Validity and Reliability of Wii Fit Balance Board for the Assessment of Balance of Healthy Young Adults and the Elderly

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Abstract. [Purpose] Balance is an integral part of human ability. The smart balance master system (SBM) is a balance test instrument with good reliability and validity, but it is expensive. Therefore, we modified a Wii Fit balance board, which is a convenient balance assessment tool, and analyzed its reliability and validity. [Subjects and Methods] We recruited 20 healthy young adults and 20 elderly people, and administered 3 balance tests. The correlation coefficient and intraclass correlation of both instruments were analyzed. [Results] There were no statistically significant differences in the 3 tests between the Wii Fit balance board and the SBM. The Wii Fit balance board had a good intraclass correlation (0.86–0.99) for the elderly people and positive correlations (r = 0.58–0.86) with the SBM. [Conclusions] The Wii Fit balance board is a balance assessment tool with good reliability and high validity for elderly people, and we recommend it as an alternative tool for assessing balance ability.

Key words: Wii Fit balance board, Smart balance master system, Balance

INTRODUCTION

Balance is an indispensable ability of the human body. Whether for sports or daily activities in life, humans rely on body balance⁵). Dynamic balance is required during walking to maintain body movement. Humans have sensory receptors and mechanical receptors in the skin or joints, muscle spindles, and Golgi tendons have pressure or proprioceptive receptors⁶, ²). When the human body encounters environmental changes, the sensory and motor neurons, and muscles function together to react appropriately to the changes.

Clinical testing of balance ability is often measured with the smart balance master system (SBM)⁷), which requires a significant amount of space and relies on the assistance of a professional. A somatosensory gaming console known as the Nintendo Wii has gained popularity in recent years. It integrates the Wii Fit balance board and balance sensor devices into interactive games⁸). The Wii Fit balance board is economical and easy to use. Therefore, we designed a balance assessment device based on the Wii Fit balance board. This real-time device comprises the balance board, software, and database. It can show and calculate the distance of weight shifting. The purpose of our study was to examine its reliability and validity compared to the SBM, and to present the feasibility of the modified Wii Fit balance board a balance assessment.

SUBJECTS AND METHODS

This study had a pretest-posttest design, and healthy 20 young adults and 20 elderly people were recruited. Participants were excluded if they had history of neurological diseases (e.g., stroke, Parkinson's disease, or cerebellar atrophy), were unable to stand, or had poor physical fitness that would have affected their abilities in the tests. They provided their informed consent before participation. Three balance tests with the modified Wii Fit balance board and the SBM were used for the assessment. All participants were assessed using these 2 instruments in a random manner, and both test times were of 1 hr duration.

We used the Wii Fit balance board (Wii Fit® platform, Nintendo, Japan) to design a suitable balance assessment tool. The 4 sensors in the balance board can sense weight changes and show the distribution of body weight. The 4 sensors measure weight and the data can be summed to obtain the body weights of individual users. The data can be transmitted to a personal computer using Bluetooth. The software DarwinRemote (Mac OS X v10.4, Nintendo, Japan) of the gaming console was used for this study, which has a compatible Bluetooth transmission feature. The data from the sensors were transmitted via Bluetooth, and the software can display the real-time sensor signals. The average displacement of the center of gravity calculated to evaluate the balance status.

Our study used 3 balance tests which were performed on the SBM (NeuroCom International Inc., Clackamas, USA) and the modified the Wii Fit balance board to compare their
reliability and validity. The SBM has a long force plate and a suspension protection device. The force plate has 4 strain gauges, and can measure the pressure derived from changes in posture, and is connected to a computer screen. The center of gravity point can be displayed on the screen to provide a user with visual feedback, and to measure the balance status.

Three clinical balance tests were performed. 1) standing with eyes open: subjects stood on both feet and maintained body balance for 10 sec with their eyes open; 2) standing with eyes closed: subjects stood on both feet and maintained body balance for 10 sec with their eyes closed; and 3) one-leg standing: subjects stood on their dominant leg, and maintained body balance for 10 sec with eyes open. Each test was performed 3 times at 10-min intervals. The average displacement of the center of gravity was calculated and recorded.

All the recorded data are presented as mean ± standard deviation. Data were analyzed using SPSS version 16 (SPSS inc., Chicago, USA). The Spearman correlation coefficient was used to analyze the correlations of the results between the Wii Fit balance board and the SBM. A correlation coefficient greater than 0.5 represents a high degree of validity, 0.5 − 0.35 represents moderate validity, and < 0.35 represents low validity). The independent t test was used to compare the average values of the 3 balance tests, and to determine the significance of differences between the young and elderly groups. The intraclass correlation (ICC) was used to measure the intrarater reliability of the 2 tests using ANOVA. We used the two-way random model (ICC3,1 model) to calculate the ICCs and 95% confidence intervals of the Wii Fit balance board and the SBM. All significance levels were chosen as α < 0.05.

