

Activities-specific balance confidence scale for predicting future falls in Indian older adults

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Background: Activities-specific balance confidence (ABC) scale is a subjective measure of confidence in performing various ambulatory activities without falling or experiencing a sense of unsteadiness.

Objective: This study aimed to examine the ability of the Hindi version of the ABC scale (ABC-H scale) to discriminate between fallers and non-fallers and to examine its predictive validity for prospective falls.

Design: This was a prospective cohort study.

Materials and methods: A total of 125 community-dwelling older adults (88 were men) completed the ABC-H scale. The occurrence of falls over the follow-up period of 12 months was recorded. Discriminative validity was analyzed by comparing the total ABC-H scale scores between the faller and non-faller groups. A receiver operating characteristic curve analysis and a logistic regression analysis were used to examine the predictive accuracy of the ABC-H scale.

Results: The mean ABC-H scale score of the faller group was significantly lower than that of the non-faller group (52.6 ± 8.1 vs 73.1 ± 12.2 ; $P < 0.001$). The optimal cutoff value for distinguishing faller and non-faller adults was ≤ 58.13 . The sensitivity, specificity, area under the curve, and positive and negative likelihood ratios of the cutoff score were 86.3%, 87.3%, 0.91 ($P < 0.001$), 6.84, and 0.16, respectively. The percentage test accuracy and false-positive and false-negative rates were 86.87%, 12.2%, and 13.6%, respectively. A dichotomized total ABC-H scale score of $\leq 58.13\%$ (adjusted odds ratio = 0.032, 95% confidence interval = 0.004–0.25, $P = 0.001$) was significantly related with future falls.

Conclusion: The ABC-H scores were significantly and independently related with future falls in the community-dwelling Indian older adults. The ability of the ABC-H scale to predict future falls was adequate with high sensitivity and specificity values.

Keywords: aged, balance, cross-cultural adaptation

Introduction

In India, “older adults” are defined as individuals aged ≥ 60 years, accounting for 8.6% of the country’s population.¹ It is expected that the proportion of the older population will increase to 11% by 2025 and 19% by 2050.² Falls are a leading public health issue in the older adults.^{3,4} In the Indian population, the prevalence of falls among elderly was between 14% and 53%.^{5,6} In a previous study, the prevalence of fall-related injuries in elderly in developing countries ranged from 1.0% to 6.6%.⁷ Falls can influence psychological functioning, which causes increased fear of falling (FOF).⁸

Several scales and tests, including activities-specific balance confidence (ABC) scale, have been developed for screening the risks of fall and tested in the elderly population.^{9–14} The ABC scale is an instrument developed in English language that measures FOF. Huang and Wang¹⁵ reported a strong internal consistency reliability

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of the ABC scale in community-dwelling elderly. Similarly, Talley et al¹⁶ reported a strong internal consistency reliability and validity of the ABC scale in older women. Myers et al¹⁷ investigated the discriminative and assessment qualities of the ABC scale and reported that the scale is able to distinguish between older adults at various levels of functional mobility. Beninato et al¹⁸ reported that the ABC scale was most accurate in identifying individuals with risk of multiple falls. In addition, Lajoie and Gallagher¹⁹ and Pang et al²⁰ found associations between the ABC scale and risk of falls in older adults and in people with stroke, respectively.

The use of a self-administered scale in a native language would make research and the clinical management more effective. Recently, the ABC scale was adapted into various languages and cultures.^{21,22} Good intra- and inter-rater reliabilities were reported for the Brazilian-Portuguese adaptation and translation of the ABC scale for the Brazilian population.²¹ Similarly, the Chinese Mandarin adaptation of the ABC scale was found to be reliable and valid for the evaluation of balance confidence in the elderly population in mainland China.²² More recently, Moiz et al²³ had reported the psychometric properties of the cross-culturally adapted Hindi version of the ABC scale (ABC-H). This study aimed to examine the ability of the ABC-H scale to discriminate between fallers and non-fallers and to examine its predictive validity for prospective falls.

