Research Article

Comparison of the Diagnostic Accuracy of Common Balance Measurement Tools in Community-Dwelling Older Adults

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Citation: Meimandi M, Taghizadeh G, Moulodi B, Azad A. Comparison of the Diagnostic Accuracy of Common Balance Measurement Tools in Community-Dwelling Older Adults. Journal of Modern Rehabilitation. 2023; 17(1):103-113. https://doi.org/10.18502/jmr.v17i1.11310

https://doi.org/10.18502/jmr.v17i1.11310

Article info:
Received: 08 Jan 2022
Accepted: 01 Feb 2022
Available Online: 01 Jan 2023

ABSTRACT

Introduction: Balance screening has been identified as a major predictor of falls in the elderly. The current study compares the diagnostic accuracy of various balance instruments in community-dwelling older adults.

Materials and Methods: In this cross-sectional study, 145 older adults were recruited. The Berg balance scale (BBS), Fullerton advanced balance (FAB) scale, dynamic gait index (DGI), performance-oriented mobility assessment (POMA), timed up and go (TUG) test, gait speed, step length, step test, and single item question were administered. The receiver operating characteristics curve analysis was used to calculate diagnostic accuracy.

Results: All single-item tools had moderate diagnostic accuracy (area under the curve [AUC]=0.76-0.89) and all multi-item tools had high diagnostic accuracy (AUC=0.91-0.95) when using the recommended cut-off point of 45 for BBS. All multi-item tools maintained high to moderate diagnostic accuracy (AUC=0.85-1.00) in all thresholds while using BBS severity cut-off points. The FAB scale showed the highest diagnostic accuracy (AUC=0.95) among all assessment tools. Single-item question scores (Wald=22.61, df=1, P=0.0001, Exp(B)=8.82) were significant as covariates in the regression model.

Conclusion: For older adults with or without a history of falling, the FAB scale demonstrated the highest diagnostic accuracy. Along with single-item tools, the FAB scale may be a preferred multi-item tool.

Keywords:

Accidental falls; Diagnostic tests; Geriatric assessment; Older adults; Postural balance

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1. Introduction

Balance deficits are associated with poor performance in daily activities and functional mobility [1-3]. Screening balance has been recognized as a major determinant of falls in older adults. Screening can help clinicians in planning or allocating assistive devices [4-6].

Multiple valid and reliable tools are divulged in rehabilitation to evaluate balance and gait function. Performance-oriented mobility assessment (POMA), Berg balance scale (BBS), Fullerton advanced balance (FAB) scale, and dynamic gait index (DGI) are widely used multiple-item tools [4, 7-9]. While POMA measures both balance and gait, the BBS and the FAB scale are only used to measure balance and the DGI is only used to evaluate gait [10-12]. The BBS is a 14-item scale that is extensively used to measure functional balance in a variety of conditions and settings. The BBS, while thorough, valid, and reliable, is lengthy to be administered (i.e. 45 to 50 minutes) and may not always be feasible in busy outpatient settings [5, 13, 14]. Although the BBS is considered the golden standard [14], it has some drawbacks, such as a ceiling effect in independent older adults, lack of assessing response to perturbation, as well as category redundancy. Therefore, people with mild balance deficits are misdiagnosed and thus are less likely to receive treatment [13, 15]. The FAB Scale evaluates static and dynamic postural control with 10 items in high-functioning older people. Unlike the BBS, the FAB scale evaluates reactive postural control response to perturbation and reflects balance challenges during daily activities. Another merit of the FAB scale is that it's faster to perform (i.e. 10 minutes) than the BBS [5, 13]. Furthermore, the FAB scale has a moderate correlation with the BBS which suggests that these two scales measure similar constructs [5].

