The Relationship Between the Balance and the Cognition in Community-dwelling Elderly Individuals

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ABSTRACT: Objective: The debate about whether the balance performance is associated with cognition in older people has recently re-emerged. The aim of the study is to analyze the relationship between the balance and the cognition in community-dwelling elderly individuals. Methods: Thirty-seven participants were healthy volunteers aged 50-70 years old, from a community-based sample. Subjects completed a static balance test (eyes open/close, stance with single-leg/double-leg) using an evaluation system. Cognitive parameters included simple reaction time and spatial positional memory span. The collected data were analyzed by correlation analysis using the SPSS program (ver. 20). Results: The spatial positional memory span was strongly correlated with length of SKG (r=-0.43, p=0.01) in double-leg standing with eyes open condition. The simple reaction time was strongly correlated with the LFS(r=0.44, p=0.01) in single-leg standing with eyes open condition. The spatial positional memory span was strongly correlated with length of SKG (r=-0.42, p=0.01) in double-leg standing with eyes close condition. The simple reaction time was correlated with the Y axis value in center of pressure (r=-0.34, p<0.05) in single-leg standing with eyes open condition. Conclusions: These results suggest that the balance performance is associated with cognition in older individuals.

1. INTRODUCTION

The risk of falls increases while aging (Nicolussi AC, Fhon JR& Santos CA, 2012) and it has been predicted that one-third of the community-dwelling elderly people will fall over every year (Gama ZAS and Gómez-Conesca A, 2008). After the fall, elderly individuals become vulnerable to subsequent falls (Perracini MR and Ramos LR, 2002). Thus, preventing the first fall seems to be essential if one hopes to minimize the possibility of subsequent falls. It has been reported that approximately 10-25% of all falls have been attributed to poor balance (Shumway-Cook A, Gruber W& Baldwin M, 1997). Furthermore, a recent study suggests that the degree of cognitive impairment is closely associated with the incidence of falls (Li Z1, Yu Z& Zhang J, 2015). As far as we know, despite the balance performance and cognitive function are important; there is no evidence that the balance performance is associated with cognition in elderly individuals. Therefore, the present study aims to examine the relationship between the balance and the cognition in community-dwelling elderly individuals.

2. METHODS

2.1 Participants

Thirty-seven community-dwelling older adults ranging in age from 52 to 70 years gave written informed consent to participate in the study after experimental procedures were explained. Participants’ characteristics are presented in Table 1. None had any history of musculoskeletal, neurological, or orthopedic disorders that might have affected their ability to perform balance tests, reaction time task and spatial positional memory span task.

Table 1. Characteristics of the Participants (N = 37).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean (SD) or N (%)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (females)</td>
<td>28(76%)</td>
<td>n/a</td>
</tr>
<tr>
<td>Age (years)</td>
<td>60.15 (4.6)</td>
<td>52.0-70.0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161.8 (6.4)</td>
<td>148.0-176.0</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>66.8 (10.9)</td>
<td>46.0-90.0</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>25.6 (4.4)</td>
<td>16.9-32.7</td>
</tr>
</tbody>
</table>
2.2. Procedures

All the participants were tested static balance and cognitive function. In each testing sessions, participants were interviewed and tested in a quiet room by professionals.

2.2.1. Static Balance

For the evaluation of the balance position, the balance testing training system PC708 was used. In this task, all participants stood on the platform while their hands were next to their bodies and stared at a red point on the screen. Balance was measured under the following conditions: (a) single-leg stance with open eyes, (b) double-leg stance with open eyes, (c) single-leg stance with closed eyes, and (d) double-leg stance with closed eyes. Each test was run for 10s. The main index includes the X axis value in center of pressure (average-x), the Y axis value in center of pressure (average-y), the length of statokinesigram (SKG), the length in function of surface (LFS), the anterio of pressure distribution (anterio), the posterior of pressure distribution (posterior) and so on.

2.2.2. Cognitive function tests

2.2.2.1. Simple Reaction Time (SRT)

For the evaluation of the simple reaction time, psychological education System PsyKey was used. Simple reaction time was measured by asking participants to react as quickly as possible to the target signal by pressing a key on the keyboard.

