Creating and Validating a Shortened Version of the Community Balance & Mobility Scale for Application in Young Seniors

Shortened Community Balance & Mobility Scale

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ABSTRACT

Background: The Community Balance & Mobility Scale (CBM) was shown to be reliable and valid for detecting subtle balance and mobility deficits in young seniors. However, item redundancy and assessment time call for a shortened version.

Objective: To create and validate a shortened version of the CBM (s-CBM) without detectable loss of psychometric properties.

Design: Cross-sectional

Methods: Exploratory factor analysis with data from 189 young seniors (66.3±2.5; 61-70 years) was used to create the s-CBM. Sixty-one young seniors (66.5±2.6; 61-70 years) were recruited to assess construct validity (Pearson correlation coefficient) by comparing the CBM-versions with Fullerton Advance Balance Scale, Timed Up-and-Go, habitual and fast gait speed, 8 Level Balance Scale, 3 meter tandem walk, and 30 seconds chair stand test. Internal consistency (Cronbach's alpha), ceiling effects, and discriminant validity (area under the curve (AUC)) between fallers and non-fallers, and self-reported high and low function (Late-Life Function & Disability Index) and balance confidence (Activities-Specific Balance Confidence Scale), respectively, were calculated.

Results: The s-CBM, consisting of four items, correlated excellent with the CBM (r=0.97; p<.001). Correlations between s-CBM and other assessments (r=0.07-0.72), and CBM and other assessments (r=0.06-0.80) were statistically comparable in 90% of the correlations. Cronbach's alpha was 0.84 for the s-CBM, and 0.87 for the CBM. No CBM-version showed ceiling effects. Discriminative ability of the s-CBM was statistically comparable to the CBM (AUC=0.66-0.75 vs. AUC=0.65-0.79).

Limitations: Longitudinal studies with larger samples should confirm the results and assess the responsiveness for detecting changes over time.

Conclusions: The psychometric properties of the s-CBM were similar to those of the CBM. The s-CBM can be recommended as a valid and quick balance and mobility assessment in young seniors.

Keywords: postural balance, outcome assessment, psychometrics, mobility

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INTRODUCTION

The largest deterioration of balance, gait and mobility per decade is noted for adults aged 60 to 70 years[1,2]. Several studies [1,3-6] have shown a significant decline in balance ability from the age of 60 during different standing positions (standing on firm surface or foam, eyes open, eyes closed) compared to the other decades. In addition to static balance ability, the largest decline of dynamic balance ability [6], in terms of reduced habitual walking speed [7,8] and increased gait variability [8], has also been reported in the sixth decade. Balance deficits during this decade lead to loss of confidence and increased fear of falling [9], predicting mobility impairments and falls in older age [10].

Despite the increasing knowledge about the importance of detecting and treating early balance deficits, efforts in the field of balance screening and early interventions continue to play a minor role in public health approaches [11,12]. Fall prevention predominately addresses older adults who have already fallen (secondary prevention), rather than early balance deficits via preventive interventions in high-functioning community-dwelling young seniors [13].

Primary prevention of balance deficits requires sensitive and quick to administer low-cost assessment tools without a multitude of equipment. Tools need to be ecologically valid reflecting balance abilities of high-functioning young seniors [14]. Assessments meeting this requirement should not show ceiling effects in this group, which would lead to a limited discriminatory ability and identification of intervention-related changes [15]. In addition to ecological validity, construct validity - the ability to measure a specific construct such as balance – and discriminant validity - the ability to discriminate between different groups - are important psychometric properties for the use of an assessment [16].

Frequently used balance assessments such as the Berg Balance Scale [17] and the Performance Oriented Mobility Assessment [18] have shown limited ecological validity for the use in high-functioning young seniors. A study validating the Balance Evaluation Systems Test (BESTest) found that the BESTest reaches its limits in high-functioning young seniors as well. The study reported a mean value close to the maximum value and a small standard deviation in the group of 60-69 year old, indicating a limited ability to differentiate the balance performance in young seniors [19].These tools were developed to assess basic balance and mobility performance in geriatric populations, but are unable to adequately detect early balance deficits in young seniors [20-22].