The DGI is composed of 8 common gait tasks to measure dynamic balance during walking. The DGI requires less time to complete (i.e. less than 10 minutes) than the BBS and the FAB scale [12, 14]. The DGI measures the ability to modify gait in changing situations with fewer items than the BBS and can be used to accompany scales that only measure static balance. The drawback of the DGI is that it requires more stairs and space with no obstacles to managing [12, 16]. Moreover, the DGI has a moderate correlation with the BBS [14]. The POMA is a performance-based measure with 28 items that measure balance under perturbed conditions as well as gait characteristics. The POMA can be easily performed with a chair and stopwatch in any clinical setting. Balance items in POMA can suggest the need for assistive devices, but the performance of all items is exhaustive for frail older adults [11, 17]. Despite being standard and having high validity and reliability, these tools cause fatigue and frustration in the screening of older adults due to multiple items [18, 19].

On the other hand, the literature suggests that common single-item measures are preferred in older people [19-21]. The timed up and go (TUG) provides more information than other single-item measures mentioned above. Gait speed and step length can be measured via walking at a short distance, and step tests can be administered in a short time (i.e. 15 seconds) [20, 22-24]. These tools are quick, inexpensive, easily executed, informative, and do not need scoring or interpretation. Unlike these pros, single-item measures may fail to record multiple facets of a complex construct, such as balance and gait [25-28].

Occupational therapy guidelines for fall prevention and management recommend providing balance training for older adults [29]. Proper screening should be performed to provide adequate intervention and better outcomes. The pros of the tools must be weighed against the number of false negatives (i.e. those with an impairment that is misidentified). The choice of a measurement tool is critical due to time constraints in clinical settings. This study adds to the growing literature on balance and gait measurement tools. Consequently, the specific aim of the current study is to compare the diagnostic accuracy of single- and multi-item balance tools in community-dwelling older adults.

2. Materials and Methods

Study Design And Participants

This cross-sectional study was conducted from 2019 to 2020. Data from 145 community-dwelling older adults were collected in daily rehabilitation centers in two sessions. The inclusion criteria included being 65 or older, not having musculoskeletal diseases leading to the inability in standing or walking, the ability to walk with or without a walking aid for 6 m, not having a cognitive impairment (i.e. mini-mental status examination ≥21) [30], and not having lower extremity prosthesis. Older adults who unable to provide consent were excluded. Written informed consent was provided before any study procedures.

Procedure

Following recruitment, the purpose and procedures of the study were explained to all participants. Demographic characteristics were recorded and the BBS, FAB Scale, DGI, POMA, TUG, gait speed, step length, and step test were randomly administered in two sessions (i.e. 45 to 60 minutes in each session) for each participant. Fear of falling (FOF) was also recorded with a single-item question (SIQ) [31]. An experienced occupational therapist conducted the evaluations. Rest was provided if participants felt tired, due to the variety of the tests.

Measurements

The BBS evaluates various balance features needed for daily activities. This scale includes 14 items with a 5-point grade. This scale was considered the golden standard with a cut-off point of < 45 in the present study [14].

The FAB scale includes 10 static and dynamic balance activities. Performance is scored using a 5-point Likert scale (0: unable to perform; 4: performing independently) with a maximum score of 40 points [13, 32].

The DGI evaluates dynamic balance by performing eight tasks. The items are scored with a 4-point scale ranging from 0 (lowest level of function) to 3 (highest level of function). Scores on the DGI range from 0 to 24 [14].

The POMA measures gait and balance abilities in older adults. The POMA includes two subscales of balance and gait. The balance subscale (POMA-B) includes 9 items and a maximum score of 16 and the gait subscale (POMA-G) has 7 items with a maximum score of 12. Each item in both subscales is scored on a 2- or 3-point Likert scale. The maximum total score of POMA-T is 28 [17, 33].

The TUG measures functional mobility in dynamic and static balance. The time recorded during rising from a chair, walking 3 meters, turning around, walking back to the chair, and sitting down was considered the participant's score [4].

The gait speed is measured by walking at a comfortable speed over a 5-meter distance. The distance is determined by a tape on the floor to mark the start and end points. Additional tapes are pasted 2 m before and after the course to control acceleration and deceleration. The time in the middle of 5 m was recorded by a stopwatch. This test was performed three times and the average time was considered the participant's score [34].

The step length, as an ambulation parameter, was measured over a 10-meter course. The step length was calculated by the walking distance in the predetermined distance divided by the number of steps [35].