Materials and methods

Subjects

A sample of 125 subjects, aged 60–86 years, who could read and communicate in Hindi participated. The subjects included neighborhood older individuals, university employees, and patients' attendants at the physiotherapy clinic at Jamia Millia Islamia, New Delhi, India. Patients who received physiotherapy regimen or those with a history of psychotic and cognitive problems were excluded. All subjects gave their written informed consent. The institutional human ethics committee of Jamia Millia Islamia approved the study (JMI/IEC-1210/2011).

ABC-H scale

The ABC-H has been proposed as an alternative balance confidence measure in Hindi-knowing Indian older adults. The ABC-H scale is a self-reported questionnaire providing information on balance confidence in the performance of 16 different daily activities, such as stair climbing, walking in the house, and walking on slippery floors. The questionnaire contains 16 items scored on a range from 0% to 100% (0 indicating no confidence and 100 indicating full

confidence). Its cross-cultural adaptation, validity, and reliability in the elderly population have been established.²¹ The total ABC scale score of ≤ 67 in the original English version indicates an increased risk of fall.¹⁹ All the subjects were requested to answer the questionnaire of the ABC-H scale as reported previously.²³

Prospective fall assessment

The number of falls over the 12-month follow-up period was collected using the monthly mailed “fall calendars” printed on postcards (12 diaries per participant; Figure 1). The participants were advised to record all falls in this calendar and return it back by mail at the end of each month. The participants who indicated falls in a given month were contacted and interviewed to obtain details about the falls recorded. Individuals were grouped as “fallers” if they reported one or more falls and as “non-fallers” if they had no incidence of falls. A faller was characterized as “an individual who has fallen at least once in a given time period”.²⁴ The definition of fall in this study was “any event when the resident unintentionally comes to rest on the floor regardless of the cause”.²⁵

Other measurements

Sociodemographic and clinical data including the total ABC-H score, age, sex, height, weight, body mass index (BMI), educational level, cognitive ability (using the Mini Mental State Examination), use of walking aids, marital status, and number of comorbidities and medications were measured at baseline.

Sample size estimation

Sample size estimation for logistic regressions is a compound problem.²⁶ Sample size was determined using the formula

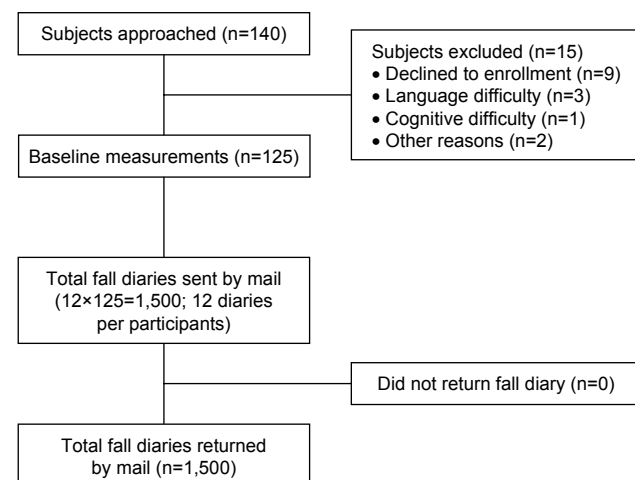


Figure 1 Flow chart showing the number of fall diaries sent and retrieved.

$n=10 k/p$, suggested by Peduzzi et al,²⁶ where p is the smallest of the proportions of positive or negative cases in the population. According to Joshi et al,²⁷ who found a prevalence of falls of (p) 51.5%, and k is the number of covariates (in our study, six independent variables were used). The calculated sample size was 117, and by adding the expected loss, it would be at least 125.

Data analyses

Descriptive statistics, discriminative validity, and logistic regression analyses were conducted using SPSS 21.0. Discriminative validity was investigated by analyzing the total ABC-H scale scores between the faller and non-faller groups using an independent t -test. The ABC-H scale scores of the fallers were expected to be significantly lower than those of the non-fallers. The Med Calc version 13.1.0 (MedCalc Soft., Ostend, Belgium) statistical software was used for analyzing the diagnostic validity indices. The fall diaries served as the tool to categorize the fallers and non-fallers during the 1-year follow-up period. The continuous and dichotomous total ABC-H scale scores of ≥ 58.13 and ≤ 58.13 , respectively, were the test variables. Sensitivity, specificity, Youden index J , area under the curve (AUC), positive and negative likelihood ratios (LR+ and LR-), and positive and negative predictive values (PPV and NPV) were calculated to investigate the predictive ability of the ABC-H scale. The percentage test accuracy (specificity + sensitivity/2), and the false-positive (100 – specificity) and false-negative rates (100 – sensitivity) were calculated manually.

