

## ORIGINAL RESEARCH

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## INTRA-RATER RELIABILITY OF WII BALANCE BOARD (WBB) IN ASSESSING STANDING BALANCE IN OLDER ADULTS

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## ABSTRACT

**Background:** Wii Balance Board (WBB) being one of the latest, advanced technologies of high sensitivity in monitoring change in balance over time and owing to, ease of use, and portability, it is being used in physical therapy clinics as a popular substitute for the expensive and complicated force plates to improve dynamic strength and balance. Despite its growing popularity, the WBB's reliability as an intervention and assessment tool for balance is still being investigated. So this study aims in finding the accuracy of WBB. The objectives of the study are to find the Intraclass Correlation Coefficient and Standard Error Measurement on both day 1 and day 2 with eyes closed and eyes open in older adults.

**Method:** 30 subjects over the age of 65 years were assessed for balance using WBB. Subjects were measured in double limb stance with eyes open and closed with feet comfortably distant apart on the board. The same procedure was repeated after 24 hours.

**Results:** The study showed to be statistically significant for eyes open on day 1 and day 2, but was not statistically significant for eyes closed on day 1 and day 2.

**Conclusion:** The study suggested that the WBB was reliable for eyes open and not reliable with eyes closed.

**Keywords:** WBB, Balance, Double limb stance, Nintendo, Older Adults.

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## INTRODUCTION

Balance is defined as the ability to align body segments against gravity to maintain or move the body within the available base of support without falling; the ability to move the body in equilibrium with the gravity via interaction of the sensory and motor systems<sup>1</sup>.

The physiology of balance is briefly described in three steps. First, a person continuously acquires information about the body's position and trajectory in space, which is done through the sensory system. Second, the body must determine process of "setting up" the postural response. And third, the body must carry out that response via the effector system (strength, range of motion, flexibility, and endurance). Sensory information required to maintain balance is provided primarily from visual, vestibular and somatosensory systems.

These systems tend to reduce the effectiveness of postural control with age. This badly affects the sensory, effector and central processing, thus leading to loss in balance. In the sensory system-visual acuity, contrast sensitivity and depth perception worsen with age. Changes in the vestibular-ocular reflex are consistent with age-related peripheral anatomical changes in the vestibular system. Mild proprioceptive and vibratory sense losses are also reported. In the effector system, joint stiffness and loss of range of motion occurs. A decline in muscle strength with age is associated with decreases in the size and number of muscle fibers. Increased stiffness in connective tissues contributes to age-related losses in joint range of motion and flexibility. In the central processing component, general slowing of sensory information processing coupled with slowing of nerve conduction velocity, increased static sway, and increases in the number of steps required to recover balance after perturbation<sup>2</sup>.

In elderly, this loss of balance is assessed by many tests, amongst which Berg balance scale and Timed up and go test are commonly used. Berg balance scale was developed by Berg and co-workers. It is an objective measure of static and dynamic balance abilities. The scale consists of 14 tasks. Scoring uses five-point ordinal scale, with scores ranging from 0 to 4. A maximum score is 56; 45 or below is associated with high fall risk, and each one point drop in scores ranging from 54 to 36 is associated with a 6 to 8% increase in fall risk. The Berg balance scale was originally developed for use with elderly patients with stroke in acute rehabilitation and has

been shown to be a sensitive measure of recovery<sup>3</sup>. Blum and Korner-Bitensky concluded that given the floor and ceiling effects, clinicians may want to use the Berg balance scale in conjunction with other balance measures<sup>4</sup>. Qutubuddin et al., suggested that research results agree with other published research in suggesting that the Berg balance scale may be used as a screening tool and ongoing assessment tool for patients with PD<sup>5</sup>.