In this context, the Community Balance & Mobility Scale (CBM) is being used more often in this younger target group [20-23]. Its tasks are sufficiently challenging and related to daily tasks, making it possible to detect subtle balance deficits. Previous studies analysing the psychometric properties of the CBM in high-functioning young seniors did not find ceiling effects [21,22]. In addition, comparing the CBM with established balance and mobility assessments, the CBM showed good to excellent construct validity [21,22]. For these reasons, the CBM is considered an appropriate assessment tool for the group of high-functioning young seniors.

However, one central drawback is the complexity and length to administer the CBM, limiting the feasibility in public health approaches. The time taken to administer the CBM lies between 20 and 30 minutes [22,24] which might be too long for daily routine use. Also, the extensive equipment needed may be a further reason why the assessment is not carried out. Several studies [20,21,25,26] have shown high internal consistency with a Cronbach's alpha >0.90 for the CBM indicating item redundancies within the scale. Redundancies lead to additional time required to complete the assessment without gathering further information about the individuals' balance performance [27]. For these reasons, the creation of a shortened version of the CBM was repeatedly requested [20-22,28]. The current study aim was to create and validate a shortened version of the CBM, while retaining the psychometric properties in comparison to the full CBM scale.

METHODS

Study design

The shortened version (s-CBM) was created and validated using cross-sectional study designs. Two samples of community-dwelling young seniors aged 60 to 70 years were used, one for creating (sample 1: n=189) and one for validating (sample 2: n=61) the s-CBM. Participants in both samples were recruited within the EU project PreventIT in Germany (Network Aging Research Heidelberg, Robert-Bosch Hospital Stuttgart), the Netherlands (Vrije Universiteit Amsterdam), and Norway (Norwegian University of Science and Technology Trondheim). Baseline data from both samples (collected from May 2016 - March 2017) were used. For both samples, inclusion criteria were being retired, being able to walk 500m without walking aid, and no cognitive impairment (Montreal Cognitive Assessment (MoCA) [29] ≥ 24 points). Exclusion criteria for both samples were being too active (moderate-intensity physical activity ≥150 min/week in the previous three months), current participation in an organised exercise class (>once/week), and severe cardiovascular, pulmonary, neurological, or mental diseases [30,(Schwenk et al. 2019 in press; DOI: 10.1159/000499962)]. Sample 1 was recruited via mail-out after a random draw from local registry data [30]. Sample 2 was recruited via research volunteer databases and by flyers. All participants provided written informed consent prior to participation. Ethical approval was obtained from the respective local institutional review board at each site and was in agreement with the Declaration of Helsinki.

Measures

<u>Descriptive, physical ability and function measures of sample 1 and 2:</u>

Age, sex, Body Mass Index, falls in the last six months, physical measures (Timed Up-and-Go (TUG) [31], habitual gait speed), and self-reported function and participation (Late-Life Function & Disability Index [32]) were collected in a standardised manner.