Besides, the logistic regression analysis was performed. The total ABC-H scale score was used as a dichotomous and continuous variable according to the cutoff value selected in the receiver operating characteristic (ROC) curve analysis. First, the odds ratios (ORs) with 95% confidence intervals (95% CIs) were calculated for the ABC-H scale score and other variables at baseline for prospective fall risks using the unadjusted logistic regression. Subsequently, the multivariable logistic regression model was used controlling for age, sex, and the variables significant in the unadjusted logistic regression models to calculate the ORs with 95% CIs for the continuous and dichotomous ABC-H scale scores for the independent prospective fall risk. A P -value < 0.05 was considered statistically significant.

Results

The mean age and the mean BMI were 70.4 ± 6.39 years and 23.65 ± 2.92 kg/m², respectively. Eighty-eight men participated in the study. The demographic attributes of the subjects are shown in Table 1.

Discriminant validity

The total ABC-H scale scores of the fallers ($n=22$) and the non-fallers ($n=103$) were significantly contrast. As expected, the mean total ABC-H scale score of the fallers was significantly below the score of the non-fallers (52.6 ± 8.1 vs 73.1 ± 12.2 ; $P < 0.001$).

ROC curve analysis

The results from the ROC curve analysis (Figure 2), Youden index J , LR+, LR-, PPV, NPV, test accuracy, and false-positive and negative rates are shown in Table 2. Based on the Youden index J and the coordinates of the ROC curve, a cutoff value of the total ABC-H scale score of ≤ 58.13 was proposed for the fallers. With this cutoff value, the ABC-H scale had a sensitivity of 86.36%, specificity of 87.38%, PPV of 59.4%, and NPV of 96.8% (Table 2). The ABC-H scale exhibited a good overall accuracy in identifying subjects with a history of fall with an excellent AUC (AUC = 0.91).

In this study, there were 22 fallers and 19 (86%) had a true-positive test result for the fall. By contrast, 103 were non-fallers; however, 13 (12.6%) had a false-positive test result. The LR+ and LR- were 6.8 and 0.16, respectively. Individuals with falls had seven times more possibility to have a positive test result, compared to those who had no prospective fall in 1 year. Three of the 22 fallers (13.6%) had a false-negative test result, whereas 90 of the 103 non-fallers (87.3%) had a true-negative test result. The ABC-H scale correctly predicted whether subjects would fall over 1 year in 109 out of the 125 participants at baseline (test accuracy = 87.2%).

Logistic regression analysis

The univariate logistic regression models exhibited a lower performance in the ABC-H scale, higher number of comorbidities and medications, and two falls at baseline in the past year, which were significantly related with falling during the 1-year follow-up period (Table 3). Specifically, each percent decrease in the total ABC-H scale score was related with 83% increased odds of future falls, and those with a dichotomized total ABC-H scale score $\leq 58.13\%$ were 0.02 times more likely to have future falls than those with a total ABC-H scale score $\geq 58.13\%$.

The multivariable logistic regression models controlled for age, sex, BMI, number of comorbidities and medications, and two falls in the past year were used to determine the ORs for the diagnostic values of the total ABC-H scale score (Table 4). Each percent increase in the total ABC-H scale score was independently and significantly related with increased risk of future falls (model 1: OR = 0.84, 95%