## RESULTS

We recruited 40 healthy volunteers: 20 young adults (age = 22.17 ± 1.35 years) and 20 elderly people (age = 67.32 ± 3.43 years). During pilot testing, we did not place any load on the Wii Fit balance board, and found the initial sensed value. Results of the thrice repeated calibration test indicated values of the left front of 1.25 ± 0.78 kg and right rear of 2.32 ± 0.62 kg, and the values of the left rear and right rear were 0 kg; thus, a total test error of 2.79 ± 0.69 kg was shown for the Wii Fit balance board. The DarwinRemote software was used to automatically correct the error, and to display the center of gravity as the origin of the 2D graph.

No significant differences were identified in the pretest and posttest comparisons of the 3 balance tests for the Wii Fit balance board and the SBM in the young adults and elderly people (p > 0.05). The between-group comparison for the 3 balance tests (i.e., standing with eyes open, standing with eyes closed, and one-leg standing) for the Wii Fit balance board and the SBM were significantly different (p < 0.05), with the young adults group showing a higher value (Table 1). However, no significant difference was present in the between-group comparison for the standing position with the eyes open test for the Wii Fit balance board.

Table 1. The inter-rater reliability of the three balance tests for the young adults and elderly people

|                      | Young adults (n = 20) |                      | Elderly (n = 20) |
|----------------------|-----------------------|---------------------|-----------------|
|                      | Average value         | ICC3,1 (95% CI)     | Average value   | ICC3,1 (95% CI)   |
| **Wii Fit balance board** |                       |                     |                 |
| Standing with eyes open (cm) | 1.87 ± 0.59          | 0.19 (−0.57–0.64)  | 2.37 ± 1.44     | 0.93 (0.86–0.97)  |
| Standing with eyes closed (cm) | 2.29 ± 0.77          | 0.21 (−0.70–0.66)  | 9.75 ± 9.56     | 0.99 (0.97–0.99)  |
| One leg standing (cm) | 6.45 ± 1.62*         | 0.28 (−0.55–0.70)  | 13.56 ± 9.14    | 0.99 (0.98–0.99)  |
| **SBM**               |                       |                     |                 |
| Standing with eyes open (cm) | 1.05 ± 0.41*         | 0.70 (0.39–0.87)   | 2.89 ± 2.47     | 0.99 (0.98–0.99)  |
| Standing with eyes closed (cm) | 0.97 ± 0.30*         | 0.78 (0.36–0.85)   | 4.73 ± 2.39     | 0.99 (0.98–0.99)  |
| One leg standing (cm) | 3.92 ± 1.48*         | 0.97 (0.93–0.97)   | 10.96 ± 2.89    | 0.99 (0.98–0.99)  |

SBM, smart balance master system
* Young adults vs. elderly, p < 0.05

Table 2. Correlation analysis of the Wii Fit balance board and SBM

|                      | Wii Fit balance board |                      |                      |                      |
|----------------------|-----------------------|---------------------|---------------------|---------------------|
|                      | Standing with eyes open (cm) | 0.58*               | 0.12                | 0.01                |
|                      | Standing with eyes closed (cm) | 0.27                | 0.86*               | 0.08                |
|                      | One leg standing (cm) | 0.06                | 0.52a               | 0.61*               |

SBM, smart balance master system
* p < 0.05
Numerous studies have indicated that the Wii Fit balance board is a cost-effective and user-friendly gaming device that is cheap and easy to use. Our previous study showed that the Wii Fit balance board has a higher reliability for elderly people because falls often occur because of poor balance ability. Some studies have shown age-related declines in the balance ability of elderly people. Age-related increases in the displacement of the center of gravity are indicated under conditions involving changed somatosensory or visual inputs. The SBM is dependable equipment that is often used for balance assessments. A previous study showed that the SBM has a good reliability and validity score (ICC = 0.55–0.82), which is similar to our findings. Three clinical balance tests (standing with eyes open, standing with eyes closed, and one leg standing) are used. Three clinical balance tests (standing with eyes open, standing with eyes closed, and one leg standing) are used. Further studies should examine this issue. The Wii Fit balance board is reliable for elderly people. We recommend the Wii Fit balance board as an alternative tool for assessing the balance ability of elderly people.

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