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To Find Convergent and Predictive Validity of Three Scales Related to Falls in Functionally Independent Older Adults: A Cross-Sectional Study

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ABSTRACT

Background and Objective: Age related changes lead to falls and fear of fall. From many scales, Berg Balance Scale (BBS) a gold standard, Fullerton Advanced Balance Scale (FABS) for highly functioning older adults are objective tools of balance whereas Falls Efficacy Scale International (FES-I) is a subjective tool. The present study was intended to establish the convergent validity of FES-I with that of FABS and BBS and also to find which of these tools is most valid in predicting the risk of falls among the functionally independent older adults**.**
Methodology: In this descriptive cross-sectional study 100 participants were included based on selection criteria. The subjects were asked to answer three questions related to fall and fear of fall and also were assessed on three assessment tools.
Results: The results showed a significant moderate correlation between FES-I and BBS ($r = -0.62$, $P < 0.0001$), FES-I and FABS ($r = -0.48$, $P < 0.0001$), and BBS and FABS ($r = 0.58$, $P < 0.0001$). The percent of variance explained by FES-I, BBS, and FABS for frequency of falls, frequency of leaving the home and activity restriction were (21, 30, 20), (10, 20, 20) and (31, 28, 16) respectively.
Conclusion: The three scales are measuring different constructs and none of them is able to accurately predict the fall risk among highly functioning older adults.

Key Words: Convergent Validity, Predictive validity, Falls Efficacy Scale International (FES-I), Berg Balance Scale (BBS), Fullerton Advanced Balance Scale (FABS), Fall risk.

INTRODUCTION

The worldwide population is progressively aging and the number increases year by year globally. [(1)] Aging is "The progressive accumulation of changes with time, associated with or responsible for the ever increasing susceptibility to disease and death which accompanies advancing age." [(2)]

Due to age related changes in muscle and sensory function, elderly people complain of postural disturbances. [(3)] Good balance and mobility are necessary for the performance of activities of daily living and recreational activities. [(4)] Diminished balance may be associated with an increased risk of falling. [(5, 6)]

Fall can be defined as "A sudden, unintentional loss of balance leaves the individual in contact with the floor or another surface such as a step or chair." [(7)] Falls are also sixth leading cause of death in the elderly population. [(8)] Fall and unstable balance rank high among serious clinical problems and impairment of hearing and memory also tend to increase the number of

trips and stumbles. [9] Falls often occurs during routine activities of daily living, [10] which lead to laceration with suture, [11,12] dislocations, sprains and fractures. [13]
Falls also have psychological consequences like fear of fall and loss of confidence that result in self-restricted activity. [14] To identify the people at risk is the key challenge in the prevention of falls and this identification will facilitate both preventive and rehabilitative therapies to ameliorate the adverse effect of functional decline. [15]

Balance can be analysed directly by quantifying the position of body's center of mass in relation to the base of support and alternatively can also be measured directly by observation, self-reporting or other reporting methods such as objective test of functional activities. [16]

Several studies have used scales to measure risk of falls in elderly and commonly used scales are the Berg Balance Scale (BBS), [17] the 'time up and go test(TUG), [18] the 'get up and go test' (GUG), [19] the performance oriented assessment of balance (POAB), [20] the functional reach test (FR), [21] the Activities-specific Balance Confidence (ABC)Scale, [8] the Survey of Activities and Fear of Falling in the Elderly (SAFE) [8] and the falls efficacy scale (FES). [22-24]

The widely used balance performance test to assess balance in elderly people is Berg Balance Scale. The BBS has 14 items (1 sitting and 13 standing items) which are based on 5-level scores, ranging from 0-56. Cut off score of BBS is 45/56.The BBS has high inter-rater (ICC=0.88-0.99) and intra-rater reliability (ICC=0.68-0.99) and construct validity correlations between BBS and the Barthel Index were excellent (r=0.80 to 0.94), and correlations between the BBS and the Fugal Mayer-balance (FM-B) ranged from adequate to excellent (r=0.62 to 0.94). [24,25]