Table 1 Baseline characteristics of total sample, fallers, and non-fallers

Descriptive variables	Total (N=125)	Fallers (n=22)	Non-fallers (n=103)	P-value
ABC-H score	69.5±14	52.64±8.1	73.10±12.2	<0.001*
Age	70.2±6.39	74.09±5.6	69.47±6.2	0.002*
Age groups, n (%)				
60–65	26 (20.8)	2 (9.1)	24 (23.3)	0.058†
65–69	30 (24.0)	2 (9.1)	28 (27.2)	
70–74	31 (24.8)	6 (27.3)	25 (24.3)	
75–79	27 (21.6)	6 (27.3)	21 (20.4)	
80+	11 (8.8)	6 (27.3)	6 (5.8)	
Sex, n (%)				
Males	88 (70.4%)	10 (45.5%)	78 (75.7%)	<0.005†
Females	37 (29.6%)	12 (54.5%)	25 (24.3%)	
Height (cm)	164.3±5.8	162.4±5.7	164.7±5.7	0.09*
Weight (kg)	64.3±7.2	62.7±7.6	64.7±7.7	0.26*
Body mass index (kg/m ²)	23.8±2.7	23.7±2.3	23.8±2.8	0.82*
Education, n (%)				
Elementary	57 (45.6)	11 (50.0)	46 (44.7)	0.619†
Secondary	30 (24.0)	2 (9.1)	28 (27.2)	
Senior secondary	30 (24.0)	8 (36.4)	22 (21.4)	
College	8 (6.4)	1 (4.5)	7 (6.8)	
MMSE	23.9±18.9	21.3±2.2	24.5±20.8	0.472*
Use of waking aid, n (%)	4 (3.2)	3 (13.6)	1 (0.97)	<0.001†
Marital status, n (%)				
Never married	3 (2.4)	0 (0)	3 (2.9)	0.917†
Married	108 (86.4)	21 (95.5)	87 (84.5)	
Widowed	12 (9.6)	1 (4.5)	11 (10.7)	
Divorced/separated	2 (1.6)	0 (0)	2 (1.9)	
Number of comorbidities	0.54±0.88	1.55±1.05	0.32±0.6	<0.001†
Number of medications	0.50±0.88	1.64±1.0	0.26±0.6	<0.001†
Any falls in previous year, n (%)	22 (17.6)	14 (63.6)	8 (7.8)	<0.001†
Two falls in previous year, n (%)	8 (6.4)	7 (31.0)	1 (1.0)	<0.001†

Notes: Values are mean ± standard deviation, unless otherwise indicated. *Independent t-test, †Pearson's chi-squared test.

Abbreviations: ABC-H, Hindi version of activities-specific balance confidence; MMSE, mini-mental status examination; SD, standard deviation.

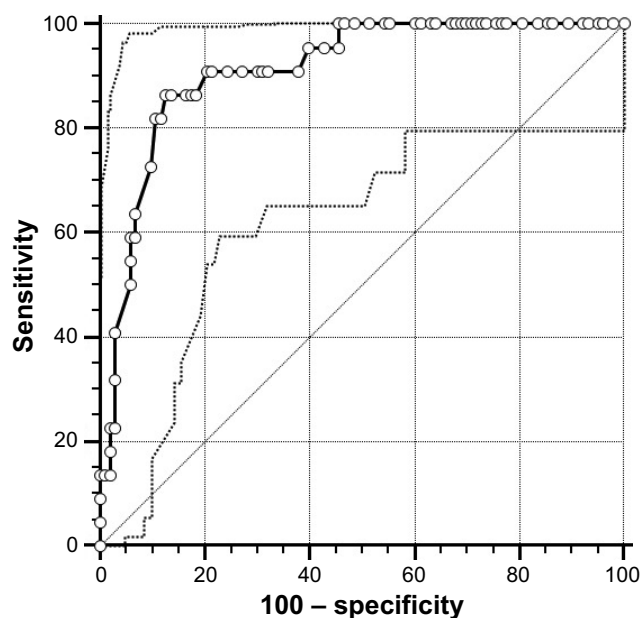


Figure 2 Receiver operating curve analysis for the ability of the Hindi version of activities-specific balance confidence scale to distinguish between fallers and non-fallers (AUC =0.91).

Abbreviation: AUC, area under the curve.