Timed up and go test developed by Mathias et al is a quick measure of dynamic balance and mobility. This test may be performed with an assistive device. Originally it was designed to assess frailty in older adults, but the test is now more commonly used to assess fall risk in population. Young adults perform this task in 5 to 7 seconds, normal older adults in 7 to 9 seconds (low risk), moderate risk older adults in 10-12 seconds and high risk older adults in 13 seconds or more<sup>6</sup>. Herman T, Giladi N, Hausdorff JM concluded that The Timed up and go test appears to be an appropriate tool for clinical assessment of functional mobility even in healthy older adults<sup>7</sup>.

Even though both the scales are widely used in assessing the balance they have their own limitations. Felicity Anne Langely concluded that a limitation of Timed up and go test is that they only provide information on a few aspects of balance, Timed up and go test provide little information about the source of balance problem. Furthermore, meaningful scores cannot be recorded for the Timed up and go test where participants are physically unable rise from a chair or walk independently. They do not have the depth of information to discriminate between various sources of impairment.

Despite of good reliability and validity reported for the Berg balance scale, the presence of ceiling effect when used with community dwelling older adults, limits the use of this scale to detect balance impairments. With few items which tests the dynamic balances, Berg balance scale may not provide a great enough challenge to older adults who live independently. A further limitation is that the Berg balance scale has one of longest administration times of functional balance tests. Difficulties interpreting scoring criteria, resulting in inconsistencies with score allocation have also been reported. Consequently, modifications of the Berg balance scale are required for the use of older community dwelling people<sup>8</sup>.

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One of the newest tools in assessing balance is WBB. The Nintendo Wii™ gaming system has been shown to encourage a task-specific, repetitive exercise program and has already been trialed in many rehabilitation clinics since it was introduced in November 2006. The Wii™ offers a low cost, commercially available. A Nintendo Wii™ is now regularly being used at St James's Hospital in Dublin. It is used primarily in the rehabilitation of stroke patients, the majority of whom seem to enjoy the games while simultaneously receiving rehabilitation benefits. According to Sinead Coleman, Senior Physiotherapist in Care of the Elderly Rehabilitation Unit at St James's Hospital, the boxing and bowling games are the most popular and also the most efficacious in improving balance, trunk control and general upper extremity movements<sup>9</sup>.

Ross A. Clark et al. concluded that the WBB has the potential to bridge the gap between laboratory testing and clinical assessment of standing balance. WBB provides practitioners supplementary balance information from a range of medical specialties and discipline that is not apparent using visual assessment tool. His findings also suggest that the WBB is a valid tool for assessing standing balance. Given that the WBB is portable, widely available and at a lower price, it could provide the average clinician with a standing balance assessment tool suitable for the clinical setting.<sup>10</sup> No studies have yet been performed to test the reliability of WBB on elderly individuals, so if WBB data is found to provide important information, it could allow for more sensitive monitoring of change in balance over time and a better evaluation of the effectiveness of treatment for an individual and hence the need for study arises.

## **METHOD**

The subjects were taken from Nagarbhavi village, Bangalore. The subjects included in the study were older adults who were injury free. These individuals included both male and female subjects. The sample design was area sampling with Sample size 30.

Materials required were WBB, Wii wireless Remote, Television and Calculator. The subjects with lower back pain and lower limb pathology, who use medications aspirin, sedatives, tranquilizers, anti-depressants, and subjects with history of neurological and musculoskeletal diseases that affect balance were excluded from study.

Subjects above the age group of sixty five years and who fulfilled the selection criteria were considered for study. Informed consent was taken from the subjects. Demographic details like name, age, gender, occupation, address, phone number, past history, medical history was taken.

The Wii™ is unique among other gaming systems in that it is based on motion and a spatially sensitive wireless controller, which uses accelerometers in three axes and an infrared sensor bar to recognize and interpret gestures in the environment.