The step test is measured with a 15-cm block which is positioned 5 cm in front of each participant's leg. The number of times the participant can step on and off a block in 15 s is considered the participant's score [24].

The SIQ measures FOF with a simple question. First, the participants were asked 'were you afraid of falling in the past 6 months?'. The next question was 'did you avoid certain activities due to FOF?' Dichotomous variables were 'yes' and 'no' to answer both questions [31].

Statistical analysis

All analyses were conducted using SPSS 16.0 and MedCalc 14.8.1. Descriptive statistics and frequency distributions were calculated for demographic characteristics. Based on a cut-off point of < 45 in BBS, participants were classified with or without balance impairment [36, 37]. The severity of balance impairment measured by the BBS was also determined via the following cut-off points, <20 as balance impairment, >21 to ≤40 as acceptable balance, and >41 to 56 as good balance [38, 39]. Diagnostic accuracy was done by calculating a receiver operating characteristics (ROC) curve analysis to determine the sensitivity (S) (true positive rates), specificity (SP) (true negative rates), positive predictive value (PPV) (true positives/true positives+false positives), Negative Predictive Value (NPV) (true negatives/true negatives+false negatives), as well as the area under the curve (AUC). An AUC of 0.5-0.7, 0.71-0.89, and more than 0.9 are considered acceptable, moderate, and high, respectively [40]. A 95% confidence interval (CI) was considered for all analyses. A comparison of ROC curves was also done to determine the best tool regarding sensitivity and specificity. Multivariate logistic regression analysis was done by considering the best identified tool (i.e. determined by comparing ROC curves) as the dependent variable and SIQ scores as covariates.

3. Results

A total of 145 older adults (Mean±SD of age = 73.68±7.03; male: n=75) participated in the present study. Table 1 presents the descriptive and clinical features of the sample.

Table 1. Demographic and clinical characteristics of participants (n=145)

Variable		Mean±SD/ No. (%)
		All Participants
Sex	Female	70 (48.3)
	Male	75 (51.7)
Age (y)		73.68±7.03
Body mass index (kg/m2)		27.87±4.70
Fall history (6 months)	0	96 (66.2)
	1	29 (20)
	2	16 (11)
	>2	4 (2.8)
Fear of falling	With fear of falling	50 (34.5)
	Without fear of falling	95 (65.5)
Job	Unemployed	20 (13.8)
	Employed	60 (41.4)
	Retired	65 (44.8)
Assistive device use	Yes	4 (2.8)
	No	141 (97.2)
Living arrangements	Alone	17 (11.7)
	With family	128 (88.3)
POMA	Balance subscale	11.48±3.77
	Gait subscale	7.57±2.70
	Total	19.15±6.23
BBS		38.39±11.45
TUG		11.60±5.33
FAB scale		23.77±9.12
DGI		15.13±5.73
Gait speed		0.62±0.16
Step length		40.55±7.56
Step test	Right	5.10±2.40
	Left	5.06±2.36
Mini mental status examination		26.65±2.95

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POMA: Performance-oriented mobility assessment; BBS: Berg balance scale; FAB: Fullerton advance balance; DGI: Dynamic gait index