CI =0.75–0.96, $P=0.009$; Table 4). A dichotomized total ABC-H scale score with a cutoff value of $\leq 58.13\%$ was also related with the odds of future falls, adjusted for age, sex, number of comorbidities and medications, and two falls in

Table 2 Diagnostic and predictive values of ABC-H scale

Parameters	Values
Area under the curve (95% CI)	0.91 (0.84–0.95)
Cutoff score	58.13
Youden index J^a	0.73 (0.57–0.86)
Sensitivity (95% CI)	86.36% (65.1–97.1)
Specificity (95% CI)	87.38% (79.4–93.1)
LR+ (95% CI)	6.8 (5.7–8.2)
LR- (95% CI)	0.16 (0.05–0.5)
Positive predictive value (95% CI)	59.4% (40.6–76.3)
Negative predictive value (95% CI)	96.8% (90.8–99.3)
Test accuracy	87.2%
False-positive rate	12.2%
False-negative rate	13.6%

Notes: ^aThe maximum vertical distance between ROC curve and diagonal line. $J = \text{sensitivity} - (1 - \text{specificity})$. Value is (range, 0–1).

Abbreviations: ABC-H, Hindi version of activities-specific balance confidence; CI, confidence interval; LR+, positive likelihood ratio; LR-, negative likelihood ratio.

Table 3 Univariate logistic regression models predicting fall during the 1-year follow-up

Variables	Odds ratio (95% CI)	P-value
ABC-H (continuous)	0.83 (0.77–0.90)	<0.001
ABC-H \leq 58.13	0.02 (0.00–0.08)	<0.001
Age	1.13 (1.04–1.22)	0.003
Female sex	0.26 (0.10–0.69)	0.007
Body mass index	0.98 (0.82–1.16)	0.82
Number of comorbidities	3.90 (2.24–6.80)	<0.001
Number of medications	4.73 (2.61–8.56)	<0.001
Any fall in previous year	0.048 (0.16–0.14)	<0.001
Two falls in previous year	0.21 (0.02–0.183)	<0.001

Abbreviations: ABC-H, Hindi version of activities-specific balance confidence; CI, confidence interval.

the past year (model 2: OR =0.032, 95% CI =0.004–0.25, $P=0.001$).

Discussion

This study examined whether the recently translated self-reported balance confidence scale (ABC-H) predicted future falling in Indian older adults. In this study, the prospective faller group had significantly lower total ABC-H scale scores than the non-faller group, which indicates that people with a prospective fall are more affected by the FOF complex; therefore, they are more restricted in their daily activities. In a previous study, Lajoie and Gallagher reported a total score of 48 and 85 for fallers and non-fallers, respectively, using the original ABC scale.¹⁹ Similarly, in this study, the total ABC-H scale scores of the fallers and non-fallers were 52.6 and 73.1, respectively. However, Powell and Myers reported a total score of 53.7 and 67.7 for the fallers and non-fallers, respectively.¹²

The result of the ROC analysis was used to determine sensitivity and specificity. The primary aim of this study was to identify an optimal cutoff value that would indicate

as many fallers as possible as true positives and older adults without prospective falls (non-fallers) as true negatives. In this study, the optimal cutoff value of the total ABC-H scale score was \leq 58.13 for distinguishing between the fallers and non-fallers in the elderly Indian population. Our cutoff value is slightly lower than that reported by Lajoie and Gallagher in the elderly using the original ABC scale (total score \leq 67%) in a Canadian population.¹⁹ There was no agreement about the general cutoff value for the ABC scale to accurately indicate those at high risk of future falls. Moreover, a variety of cutoff values were suggested for the different diseases. Mak and Pang²⁸ reported a cutoff value of <69% in Parkinson's disease.²⁸ Furthermore, Beninato et al¹⁸ had suggested that a cutoff value of 81.1 in patients with stroke can provide a relative certainty that the individual did not have a history of multiple falls.

In this study, the ABC-H scale correctly identified the number of fallers and non-fallers with sensitivity and specificity values of 86% and 87%, respectively. Similarly, in a cross-sectional study of older individuals living in a Canadian community, Lajoie and Gallagher¹⁹ reported that the original ABC scale correctly classified the fallers and non-fallers with sensitivity and specificity values of 84% and 87%, respectively. In this study, the ROC curve showed that the AUC for the outcomes of falls was 0.91; this indicates that the ABC-H scale provides a good predictive accuracy in screening the outcomes of falls in older adults. A previous study reported that an AUC of 0.8 represents a reasonably effective model.²⁹ In this study, the Youden index J was 0.73, which is a summary statistics of the ROC curves used to evaluate the performance of a diagnostic test.³⁰ It measures the effectiveness of a predictive scale and enables the selection of an optimal threshold value (cutoff) for the scale. Its value ranges from 0 (indicates uninformative tests) to