The correct procedure was explained to the participants and they were assessed using WBB. The subjects were asked to stand on the WBB and the observer operated using the remote and at the same time he instructed the subject about the information being displayed on the Television screen. When a player used the WBB system for the first time he or she was prompted to create a profile which was represented as "Mii", an avatar representing the user. It asked for date of birth, height of the subject. Later the participants were asked to undergo a body test where the WBB measured the weight of the individual and also analyzed the balance of the subject. This was done by double limb stance with eyes open and closed with feet comfortably distant apart. The subject was requested to keep their hands and shoulders relaxed so as to remain still during trial. The data was collected after measuring the subjects balance on WBB for 30 seconds. The WBB displayed the weight distribution on both the legs in percentages. It also suggested the individual the proper balance that was required to be attained for a healthy living. The same procedure was repeated after 24 hours again taking the weight distribution on both the legs in percentages.



**Figure 1:** Showing WBB, Wii remote and screen displaying the percentage of weight distribution on right and left leg.



**Figure 2:** Subject standing with eyes open on WBB and weight distribution displayed on screen with centre balance.

**Measuring Tool -** Wii Balance Board

**RESULTS**

**Table 1:** Descriptive Statistics for demographic variables

Sl. No:	Variable	Range	Mean	SD	Minimum	Maximum
1	Age (years)	11.00	69.27	3.87	65	76
2	Height (cms) *	30.00	158.17	6.69	142.50	172.50
3	Weight (Kgs) *	17.30	57.64	5.21	48.50	65.80

Cms- Centimeters\*, Kgs- Kilograms\*

**Table 2:** Descriptive Statistics for outcome variables

Sl. No:	Variable	Range	Mean	SD*	Minimum	Maximum
1	Day one eyes open, left leg	26.00	50.66	4.47	40.4	66.4
2	Day one eyes open, right leg	26.00	49.34	4.47	33.6	59.6
3	Day one eyes closed, left leg	9.30	50.99	3.13	46.1	55.4
4	Day one eyes closed, right leg	9.30	49.01	3.13	44.6	53.9
5	Day two eyes open, left leg	20.10	50.9	3.9	42.8	62.9
6	Day two eyes open, right leg	20.10	49.12	3.9	37.1	57.2
7	Day two eyes closed, left leg	9.60	49.99	2.8	45.1	54.7
8	Day two eyes closed, right leg	9.60	50.01	2.8	45.3	54.9

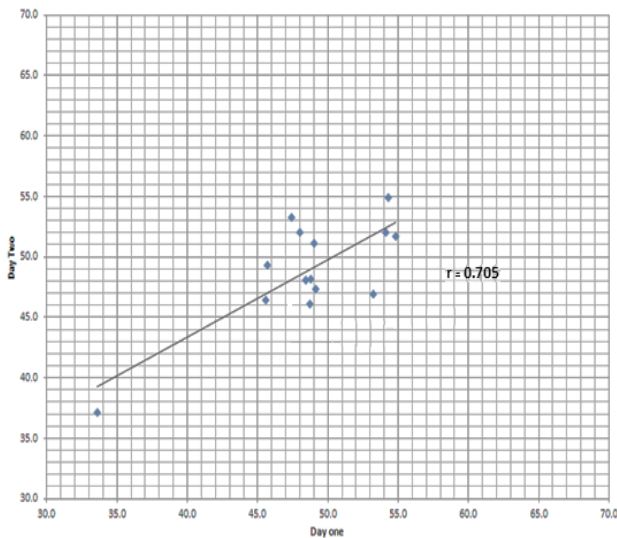
Standard deviation\*

**Table 3:** Intra rater reliability, Intraclass Correlation Coefficient (ICC) (single), 95% Confidence Interval (CI) & results