Table 2. Diagnostic accuracy indexes for measurement tools

Variable \ Scale		Cut-off Point	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)	Area Under the Curve
POMA-T		≤ 21	85.26 (76.5-91.7)	96 86.3-99.5)	70.3 (37.8-90.2)	98.3 (97.3-99.0)	0.94
POMA-B		≤ 13	90.53 (82.8-95.6)	90 (78.2-96.7)	50.1 (30.4-69.8)	98.8 (97.9-99.4)	0.95
POMA-G		≤ 9	89.47 (81.5-94.8)	80 (66.3-90.0)	33.2 (22.1-46.5)	98.6 (97.4-99.2)	0.91
TUG		> 8	85.26 (76.5-91.7)	80 (66.3-90.0)	32.1 (21.3-45.3)	98 (96.7-98.8)	0.89
FAB		≤ 26	87.37 (79.0-93.3)	94 (83.5-98.7)	61.8 (35.0-82.9)	98.5 (97.5-99.1)	0.95
DGI		≤ 16	82.11 (72.9-89.2)	90 (78.2-96.7)	47.7 (28.3-67.8)	97.8 (96.7-98.6)	0.93
Step test	Right	≤ 5	78.95 (69.4-86.6)	80 (66.3-90.0)	30.5 (20.0-43.5)	97.2 (95.8-98.1)	0.84
	Left	≤ 5	84.21 (75.3-90.9)	84 (70.9-92.8)	36.9 (23.5-52.6)	98 (96.7-98.7)	0.86
Gait speed		≤ 0.625	86.32 (77.7-92.5)	70 (55.4-82.1)	24.2 (17.2-33.0)	97.9 (96.4-98.7)	0.86
Step length		≤ 41	74.74 (64.8-83.1)	64 (49.2-77.1)	18.7 (13.5-25.4)	95.8 (93.8-97.2)	0.76

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POMA-T: Performance-oriented mobility assessment-total; POMA-B: Performance-oriented mobility assessment-balance subscale; POMA-G: Performance-oriented mobility assessment-gait subscale; DGI, dynamic gait index; FAB, Fullerton advanced balance; TUG, timed up and go; CI, confidence interval.

Table 3. Validity parameters for discriminating impairment severity

Scales	POMA-T	POMA-B	POMA-G	TUG	FAB	DGI	Step Test Right	Step Test Left	Gait Speed	Step Length
	Parameters No or Mild Impairment vs. Moderate Impairment									
Area under the curve	0.90	0.92	0.86	0.85	0.94	0.92	0.82	0.84	0.81	0.76
Cut-off point	≤20	≤12	≤9	>8	≤25	≤16	≤5	≤5	≤0.625	≤38
Sensitivity (95% CI)	80.28 (69.1-88.8)	87.32 (77.3-94.0)	90.14 (80.7-95.9)	85.92 (75.6-93.0)	91.55 (82.5-96.8)	88.73 (79.0-95.0)	83.10 (72.3-91.0)	88.73 (79.0-95.0)	87.32 (77.3-94.0)	59.15 (46.8-70.7)
Specificity (95% CI)	87.50 (76.8-94.4)	85.94 (75.0-93.4)	67.19 (54.3-78.4)	68.75 (55.9-79.8)	89.06 (78.8-95.5)	84.37 (73.1-92.2)	73.44 (60.9-83.7)	75 (62.6-85.0)	60.94 (47.9-72.9)	76.69 (67.8-88.7)
Positive predictive value (95% CI)	41.6 (27.0-58.0)	40.8 (27.2-56.0)	23.4 (17.6-30.4)	23.4 (17.3-30.8)	48.2 (31.5-65.3)	38.7 (26.2-52.9)	25.8 (18.6-34.6)	28.3 (20.4-37.8)	19.9 (15.3-25.5)	24.4 (16.1-35.3)
Negative predictive value (95% CI)	97.6 (96.1-98.5)	98.4 (97.0-99.1)	98.4 (96.7-99.2)	97.8 (96.0-98.8)	99.0 (97.8-99.5)	98.5 (97.2-99.2)	97.5 (95.8-98.5)	98.4 (96.8-99.2)	97.7 (95.8-98.8)	94.6 (92.8-96.0)
Parameters	**Moderate Impairment vs. Severe Impairment**									
Area under the curve	0.94	0.90	0.90	0.75	0.99	0.85	0.79	0.78	0.83	0.51
Cut-off point	≤10	≤6	≤3	>17	≤10	≤8	≤2	≤2	≤0.5	≤31
Sensitivity (95% CI)	90 (55.5-99.7)	80 (44.4-97.5)	80 (44.4-97.5)	90 (55.5-99.7)	100 (69.2-100)	90 (55.5-99.7)	80 (44.4-97.5)	70 (34.8-93.3)	90 (55.5-99.7)	30 (6.7-65.2)
Specificity (95% CI)	88.73 (79.0-95.0)	87.32 (77.3-94.0)	92.96 (84.3-97.7)	59.15 (46.8-70.7)	97.18 (90.2-99.7)	69.01 (56.9-79.5)	76.06 (64.5-85.4)	80.28 (69.1-88.8)	66.20 (54.0-77.0)	87.32 (77.3-94.0)