2.2.2.2 Spatial Positional Memory Span (MS)

For the evaluation of the spatial positional memory span, psychological education System PsyKey was used. In this task, participants are required to discriminate a novel location of a stimulus among an increasing array of stimuli presented sequentially in various locations on the screen. A stimulus is presented in one of the possible locations on the screen and the participants have to touch it and reappear at the same location. These steps continue for the maximum number of stimuli pre-selected by the experimenter or until piled up a certain amount of mistakes.

2.2.3. Statistical analysis

All statistical analyses were performed using the statistical package for social sciences (SPSS) 20.0 software package. Spearman’s correlation coefficients between balance and cognitive function tests were determined. A P-value smaller than 0.05 on the two-tail was considered to indicate statistical significance.

3. RESULTS

There was a significant correlation between the simple reaction time and the left of pressure distribution (r=-0.34, P<0.05) and the right of pressure distribution (r=0.34, P<0.05) on Spearman’s correlation tests (Table 2). A negative and significant correlation was found between the spatial positional memory span and the length of SKG (r=-0.43, P=0.01).

Table 2 Correlation coefficients of cognitive function tests and the balance performance in eyes-open and double-leg condition

<table>
<thead>
<tr>
<th></th>
<th>average-x</th>
<th>average-y</th>
<th>length</th>
<th>ellipse</th>
<th>LFS</th>
<th>anterior</th>
<th>posterior</th>
<th>left</th>
<th>right</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRT</td>
<td>0.05</td>
<td>0.77</td>
<td>-0.27</td>
<td>0.11</td>
<td>0.17</td>
<td>0.31</td>
<td>-0.34*</td>
<td>0.04</td>
<td>0.1</td>
</tr>
<tr>
<td>MS</td>
<td>0.02</td>
<td>0.91</td>
<td>0.23</td>
<td>0.18</td>
<td>0.3</td>
<td>0.26</td>
<td>0.12</td>
<td>0.24</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Notes: *P<0.05; **P<0.01.

Abbreviations: SRT, simple reaction time; MS, spatial positional memory span

Table 3 Correlation coefficients of cognitive function tests and the balance performance in eyes-open and single-leg condition

<table>
<thead>
<tr>
<th></th>
<th>average-x</th>
<th>average-y</th>
<th>length</th>
<th>ellipse</th>
<th>LFS</th>
<th>anterior</th>
<th>posterior</th>
<th>left</th>
<th>right</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRT</td>
<td>0.24</td>
<td>0.15</td>
<td>-0.18</td>
<td>0.29</td>
<td>0.24</td>
<td>0.16</td>
<td>-0.06</td>
<td>0.72</td>
<td>-0.04</td>
</tr>
<tr>
<td>MS</td>
<td>-0.02</td>
<td>0.89</td>
<td>0.3</td>
<td>-0.42**</td>
<td>0.01</td>
<td>0.08</td>
<td>0.65</td>
<td>0.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Notes: *P<0.05; **P<0.01.

Abbreviations: SRT, simple reaction time task; MS, spatial positional memory span task
There was a negative significant correlation between the simple reaction time and the max distance of swinging pathway (r=-0.34, P<0.05) on Spearman’s correlation tests (Table 3). A positive and significant correlation between the simple reaction time and the LFS (r=0.44, P<0.05). There was a significant correlation between the spatial positional memory span and the anterior of pressure distribution (r=0.35, P<0.05) and the posterior of pressure distribution (r=-0.35, P<0.05) on Spearman’s correlation tests.

A negative and significant correlation was found between the spatial positional memory span and the length of SKG (r=-0.42, P=0.01) in eyes-close and double-leg condition (Table 4).

| Table 4 Correlation coefficients of cognitive function tests and the balance performance in eyes-close and double-leg condition |
|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|
| average-x | average-y | length of max | ellipse area | LFS | anterior | posterior | left | right |
| SRT | 0.24 | 0.16 | -0.07 | 0.67 | -0.01 | 0.97 | -0.14 | 0.39 | 0.04 | 0.81 | 0.15 | 0.39 | 0.22 | 0.18 | -0.22 | 0.18 | -0.34* | 0.04 | 0.34* | 0.04 |
| MS | 0.25 | 0.14 | 0.22 | 0.19 | -0.43** | 0.01 | 0.23 | 0.18 | 0.06 | 0.72 | -0.13 | 0.44 | -0.07 | 0.00 | 0.88 | 0.08 | 0.65 | 0.08 | 0.65 | -0.08 | 0.65 |

Notes: *P<0.05; **P<0.01.