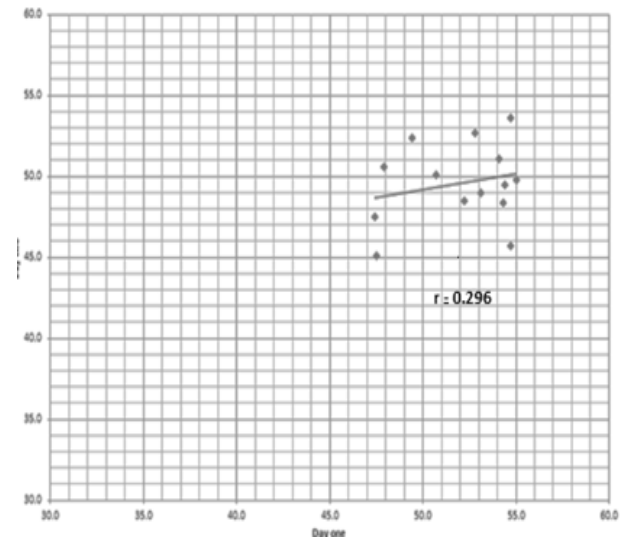
Sl. No:	Variable	ICC	95%CI	p-value	SEM
1	eyes open, left leg	0.705	0.467-0.848	<0.0001	2.273
2	eyes open, right leg	0.705	0.467-0.848	<0.0001	2.273
3	eyes closed, left leg	0.296	-0.066-0.589	>0.053	2.487
4	eyes closed, right leg	0.296	-0.066-0.589	>0.053	2.487

**Table 4:** Intra rater reliability, Intraclass Correlation Coefficient (ICC) (average), 95% Confidence Interval (CI) & results

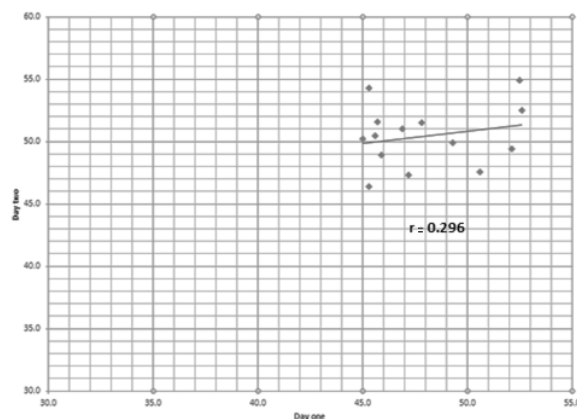
Sl. No:	Variable	ICC	95%CI	p-value	SEM
1	eyes open, left leg	0.827	0.636-0.918	<0.0001	1.740
2	eyes open, right leg	0.827	0.636-0.918	<0.0001	1.740
3	eyes closed, left leg	0.457	-0.141-0.741	>0.053	2.184
4	eyes closed, right leg	0.457	-0.141-0.741	>0.053	2.184



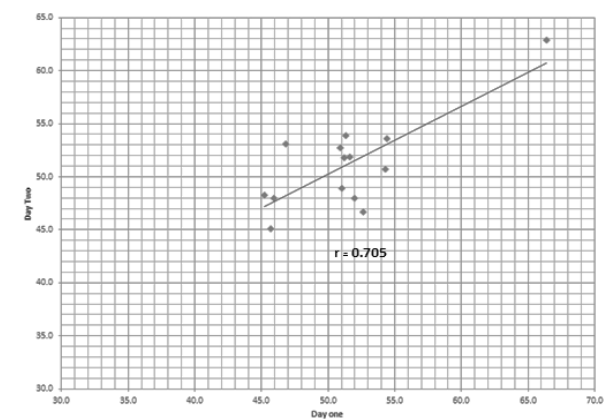
**Graph 1:** Scattered gram for Eyes open, right leg on day 1 and day 2 shows Intraclass Correlation Coefficient (r= 0.705) suggesting good reliability



**Graph 2:** Scattered gram for Eyes closed left leg on day 1 and day 2 shows Intraclass Correlation Coefficient (r= 0.296) suggesting poor reliability.



**Graph 3:** Scattered gram for Eyes closed right leg on day 1 and day 2 shows Intraclass Correlation Coefficient (r= 0.296) suggesting poor reliability.