One previous study concluded that those older adults who score higher than the cut off score on Berg Balance Scale were less likely to fall than were those adults who score below the cut off score. [26] But there are some contradicting studies which suggest that use of BBS to identify the people at high risk of fall should be discouraged because it fails to identify the majority of such people. [15]

For the highly functioning older adults long form Fullerton Advanced Balance (FAB) scale is used as a predictive measure of fall. [27] The long form FAB scale is a 10 item scale which is based on 5 level scores, ranging from 0-40. The scale has a cut off score of 25 and good test retest reliability 0.96. Individual item correlation of Fullerton Advance Balanced Scale is 0.52 to 0.82. Also, it is an objective type of measure. [28]

From the subjective type of measurement the Fall Efficacy Scale - International also has excellent reliability and validity. [29] The scale was developed and validated by the prevention of Falls Network Europe and it is a highly accepted tool for assessing falls. [30] The FES –I is a 16 item questionnaire, including the 10 original items from the FES (with some rewording where necessary) and six new items and assesses level of concern about falling when carrying out each activity on a four point scale (1= not at all concerned, 4= very concerned). Both, the internal reliability and test-retest reliability of FES – I were 0.96. One of the recommendations given by the authors of FES – I is to carry out a study to examine the correlations of FES –I score with other objective measures of balance. [29]

Convergent validity indicates that two measures believed to reflect the same underlying phenomenon will yield similar results or will correlate highly. Predictive validity attempts to establish that a measure will be a valid predictor of some future criterion score. [31]

PURPOSE & SIGNIFICANCE OF THE STUDY:

The present study is intended to establish the convergent validity of FES-I (which is a subjective measure), with that of FABS and BBS (which are objective measures) and

also to find which of these tools is most valid in predicting the risk of falls among the functionally independent older adults. This information would be helpful in identifying people at risk of falls among them.

AIMS AND OBJECTIVE OF THE STUDY:

To determine the convergent and predictive validity of Falls Efficacy Scale – International, Fullerton Advanced Balance Scale and Berg Balance Scale in highly functioning older adults.

MATERIALS AND METHODS

A descriptive cross-sectional study design has been adapted for this study. A total of 100 elderly participants were selected from old age homes and temple community residents. Permission for ethical clearance from the institute and respective places where the study was done was obtained.

The participants were recruited using a purposive sampling technique. The study was done on elderly people between the age of 60 and 80 years of both genders living independently using any assistive device into the community. They also were checked and only included if their Mini Mental State Examination (MMSE) Score >23 and modified Barthel index score is 20. According to their record participants who had musculoskeletal problems such as amputation, any neurological disorder, high blood pressure, vertigo or heart disease were excluded from this study.

A written consent form was obtained and whole procedure was explained to participants. A general geriatric assessment was also taken. After that participants were asked to fill a brief questionnaire consisting of following questions:

How many falls have you had in the past year?

How often did you leave your home in the past week?

How many of the following places you do not go because you are afraid of falling? [8] (To know level of restriction) (temple, church or masjid, mall, relative function or movie, restaurant) (Each one is given score 1. If they are able to visit all the places without fear of fall the score given is 0. And according to their fear of fall in visiting these four places the score is given 1, 2, 3, and 4.)

ASSESSMENT TOOLS:

The Berg Balance Scale included 14 functional activities performed in a standard order. The tasks ranged from relatively simple to quite complex. Each task was scored on a five point ordinal scale (0 to 4). The subject received points on a skill for the quality of the performance, the time taken to complete the skill, and/or the time the subject can maintain a specified posture. The maximum score for the Berg Balance Scale was 56.

The long form Fullerton Advanced Balance Scale included 10 functional activities performed in a standard order. The tasks ranged from relatively simple to those requiring better functional skills. Each task was scored on a five point ordinal scale (0 to 4). The subject received points on a skill for the quality of the performance, the time taken to complete the skill, and/or the time the subject maintained a specified posture. The maximum score for the long form FAB scale is 40.