Table 4 Multivariable logistic regression models predicting falls during the 1-year follow-up

Variables	Model 1		Model 2	
	Odds ratio (95% CI)	P-value	Odds ratio (95% CI)	P-value
ABC-H (continuous)	0.84 (0.75–0.96)	0.009	–	–
ABC-H \leq 58.13	–	–	0.032 (0.004–0.25)	0.001
Age	0.91 (0.76–1.08)	0.28	0.96 (0.81–1.14)	0.68
Female sex	0.56 (0.12–2.49)	0.44	0.61 (0.12–2.97)	0.54
Body mass index	0.91 (0.67–1.24)	0.57	0.89 (0.65–1.23)	0.49
Number of comorbidities	5.15 (0.44–6.04)	0.59	0.34 (0.25–4.68)	0.42
Number of medications	6.97 (0.65–74.0)	0.10	11.57 (0.86–154.13)	0.64
Any fall in previous year	0.83 (0.11–5.84)	0.70	1.22 (0.17–8.58)	0.83
Two falls in previous year	0.53 (0.21–13.8)	0.70	0.23 (0.14–3.88)	0.30

Note: Continuous ABC-H percentage was used in model 1 and dichotomous ABC-H with the cutoff point of 58.13% was used in model 2, both controlling for age, sex, body mass index, number of comorbidities and medications, and two falls in the previous year.

Abbreviations: ABC-H, Hindi version of activities-specific balance confidence; CI, confidence interval.

1 (indicates perfect tests). No previous study reported the Youden index J for the ABC scale.

In this study, the PPV and NPV showed acceptable levels in classifying individuals who reported a fall at the given cutoff values. PPV is the percentage of subjects with positive test results who had prospective falls. NPV is the percentage of subjects with negative test results who had no incidence of fall.³¹ In this study, the PPV was low (59.4%) and the NPV was high (96.4%), which indicates accuracy of the test. The diagnostic values of the test usually depend on the prevalence of the condition in the individuals being tested.³¹ In the presence of a very low prevalence of the disease, the PPV will not be close to 1, even though both the specificity and sensitivity are high.³¹ A standardized approach has been suggested, where the PPV is normalized to a sensitivity prevalence of 50%.³² In this study, the non-faller group had a higher proportion (n=103) than the faller group (n=22); therefore, the PPV was low and the NPV was high. If all participants had a history of fall, the PPV and NPV would be 100% and 0%, respectively. Moreover, in this study, the LR+ was 6.8, indicating that people with a score below 58.13% are seven times more prone to have a fall than those with higher scores.

A previous study indicated that the ORs of the total ABC scale score of -0.041 and that of the ABC question of -0.071 were important predictors of fall.¹⁹ This means that the ABC scale score was related with a 4%–5% greater risk of future falls. The higher risks of future falls demonstrated in this study may be associated with the use of rigorous fall monitoring system using fall diaries than with the reaction time, Berg score and the mean ABC score used as predictors in the past study.

A good-quality data of the fall incidence was the major strength of this study. To identify prospective fall, a fall diary was used, which was recorded by each participant on a daily basis and submitted at the end of each month, in addition to follow-up telephone calls as required. This type of vigorous monitoring system was effective in reducing recall bias.³³

This study had some potential limitations. It is limited to only healthy older adults. Participants with neurologic disorders or musculoskeletal disorders of lower extremities might respond differently. Although the ABC-H scale was able to assess balance confidence, it may not be exhaustive enough to include other fall risk components, such as intrinsic and environmental factors. Furthermore, the small prevalence of the fallers in this study may be attributed to the inadequate sample size; therefore, these results must be interpreted with

caution. Future studies must use a larger sample size for better prediction of the occurrence of falls.

Conclusion

The results provide a strong support for establishing the use of the ABC-H scale as a predictive tool for correctly identifying elderly individuals more susceptible to falls. This would allow health care professionals to screen those with a substantial risk of falling and enroll them in a fall prevention training program.

Acknowledgment

The authors are grateful to the Deanship of Scientific Research, King Saud University for funding through Vice Deanship of Scientific Research Chairs.

Disclosure

The authors report no conflicts of interest in this work.

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