&lt;sup&gt;7&lt;/sup&gt;</th>
<th>MDC/MCID&lt;sup&gt;7&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBS</td>
<td>Acute stroke</td>
<td>6.3 pts</td>
</tr>
<tr>
<td>BBS</td>
<td>Chronic stroke</td>
<td>2.5-4.66 pts</td>
</tr>
<tr>
<td>TUG</td>
<td>Chronic stroke</td>
<td>2.9 seconds</td>
</tr>
<tr>
<td>FGA</td>
<td>Stroke</td>
<td>4.2 pts (5pts clinically)</td>
</tr>
<tr>
<td>BBA</td>
<td>Stroke</td>
<td>1 pt out of 12</td>
</tr>
<tr>
<td>FRT/ART</td>
<td>Acute Stroke</td>
<td>3.7 cm</td>
</tr>
<tr>
<td>FRT/ART</td>
<td>Subacute Stroke</td>
<td>6.79 cm</td>
</tr>
<tr>
<td>2 min walk test</td>
<td>Brain injury</td>
<td>16.4 m ~ 53.8 ft</td>
</tr>
<tr>
<td>10 min walk test</td>
<td>Brain injury</td>
<td>&gt;.05 seconds is &gt; rater error</td>
</tr>
<tr>
<td>Common balance and mobility</td>
<td>Brain injury</td>
<td>7.5-9.6 pts</td>
</tr>
</tbody>
</table>