

# A Standard Low-Cost Worldwide Accessible Nintendo Wii Balance Test Can Differentiate Older Fallers from Non-fallers

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**Abstract.** The purpose of this study was to explore if the Nintendo Wii Stillness test could differentiate between age and gender matched fallers and non-fallers. 20 older fallers and 23 older non-fallers performed three trials of the Stillness balance test. Results showed a ~23% difference in the scores of the two groups ( $p=0.007$ ). The Stillness test therefore appears to be able to differentiate age- and gender matched fallers and non-fallers. In addition, the test is low-cost, time-efficient, and widely available across the world and could therefore become a good alternative to existing tools/scales for assessment of standing balance.

## 1 Introduction

Fall accidents within the older population are a major concern worldwide, as they are associated with elevated morbidity, mortality, poorer overall functioning, and early admission to long-term care facilities [1]–[3]. In Denmark a growth of approximately 80% is expected in older adults (+65 years) through the next 30 years [4]. A similar growth is projected in USA as the population of older adults is estimated to go from 45.1 million in 2014 to 92.0 million in 2060 [5]. More than 400 risk factors for falls have been identified [2], [6], and impaired balance control is one of the most important factors.

A common way of measuring balance performance in older adults is through objective force plate- or gait analysis. However, objective balance tools such as these are expensive and technically difficult to operate in a clinical environment. Thus, a need exists to find or develop low-cost, objective, quantitative balance assessment tools directed towards a clinical setting.

In 2008, Nintendo Corporation (Kyoto, Japan) launched the Nintendo Wii Balance Board (NWBB) primarily intended as a toy for kids. However, not long

after the launch, researchers worldwide started exploring the NWBB for additional purposes than solely entertainment, and found that the NWBB could be used as a training device [7]–[9], a physical examination tool [10], [11] and a prediction tool [12]. A recent study reported that the Nintendo Wii Stillness test was highly reproducible in community-dwelling older adults when assessing standing balance [10]. However, the study did not explore the ability of the Stillness test to discriminate between different populations (i.e. fallers vs. non-fallers). The purpose of this study was therefore to explore if the Wii Stillness test could discriminate between fallers and non-fallers.

## 2 Methods

### 2.1 Participants

This case-control study compared 20 older adults with a history of fall accidents within the last 12 months with 23 age and gender matched older adults with no history of falls (Tab.1). The recruitment of fallers took place between May 2013 and July 2013 at the geriatric fall clinic of Bispebjerg Hospital, Copenhagen, Denmark and the non-fallers were recruited at senior society organizations in Copenhagen, Denmark. Participants in both groups had to be at least 65 years or older and with a minimum score of 27 in the mini-mental state examination, ability to ambulate independently with or without use of a cane, and with no severe hearing and vision impairments. In this study, a fall was defined as “an unexpected event in which the participant came to rest on the ground, floor, or lower level“ [13].

**Table 1** Characteristics of the participants

<i>Characteristics</i>	<i>All</i> (n=43)	<i>Fallers</i> (n=20)	<i>Non-fallers</i> (n=23)
Age (yr.)	74.2±6.1	75.9±6.5	72.8±5.5
Weight (kg)	69.5±14.7	69.7±13.7	69.3±15.8
Height (cm)	167.4±8.0	165.1±6.5	169.4±8.8
Women (men)	33 (10)	16 (4)	17 (6)

### 2.2 Design

The study was a case-control study with age and gender matched cases and controls (Fig. 1). To ensure transparency the study followed the STROBE statement ‘STrengthening the Reporting of OBServational studies in Epidemiology’ [14]. In addition, the study was conducted according to the Declaration of Helsinki and all participants gave their written informed consent prior to enrollment. Finally, the local ethics committee of the North Denmark Region and the Danish Data Agency approved the study.