In addition, all participants were assessed using the original version of the *Community Balance & Mobility Scale* [24]. The CBM is a performance-based measure including 13 static, dynamic, or proactive items: 'Unilateral Stance', 'Tandem Walking', '180 Degree Tandem Pivot', 'Lateral Foot Scooting', 'Hopping Forward', 'Crouch and Walk', 'Lateral Dodging', 'Walking and Looking', 'Running with Controlled Stop', 'Forward to Backward Walking', 'Walk, Look & Carry', 'Descending Stairs', and 'Step-Up x 1' [24]. Six tasks ('Unilateral Stance', 'Lateral Foot Scooting', 'Hopping Forward', 'Walking and Looking', 'Walk, Look & Carry', and 'Step-Up x 1') are performed bilaterally. Standardized instructions and scoring guidelines with detailed rating descriptions (0-5 points) are provided. A score of 0 denotes the inability to perform the task. Scores from 1-5 correspond to better performance (e.g. distance covered, time spent and quality of performance). For 'Descending Stairs' a bonus point can be awarded for successfully carrying a basket while descending stairs leading to a total maximum score of 96 points. Most of the tasks are performed on a predefined track [33], which enables accurate measurement of foot placement, deviation from a straight line, and speed of the task performance. The equipment required includes an eight-meter track with a target laterally mounted on the wall, a stopwatch, a weighted laundry basket (0.9 kg), two weighted bags (3.4 kg each), a beanbag, and a staircase (minimum 8 steps).

<u>Measures used for validating the s-CBM:</u>

Sample 2 completed the following additional series of established measures assessing different domains of balance, self-reported function, and confidence, which are expected to be associated with the CBM for validating the shortened version.

Mobility measures

The *Fullerton Advanced Balance Scale (FAB)* is a valid and reliable tool measuring balance ability in high-functioning older adults [34]. It consists of 10 items requiring static, dynamic, proactive, and reactive postural control tasks under varying sensory conditions. Items are scored from 0 to 4, with higher scores indicating better balance.

The *Timed Up-and-Go (TUG)* assesses functional ability by asking the participant to stand up from a chair (height 45 cm), walk 3 meters at a comfortable and safe pace, turn around, walk back to the chair, and sit down [31]. The time to complete the test is recorded.

Habitual and fast gait speed (cm/s) is assessed while walking a distance of 7 meters. The time to complete is recorded using a stopwatch [35].

The *3 Meter Tandem Walk (3MTW)* assesses dynamic balance ability [36]. Participants are asked to complete the 3MTW with as few errors as possible [36]. Errors are defined as stepping next to the given line or heel-toe distance >8 cm. Number of errors are recorded.

The *8 Level Balance Scale (8LBS)* is an extended version of the Short Physical Performance Battery [37]. Eight static balance tasks with progressing difficulty are performed. Each position needs to be maintained for 15 seconds without support, taking a reactive step or arm movement [36]. The best task performed for 15 seconds is rated.

The *30 seconds chair stand test (30CST)* assesses functional lower extremity strength in older adults [38]. The participant is seated on a chair (45cm height) without arms. On cue the participant raises to a full stand and then returns back to the seated position. The number of full movements (stand and sit) completed within 30 seconds is recorded.

Self-reported function

The *Late-Life Function & Disability Index (LLFDI)* is a self-reported questionnaire to assess function and disability in different activities performed in the community [32,39,40]. The scale is used to evaluate self-reported difficulties in performing physical activities. Scaled scores range between 0 and 100, with higher scores indicating higher levels of function.

Balance confidence

The *Activities-Specific Balance Confidence Scale (ABC)* is a 16-item self-report questionnaire for assessing the degree of confidence to perform common activities within the home and community [41]. Percentage values between 0% (no confidence) and 100% (completely confident) can be achieved.

Statistical Analysis

All data were normally distributed using skewness and kurtosis as criterion [42] and the CBM was therefore treated as a continuous scale [25] and summarized as mean and standard deviation (SD). Number and percentage was used for dichotomous measures.

Creation of the s-CBM

To create the s-CBM, an established procedure including descriptive item analysis [43] followed by the analysis of the structural validity of the CBM based on an exploratory factor analysis (EFA) was used [43-45]. In line with previous approaches for scale-shortening [46,47], an intermediate version (i-CBM) was created which was further shortened (s-CBM) based on the highest item-factor-correlations [48]. Creating and validating different versions was done to find the optimal ratio between feasibility and quality of the psychometric properties.