Scales	POMA-T	POMA-B	POMA-G	TUG	FAB	DGI	Step Test		Gait Speed	Step Length
							Right	Left		
Positive predictive value (95% CI)	47 (30.9-63.8)	41.2 (26.1-58.2)	55.8 (33.9-75.6)	19.7 (14.7-25.7)	79.8 (50.2-93.9)	24.4 (17.7-32.6)	27.1 (18.1-38.4)	28.3 (17.5-42.3)	22.8 (16.7-30.3)	20.8 (7.9-44.8)
Negative predictive value (95% CI)	98.8 (92.5-99.8)	97.5 (91.9-99.3)	97.7 (92.4-99.3)	98.2 (89.1-99.7)	100	98.4 (90.6-99.8)	97.2 (90.8-99.2)	96 (90.3-98.4)	98.3 (90.2-99.7)	91.8 (88.1-94.4)
Parameters	No or Mild Impairment vs. Severe Impairment									
Area under the curve	1.00	1.00	0.99	0.98	0.99	0.99	0.92	0.95	0.97	0.75
Cut-off point	≤11	≤7	≤6	>16	≤10	≤10	≤2	≤3	≤0.55	≤35
Sensitivity (95% CI)	100 (69.2-100)	100 (69.2-100)	100 (69.2-100)	90 (55.5-99.7)	100 (69.2-100)	100 (69.2-100)	80 (44.4-97.5)	90 (55.5-99.7)	100 (69.2-100)	50 (18.7-81.3)
Specificity (95% CI)	100 (94.4-100)	100 (94.4-100)	96.87 (89.2-99.6)	98.44 (91.6-100)	98.44 (91.6-100)	96.87 (89.2-99.6)	95.31 (86.9-99.0)	93.75 (84.8-98.3)	85.94 (75.0-93.4)	93.75 (84.8-98.3)
Positive predictive value (95% CI)	100	100	78 (47.6-93.3)	86.5 (47.5-97.8)	87.7 (50.4-98.0)	78 (47.6-93.3)	65.5 (37.6-85.7)	61.5 (37.7-80.9)	44.1 (30.1-59.1)	47.1 (22.3-73.4)
Negative predictive value (95% CI)	100	100	100	98.9 (93.2-99.8)	100	100	97.7 (92.5-99.3)	98.8 (92.9-99.8)	100	94.4 (90.1-96.9)

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POMA-T: Performance-oriented mobility assessment-total; POMA-B: Performance-oriented mobility assessment-balance subscale; POMA-G: Performance-oriented mobility assessment-gait subscale; DGI: Dynamic gait index; FAB: Fullerton advanced balance; TUG: Timed up and go; CI: Confidence interval.

Table 4. Receiver operating characteristics curve comparisons for measurement tools

Measurement Tools	Area Under the Curve	Standard Error	95% CI
FAB Scale	0.95	0.022	0.90-0.98
POMA	0.94	0.019	0.89-0.97
DGI	0.93	0.018	0.88-0.97
TUG	0.89	0.026	0.82-0.93
Gait speed	0.86	0.029	0.80-0.91
Step test	0.84	0.034	0.77-0.90

JMR

POMA: Performance-oriented mobility assessment; DGI: Dynamic gait index; FAB: Fullerton advanced balance; TUG: Timed up and go; CI: Confidence interval.