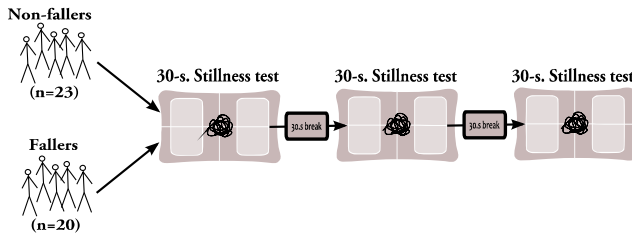


Fig. 1 Illustration of the design of the study

### 2.3 Wii Stillness Protocol

The Stillness test is a 30-second bilateral undisturbed balance test and is most likely an approximation of the movement of the Centre of Pressure (COP) in the anterior-posterior and medial-lateral plane. The outcome from the test is a stability score (between 0 and 100%) where a higher degree of stability or steadiness is given as a high percentage and vice versa (Fig. 2). The original Stillness test was intended to have people look at a TV with visual feedback from a red dot, which indicates movements in the anterior-posterior and medial-lateral plane. However, in this study, to avoid a learning effect the TV was turned off, participants did not receive visual feedback, and instead were instructed to focus on a visual focal point positioned in eye height on a wall three meters away [10]. In addition, participants were asked to remain as still as possible in a barefooted-bilateral (hip-width) standing position with arms hanging relaxed at both sides. Participants performed three successive trials of the Stillness test, separated by 30 seconds of rest between trials as this previously has been shown to be highly reproducible in older adults[10].



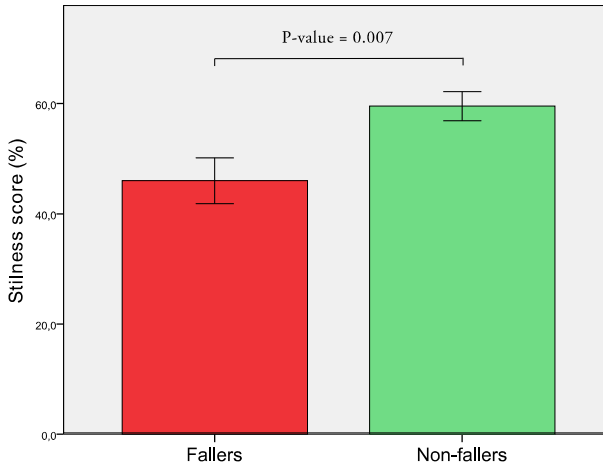
Fig. 2 Screenshot of the Stillness test with outcome score in percent

### 2.4 Statistical Analysis

Statistical analysis was performed using SPSS (version 20, IBM, New York, USA). The Shapiro-Wilk test was used to evaluate normality of distributions in the Stillness test for the two groups. Differences in characteristics and Stillness scores between fallers and non-fallers were assessed by an independent t-test (two-tailed) and Levene’s test was used to assess equality of variances. A p-value of <0.05 was considered statistically significant.

### 3 Results

The mean Stillness score in the Faller group was 46% (95%CI: 37.3% to 54.7%) while in the non-faller group it was 59.6% (95%CI: 54.1% to 65.0%). The independent t test revealed a significant difference between the two aged and gender matched groups ( $P=0.007$ ). This difference in scores between groups corresponds to approximately 23% percent (calculated relative to the non-fallers mean score).



**Fig. 3** Mean and SE of the Stillness Score for the faller and non-faller group

### 4 Discussion

This is the first study to compare age and gender matched fallers and non-fallers using standard Nintendo Wii software (Stillness test). The results showed that non-fallers performed significantly better than fallers in the Stillness test.

A recent meta-analysis of the discriminative ability of the Timed Up and Go test showed an 8.7% relative difference between healthy fallers and non-faller[15]. This discriminative ability is clearly lower when compared to the results of the present study where a ~23% difference was seen between groups.

Previously we have demonstrated that the Stillness test is a highly reproducible test of static balance in community-dwelling older adults, and that a strong correlation was seen between the COP ellipse ( $\text{mm}^2$ ) recorded on a force plate and the Stillness test [10]. In addition, the test is low-cost as the whole system can be purchased for ~100 euro compared to the average price of a force plate (~8000 euro). Also, the Stillness test is widely available across the world and many physiotherapy clinics already have invested in a complete Nintendo Wii system. We therefore believe that the Stillness test could potential serve as a good

alternative to existing tools/scales for assessment of standing balance and predict falls. However, for the Stillness test to be adapted into clinical practice with the purpose of predicting fall accidents, future prospective cohort studies should explore sensitivity and specificity of the test.

## 5 Conclusion

The Study showed that the Stillness test can differentiate between age- and gender matched fallers and non-fallers. Moreover, the test is low-cost, time-efficient, and easily accessible around the world and could therefore become a good alternative to existing tools/scales for assessment of standing balance.

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