Item difficulty

First, the individual items and their distribution were analyzed [43]. Items with extreme floor or ceiling values, defined as >50% of the participants achieving the lowest or highest value, were excluded from further analysis [49]. A difficulty index (mean value/maximum value) was calculated for each remaining item [50]. Items with a difficulty index >0.8 or <0.2 were excluded from further analysis [50] suggesting that most of the participants within this cohort were either able to perform these tasks without problems or were unable to perform these tasks.

Structural validity

The internal structure of the assessment was examined by using EFA. Bilaterally performed items, e.g. 'Unilateral Stance left and right' were combined to one item ('Unilateral Stance') to ensure that the bilateral execution of these items was maintained in the shortened versions. A sample size with a subject-to-item ratio >10:1 [51] was applied for the EFA. The Kaiser-Meyer-Olkin (KMO) coefficient was determined and >0.5 was considered suitable for EFA [52,53]. A significant Bartlett's test ($p<0.05$) for sphericity was deemed suitable for EFA [52,53]. The data were then subjected to a principal axis analysis with oblique rotation [43]. Parallel analysis [51,54] was used to estimate the final number of factors obtained from the principal axis analysis [55]. The size of eigenvalues obtained from the principal axis analysis was compared with eigenvalues obtained from a randomly generated dataset of the same size and number of variables. Factors with eigenvalues exceeding the eigenvalues obtained from the random dataset were considered as significant and retained for further investigation [56].

Within each factor, a rotated factor loading for a sample size of at least 100 would need to be ≥0.512 to be considered statistically meaningful [57]. Therefore, items with loading ≥0.512 were considered for the i-CBM.

In the final step, to ensure that the internal structure found in the CBM was maintained in the s-CBM, the number of items was reduced by the same percentage within each factor. The items with the lowest factor loadings were eliminated. This approach has been previously applied when shortened balance scales were created while retaining good psychometric properties [44,46,58]. The remaining items constituted the s-CBM.

Validation of the s- and i-CBM

Sample 2 was used for validating the s- and i-CBM compared to the CBM. Sum scores of the three CBM-versions were calculated and used for the validation. Mean, SD, floor and ceiling effects were calculated for all CBM-versions.

Internal consistency

Internal consistency of the three CBM-versions was assessed by Cronbach‘s alpha. Values >0.70 indicated acceptable homogeneity of the items within the total scale [59]; values >0.90 indicated redundancies [27].

Construct validity

Pearson correlation coefficients were calculated for analysing the construct validity between the three CBM-versions and between each CBM-version and other established assessments [60]. Correlation coefficients of r=0.10-0.30 were classified as small, 0.30–0.50 as medium, and >0.50 as large [61]. To compare the construct validity of the different CBM-versions, values lying in the same range, e.g. between 0.30 and 0.50, were classified as comparable [21].

Comparing the CBM-versions, large correlation (>0.50) between the s- and i-CBM, respectively, and the CBM were expected. In addition, high correlations between the three individual CBM-versions and other assessments were expected if the comparing scales measure similar balance constructs [21,22]. Correlations with assessments measuring only specific components of balance control were expected as moderate (0.30-0.50) [21,22]. Furthermore, correlations with LLFDI and ABC were expected to be moderate (0.30-0.50), based on a previous study [20]. Statistical differences between the Pearson correlation coefficients were calculated [62].

Discriminant validity

The discriminant validity between fallers and non-fallers and self-perceived high- and low-functioning was assessed using the area under the receiver operating characteristic curve (AUC) with 95% confidence intervals (CI). AUC was computed for fallers (≥1 fall) vs. non-fallers. Median split was used to divide the participants into high- and low-functioning based on their perception (LLFDI, ABC). Cut-points for discriminating the ABC- and LLFDI-median-split, respectively, were established for the s-CBM based on examination of receiver-operating characteristic (ROC) curves [63]. The optimal trade-off between sensitivity and specificity is the point on the ROC curve that is closest to the upper left-hand corner of the graph. Statistical differences between the AUCs of the three CBM-versions were analyzed using chi-square tests [64].