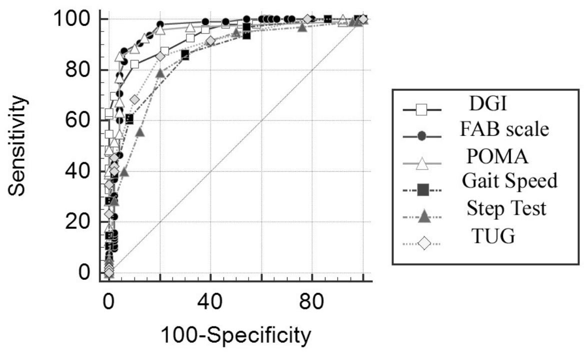

Figure 1. Comparison of receiver operating characteristics curves for various balance measurement tools JMR

By considering the recommended cut-off point of < 45 for BBS, 65.5% (n=95) of the whole sample had balance impairments. Using this cut-off point as an external criterion for other measurement tools, high diagnostic accuracy (AUC=0.91-0.95) was calculated for performance-oriented mobility assessment-total (POMA-T), performance-oriented mobility assessment-balance (POMA-B), performance-oriented mobility assessment-gait (POMA-G), FAB scale, and DGI. Moreover, moderate diagnostic accuracy (AUC=0.76-0.89) was obtained for TUG, gait speed, step test, and step length. Table 2 lists the calculated validity parameters used to compare the diagnostic accuracy of each measurement tool.

As shown in Table 3, by considering the severity cut-off points of BBS (i.e.< 20 as balance impairment, >21 to ≤40 as acceptable balance, and >41 to 56 as good balance), in the no or mild impairment vs. moderate impairment, high diagnostic accuracy (AUC=0.90-0.94) was obtained for POMA-T, POMA-B, FAB scale, and DGI. By raising the threshold and confronting moderate impairment and severe impairment, the POMA-T, POMA-B, and FAB Scale maintained their high diagnostic accuracy, but the DGI (AUC=0.85) downgraded to moderate diagnostic accuracy next to the TUG (AUC=0.75), step test (AUC: Right=0.79, left=0.78), and gait speed (AUC=0.83). Also, step length was demoted to acceptable (AUC=0.51) diagnostic accuracy. By challenging older adults with no or mild impairment vs. severe impairment, all the measurement tools, such as POMA (total score and both subscales), FAB scale, DGI, TUG, step test, and gait speed had high (AUC=0.92-1.00) diagnostic accuracy except for step length that had moderate (AUC=0.75) diagnostic accuracy.

A comparison of ROC curves was performed for measurement tools that maintained moderate and high diagnostic accuracy when discriminating impairment severity. Among all the measurement tools, FAB scale had the highest diagnostic accuracy (AUC=0.95 [CI=0.90-0.98], standard error= 0.02). Table 4 and Figure 1 show further information.

In the regression model obtained for older adults with balance impairments versus without balance impairments, using the FAB scale scores as the dependent variable and SIQ scores as covariates, the SIQ scores (Wald=22.61, df=1, P=0.0001, Exp(B)=8.82 [CI95%=3.59-21.63]) were significant.

4. Discussion

The contemporary rehabilitation environment requires valid and convenient outcome measures for goal setting, monitoring processes, and predicting other variables associated with balance and gait problems, such as fall risk. The value of diagnostic tests in both clinical and prevention practices depends on populations with certain conditions. Clinicians all over the world are searching for a single best outcome measure for a specific purpose [40, 41].

To the best of our knowledge, this study is the first research to examine the diagnostic accuracy of various single- and multi-item balance and gait outcome measures for community-dwelling older adults. Several studies have been conducted previously; however, they were not as comprehensive as the present study in terms of instruments studied and they were carried out in other populations [13, 27, 42, 43]. The results of the present study showed that all single-item measures (i.e. TUG, gait speed, step test, and step length) had moderate diagnostic accuracy but multi-item measures (POMA, FAB Scale, and DGI) had high diagnostic accuracy, by using the BBS as the golden standard, with the recommended cut-off points. Also, for discriminating older adults with various balance and gait impairment levels, all multiple-item measures except POMA-G and DGI maintained high diagnostic ability. Moreover, the FAB scale had the highest diagnostic accuracy among all measurement tools with high and moderate diagnostic accuracy in discriminating older adults with various impairment levels. Regression analysis also showed that the FAB scale is suitable to detect fall risk.