Falls Efficacy Scale-International (FES-I) was an instrument to measure fear of falling. It was a 16-item questionnaire, either self-administered or administered through interviews that asked respondents to rate their level of confidence in performing common activities. Each item was rated on a 4-point scale, with 1 indicating "not concerned" and 4 indicating "very concerned". (Where 1-no concerned, 2-somewhat concerned, 3-fairly concerned, 4-very concerned)

STATISTICAL ANALYSIS:

The data analysis was done by using the statistical software SPSS16 (Inc., Chicago, IL) for windows. The descriptive statistics were calculated for age, gender,

MMSE score, MBI score, number of falls in the past year, frequency of leaving home in the last week, and level of activity restriction. To determine the convergent validity Pearson correlation coefficients were calculated at 0.01 level of significance. The square of the correlation coefficient provided the percentage of explained variance. [32] The percent explained variance is a measure that provides information about how well knowledge of one score can be used to predict another score on another test. [8]

RESULTS

The mean age of the participants was 68.86 years with a SD of 6.53 years. Among the 100 participants, 52 were males and 48 were females. The mean (SD) of MMSE score was 27.74 (1.74). All the 100 participants had a score of 20 in MBI (Table 1).

Table 1: Summary of Basic Characteristics

Characteristics	Statistic
Age† (Mean, SD)	68.86, 6.53
Gender (n, %)	
Male	52, 52
Female	48, 48
MMSE Score (Mean, SD)	27.74, 1.74
MBI (Mean, SD)	20, 0.0

† **Age in years; MMSE: Mini-Mental State Examination; MBI: Modified Barthel Index**

Out of 100 participants, 39 did not report a fall, 35 reported at least one fall, 19 reported two falls, 4 reported three falls, and 3 reported four falls within the last year; 22 participants did not leave the home, 2 persons left the home at least 1 time, only one person left the home for a maximum frequency of 20 times, whereas the remaining participants had a frequency of leaving the home between 2 and 15 times in the past week; 32 participants did not restrict their activity and the remaining 68 restricted their activity due to a fear of falling. On average, participants left their homes 5.6 times per week and exhibited one activity restriction in their daily routine.

The convergent validity by Pearson correlation coefficients showed a significant moderate correlation between FES-I and BBS (r = -0.62, P< 0.0001), FES-I and FABS (r = -0.48, P< 0.0001), and BBS and FABS (r = 0.58, P< 0.0001) at 0.01 level infer that, though all these 3 measures are related, they measure more variable constructs.

Pearson correlation coefficients were calculated to determine (predictive validity) which of the three assessment tools could best distinguish a sample of individuals who had previously fallen, who leave their home on a regular basis, and who restricted activities. The percent of variance explained by FES-I, BBS, and FABS for frequency of falls were 21, 30, and 20 respectively. For frequency of leaving the home, FES-I explains 10% of variance, whereas both BBS and FABS explain 20% of variance. Thirty one percent of variance was explained by FES-I, whereas only 28% and 16% of variance were explained by BBS and FABS respectively in activity restriction (Table 2).

Table 2: Correlation between FES-I, BBS, and FABS and Frequency of Falls, Frequency of leaving the home and Level of activity restriction

Assessment tools	Frequency of Falls			Frequency of Leaving the Home			Level of Activity Restriction		
	R	r^2	%of Variance unexplained (1.00- $r^{2)}$	R	r^2	% of Variance unexplained (1.00 – r^2)	r	r^2	% of Variance unexplained (1.00 – r^2)
FES-I	0.45*	0.21	0.79	-0.31*	0.10	0.90	0.56*	0.31	0.69
BBS	-0.54*	0.30	0.70	0.45*	0.20	0.80	-0.53*	0.28	0.72
FABS	-0.45*	0.20	0.80	0.45*	0.20	0.80	-0.40*	0.16	0.84

r: Pearson Correlation Coefficient; r^2: Coefficient of determination; *P value significant at 0.01 level; **FES-I**: Fall Efficacy Scale International; **BBS**: Berg Balance Scale; **FABS**: Fullerton Advanced Balance Scale

DISCUSSION

The findings of this study revealed that none of these assessment tools (FES-I, BBS, and FABS) are measuring similar constructs, although they are significantly related to each other. Moreover, the frequency of falls is best predicted by BBS, but still none of these tools could accurately predict frequency of falls as 70% of variance is unexplained. Both BBS and

FABS, predict the frequency of leaving the home in a better way compared to FES-I. With respect to activity restriction, FES-I is the best predictor, but still 69% of variance is unexplained. Hence none of these tools are accurately predicting the frequency of falls, frequency of leaving the home, and level of activity restriction.