**Graph 4:** Scattered gram for Eyes closed, left leg on day 1 and day 2 shows Intraclass Correlation Coefficient (r = 0.705) suggesting good reliability.



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## DISCUSSION

The objective of the study was to measure the accuracy of WBB in assessing the standing balance of older adults. The subjects included in the study were older adults who were injury free. These individuals included both male and female subjects. The mean age of study group was 69.27. Accuracy was calculated using Intraclass Correlation Coefficient and standard error of mean. The WBB was introduced in 2001 by Nintendo and is being marketed as Wii Balance Board™ all over the world. It is being used by many people as a weight and balance measuring tool. This tool stays true to psychometric properties which were established through a study done by Ross Clark on thirty young injury free individuals with an average age of twenty three concluding that the WBB exhibits excellent test–retest reliability for COP path length assessment and possesses concurrent validity with a laboratory-grade force- platform<sup>10</sup>.

WBB is also used to help improve balance during rehabilitation in patients with acquired brain injury<sup>11</sup>, Parkinson's disease<sup>12</sup>, while training for sports, in older adults with perceived balance deficit<sup>13</sup>, mild Alzheimer's dementia<sup>14</sup>. WBB has also been shown to improve balance and gait in subjects with dynamic balance impairment according to the study done by Brendan Sullivan<sup>15</sup>. Another study done by Bateni H suggested that WBB will improve balance; however physical therapy training in addition to WBB training appears to improve balance to greater extent<sup>16</sup>. Wii fit is known to say about the weight distribution of lower extremities thus providing appropriate information about the symmetry of weight distribution on lower extremities. This was in accordance to the study done by Brittany Gardner who suggested that the participant's weight distribution of lower extremities became more symmetrical and had a decrease in postural sway, indicating an increase in stance stability<sup>17</sup>.

In the present study involving older adults with the mean age of 69.27, it has been shown that eyes closed state was not reliable but the eyes open was reliable. This could be due to the fact that subjects being in the older age group do not have control over balance with their eyes closed. This was in accordance to the study done by Stephen Lord on visual risk factors for falls in older people suggested that vision plays an important role in stabilizing balance by providing the nervous system with continually updated information regarding the position and movements of body segments in

relation to each other and the environment. Advancing age accompanied by generalized reduction of the visual system and impaired vision has been associated with Instability<sup>18</sup>.

The current study also showed a difference in mean values of first measurement and second measurement being low on first measurement for both eyes opened and eyes closed on left and right legs. This was in accordance with the previous study done by Wrisley. Author hypothesized that the values were low during session 1 than compared to other session due to the learning effects of repetitive administrations of the Sensory Organization Test. But, however thirteen young healthy subjects were included during the study<sup>19</sup>. Another study done by Clark on WBB showed high Intraclass Correlation Coefficient values of 0.94 on second trial, but this study included thirty young injury free individuals<sup>10</sup>. But however the present study included older adults with the correlation of 0.705 and 0.296

Portney and Watkins have suggested that Intraclass Correlation Coefficient values above 0.75 are indicative of good reliability and those below 0.75 should be considered as poor to moderate<sup>20</sup>. Intraclass Correlation Coefficient measurements in this study was 0.705 for eyes open, right and left leg which suggests to be good reliability and 0.296 eyes closed, left and right leg which suggests to be poor reliability.

## LIMITATIONS

Small sample size, the findings should be substantiated in a large group of subjects, area selected for the sample is constrained, during the trial for eyes open there was a constant feedback given to the subject, each subjects balance was not measured at same time of the day.

## CONCLUSION

The objectives of this study was to find the Intra class Correlation Coefficient on day 1 and day 2 with eyes closed and eyes open in older adults and Standard Error Measurement on day 1 and day 2 with eyes closed and eyes open in older adults. The results of the study showed that the WBB was reliable with eyes open and not reliable with eyes closed. Hence WBB is reliable in assessing standing balance in older adults with eyes open and not with eyes closed.

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