Clinically, sensitivity is favored because it leads to more true positives and fewer false negatives [42]. Overall, all multi-item and single-item measures demonstrated good sensitivity compared to BBS. Previous studies reported different cut-off points with lower sensitivity or specificity [11, 22, 44-48]. This discrepancy may be explained by using the BBS as the golden standard in the present study while previous studies used fall history as the criterion. Another reason for these inconsistencies may be the diverse populations in previous studies (i.e. people with vestibular disorders, people with Parkinson's disease, older adults living in nursing homes, and older adults with dementia) [10, 13, 49-51].

Additionally, the efficiency of a scale is described in terms of PPV and NPV values of the cutoff scores. Compared to BBS, single-item measures had lower PPV (i.e. proportion of subjects with a positive test result who had balance impairment) than multi-item measures. As mentioned earlier, single-item tools cannot use all aspects of the balance construct, hence utilizing these tools lead to untimely treatment [25].

When single-item measures were compared to severity cut-off points of BBS, they had high to moderate diagnostic accuracy in challenging older adults with no or mild balance impairment versus older adults with severe balance impairment. However, moderate to acceptable diagnostic accuracy was obtained in discriminating older adults with no or mild balance impairment vs. older adults with moderate balance impairment and differentiating older adults with moderate balance impairment vs. older adults with severe balance impairment. These results indicate that these tools cannot accurately differentiate between older adults with balance impairments. Not identifying a person with moderate balance impairment from those with no or mild balance impairments leads to failure in providing timely interventions [10]. Although these single-item tools are advantageous to help evaluate balance in busy clinical settings, another multiple-item tool is needed alongside them. To the authors' knowledge, no former studies have been conducted on the diagnostic accuracy of balance tools to differentiate between subjects based on their balance capabilities. Hence, these results are novel and cannot be compared with previous studies.

The FAB scale appears to be the most appropriate and applicable measurement tool. The cut-off score of ≤ 26 produced a sensitivity of 87.37% and a specificity of 94% compared to BBS. This cut-off point is similar to those suggested by Hernandez et al. who investigated predictive properties of the FAB scale about fall status in older adults [8]. The high specificity for the FAB scale in the present study compared to Hernandez et al.'s study may be due to the inclusion of older adults without cognitive decline. Cognitive function may alter the performance of items and affect the scores. In addition, since the FAB scale is comprised of more challenging items than those used in other multiple-item instruments, its overall score may indicate subtle balance impairments. This scale is less prone to the ceiling effect and provides more guidance in designing interventions and detecting slight changes in balance abilities. Also, the content validity of this scale was obtained using the theory of postural control systems which means that all neural correlates of balance (i.e. sensory strategies, musculoskeletal systems, neuromuscular synergies, cognition, and adaptive mechanisms) are considered in this scale. Hence, the FAB scale has all the essential items [52]. Approximately 50% of people who fall admit to having FOF [53]. Regression analysis indicated that the FAB scale has a significant relationship with SIQ. Detecting balance impairments can help identify older adults who may have fallen.

This study has several limitations and clinical concerns to consider while using these results. First, the proposed cut-off points are only valid for identifying balance impairments in community-dwelling older adults and may not be appropriate for determining fall risk in other populations or frail older adults in nursing homes. Second, FOF was assessed using a retrospective design. Good memory recall is required to remember the fear of falling and to avoid activities due to FOF. Prospective research design (i.e. following participants for some time) should be done to explore the ability of the FAB scale to predict fall risk. Third, the participants in the present study had no cognitive impairment, therefore these results cannot be generalized to older adults with cognitive decline.

5. Conclusion

In summary, from a clinical point of view, we recommend that to test balance capacities, the FAB scale may be preferred over other multiple-item and single-item scales.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of the Iran University of Medical Sciences (Code: IR.IUMS.REC.1398.1189).

Funding

This study was supported by the research deputy of the Iran University of Medical Sciences (98-2-6-15579).

Authors' contributions

Analyzing, writing the manuscript, and editing: Mahsa Meimandi; Conceptualization, review, supervision, and analyzing: Ghorban Taghizadeh; Data collection: Bahman Moulodi; Conceptualization, supervision, training management, and editing: Akram Azad.

Conflict of interest

The authors declared no conflict of interest.

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