Schott N did a study to find out the reliability and validity of the German version of the FABS. He found that FABS and BBS were moderately correlated with each other (r=0.685). [33] Debra J. Rose also reported significant moderate correlation (r=0.75) between FABS and BBS and suggested that the two tests were measuring a similar construct, but it was not so high as to suggest that two scales were necessarily measuring the same dimensions of balance [28] which is in line with one of the findings of this study that a statistically significant moderate correlation obtained between FABS and BBS (r = 0.58, *P*< 0.0001).

Susan W and colleagues reported that the predictive validity of BBS is superior in identifying the multiple falls rather than other types of falls in community dwelling elderly people, which is inconsistent with the findings of the present study that BBS is the best predictor of frequency of falls compared to FES-I and FABS. [15]

On contrary, Brauer and Colleagues reported that none of the clinical balance tests (i.e., BBS, Forward Reach Test, Lateral Reach Test, and Step-Up Test) predict the faller status, either alone or in combination, in higher functioning group of older adults. [34] Boulgarides and colleagues also studied the predictive validity of 5 clinical tests of balance and gait, including the BBS, among the 99 relatively healthy, high functioning older adults and suggested that neither BBS nor any of the other 4 clinical balance tests (i.e., Modified Clinical test of Sensory Interaction on Balance, Limits of Stability, Timed Up and Go Test, and the Dynamic Gait Index) could predict faller status. Hence it is clearly understood from these studies that the current clinical balance tests are having the shortcomings in detecting the subtle changes in balance abilities that are likely occurring in independently functioning older adults. [35]

Bogle Thorbahn and Newton indicated that activity level did not appear to contribute to performance on the BBS in their study, which is in agreement with the findings of the present study where the level of activity restriction is best predicted by FES-I. [36]

Various studies are suggesting that there is a relationship between the fall efficacy (fear of falling) and the balance ability during the functional tasks. [37,38] But Hatch and Colleagues found that 57% of the variance in balance confidence could be explained by balance performance. Functional mobility and subject characteristic examined did not contribute to balance confidence. Thus, balance performance alone is a strong determinant of balance confidence in community dwelling older people. [39] In this study also frequency of falls and frequency of leaving the home are less explained by FES-I which is measuring mainly fear of fall.

Finally, the study result concluded that the BBS, FABS, FES-I are moderately correlated but all are measuring different dimensions of balance. BBS is the goal standard in predicting fall compare to FABS and FES-I. FES-I is best measuring the level of activity restriction but none of the scale is predicting fall in a way that include all the fall related dimensions.

So, there is a need for establishing a scale that can be used in a wide range of contexts. A major advantage of establishing a scale suitable for use in a wide range of contexts is that this will permit direct comparison between studies and population in different countries and settings. [29] Along with that familiarity with different balance instrument in concerns with different outcomes can be helpful in selecting the one most appropriate for clinical setting and clients in order to institute appropriate prevention programs, such as environmental modifications and lifestyle adaptations. [40]

Limitation and Recommendation:

This study used a questionnaire which collected the information related to falls in a retrospective manner to determine the predictive validity of scales (FES-I, BBS, and FABS) and this requires good memory recall form the participants. A prospective cohort study can determine the predictive properties of scales more accurately and will contribute a significant external validity and hence is warranted in future.

CONCLUSION

From the findings of this study, it is clearly understood that none of these scales (FES-I, BBS, FABS) that commonly used for assessing balance and falls are measuring similar constructs though they are significantly related to each other and also none of them (FES-I, BBS, FABS) are accurately predicting the frequency of falls, frequency of leaving the home, and level of activity restriction. Hence it is concluded that only a meagre construct and predictive validity exist for these scales (FES-I, BBS, and FABS) in highly functioning older adults.

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