Abbreviations: SRT, simple reaction time task; MS, spatial positional memory span task

There was a negative significant correlation between simple reaction time and the Y axis value in center of pressure (r=-0.34, P<0.05) on Spearman’s correlation test (Table 5).

| Table 5 Correlation coefficients of cognitive function tests and the balance performance in eyes-close and single-leg condition |
|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|:--:|
| average-x | average-y | length of max | ellipse area | LFS | anterior | posterior | left | right |
| SRT | -0.17 | 0.33 | -0.34* | 0.04 | 0.12 | 0.48 | -0.04 | 0.82 | -0.26 | 0.12 | 0.07 | 0.67 | -0.24 | 0.15 | 0.24 | 0.15 | -0.08 | 0.62 | 0.08 | 0.62 |
| MS | 0.11 | 0.53 | 0.19 | 0.25 | 0.13 | 0.44 | 0.1 | 0.56 | 0.2 | 0.23 | 0.06 | 0.72 | 0.17 | 0.32 | -0.17 | 0.32 | 0.04 | 0.83 | -0.04 | 0.83 |

Notes: *P<0.05; **P<0.01.

Abbreviations: SRT, simple reaction time task; MS, spatial positional memory span task

4. DISCUSSION

Aging-associated issues have been under the global lens now. China has the largest elderly population in the world, and its population is aging rapidly. Falling can lead to severe health issues in the elderly and contributes to morbidity, death, hospitalization and so on (Jeon M Y, Jeong H & Lee H, 2014). Strength and power reduction, and postural control, as well as visual, functional, and cognitive deficits have been listed as the main intrinsic factors (Gschwind Y J, Kressig R W, Lacroix A, 2013). The main objective of this study was to determine the association between balance and cognitive performance among community-dwelling older adults.

Balance control is based on three components: the sensory input systems, the central processing control systems, and the effector systems. Sensory input from the visual, vestibular, and proprioceptive systems provides information on the orientation of the body relative to the environment and information on the environment itself. The central processing control systems function to assess and integrate the sensory input and select an appropriate sensorimotor response for the effector system, while the effector system executes some action that is timely and effective in responding to the sensory input (Patla A E, Frank J S & Winter D A, 1992). The central processing control system can be represented by the simple reaction time and the spatial positional memory span, so theoretically, the balance performance be related to the simple reaction time and the spatial positional memory span .Hagovska M (Hagovska M1, Takac P & Dzvoník O, 2015) indicated that combining cognitive and dynamic balanced training achieved significantly higher improvements not only in the evaluation of cognitive domains but also in postural control when compared with balance training alone in seniors with MCI. Our finding is supported by previous research that indicated the balance performance is associated with cognition in older individuals.

When the healthy old adult executes the static
balance task in eyes-open and double-leg condition (Table 2), a negative and significant correlation was found between spatial positional memory span task score and the length of statokinesigram. This means the shorter the length of statokinesigram is, the better spatial memory capability will be. This finding indicates that the balance performance is associated with cognition function in older individuals. This result is consistent with previous studies, Archana Singh-Manoux et al. (Singh-Manoux A, Hillsdon M, Brunner E, 2005) recorded that there is a small but significant association between physical activity and cognitive functioning in middle age.

When the healthy old adult executes the static balance task in eyes-open and single-leg condition (Table 3), there is a positive and significant correlation between the simple reaction time task score and the length in function of surface. That means the shorter the length in function of surface is, the shorter the simple reaction time will be. This result is consistent with previous studies, Lord (Lord S R& Fitzpatrick R C, 2001) shows that compared with the nonfallers, the fallers had significantly increased the choice stepping reaction time.

When the healthy old adult executes the static balance task in eyes-close and double-leg condition (Table 4), a negative and significant correlation was found between the spatial positional memory span task score and the length of statokinesigram. This means the shorter the length of statokinesigram is, the better spatial memory capability will be. This is consistent with the result that the static balance task in eyes-open and double-leg condition. So, visual interference cannot affect the relationship between the spatial positional memory span and the length of statokinesgram in double-leg condition.

In conclusion, the balance performance is associated with cognition in older individuals.

5. CONCLUSION

These results suggest that the balance performance is associated with cognition in older individuals. It may be beneficial to promote cognitively exercises and balance training among older adults for optimal physical and cognitive function. Balance training programs may slowing the progression of the widespread cognitive impairments in the elderly.

6. ACKNOWLEDGE

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REFERENCES