Analyses were performed using IBM SPSS (Version 24.0; IBM Inc., New York, USA) and STATA 14.2 (StataCorp). Alpha level was set at $p<0.05$.

RESULTS

Descriptive results of sample 1 and 2 are shown in Table 1. In sample 1, the mean age was 66.3 (2.5) years and 52.4% (n=99) were female (Table 1). Mean value of the CBM was 66.5 (12.3). In sample 2, the mean age was 66.5 (2.6) years and 72.1% (n=44) were female (Table 1). Mean value of the CBM was 65.5 (12.5). Both samples did not differ significantly in any baseline variable, except sample 2 including significantly more females compared to sample 1 (70.6% vs. 52.4%; p=0.020).

Creation of the s- and i-CBM

Item difficulty

Table 2 shows mean, SD, floor and ceiling effects, and difficulty index for each item of the CBM. Extreme ceiling effects were found for 'Descending Stairs' with 70.9% of the participants reaching the maximum score. The difficulty index for 'Descending Stairs' (0.93) and for 'Forward to Backward Walking' (0.82) exceeded the cut-off of 0.8. Based on these criteria these two items were excluded from further consideration.

Structural validity

KMO (0.79) and Bartlett's test ($p<0.001$) verified the sampling adequacy for the principal axis analysis. After oblique rotation, parallel analysis showed a two factor structure (Appendix 1). Factor 1 with an eigenvalue of 4.19 explained 32.2% of variance, factor 2 with an eigenvalue of 1.55 explained further 11.9%. The total variance explained was 44.1%.

Loadings of the items ranged between 0.014 and 0.818 (Appendix 1). Five items had at least a loading of 0.512 on factor 1 ('Unilateral Stance', 'Tandem Walking', '180° Tandem Pivot', 'Lateral Foot Scooting', 'Hopping Forward'), and two on factor 2 ('Walking & Looking', 'Walk, Look and Carry').

These seven items formed the i-CBM, of which five ('Unilateral Stance', 'Lateral Foot Scooting', 'Hopping Forward', 'Walking & Looking', and 'Walk, Look and Carry') are performed bilaterally. Therefore, a maximum of 60 points is achievable on the i-CBM. The items that clustered on the same factor suggested that factor 1 represents balance with reduced base of support, while factor 2 represents dynamic balance with an additional visual target [28].

When further reducing the number of items, the ratio of the items in factor 1 and 2 should be maintained. Therefore, the number of items was reduced by the same percentage within each factor. The items remaining in factor 1 due to the highest loadings were 'Unilateral Stance', 'Lateral Foot Scooting', and 'Hopping Forward'. For factor 2 the item 'Walk, Look and Carry' was maintained. The s-CBM consists of these four items, which are all performed bilaterally (Table 3). Therefore, a maximum score of 40 points is achievable on the s-CBM.

Validation of the s- and i-CBM

Mean, SD, minimum and maximum scores, and floor and ceiling effects for all CBM-versions are presented in Table . No floor or ceiling effects were found for the three CBM-versions.

Internal consistency

Internal consistency (Cronbach's alpha) was 0.87 for the entire CBM, 0.85 for the entire i-CBM (factor 1: 0.83; factor 2: 0.77), and 0.84 for the entire s-CBM (factor 1: 0.81; factor 2: 0.71) (Table 4). All values ranged between the recommended values of 0.70 [59] and 0.90 [27].

Construct validity

The majority of the correlations between the referenced balance and mobility measures and the three CBM-versions, respectively, did not show significant differences (Table 5). The correlations between the CBM-versions and LLFDI-Function scale (r=-0.53 to -0.56) for self-reported function and ABC (r=0.**22**-0.**23**) as a measure for balance confidence did not show significant differences between the three CBM-versions either (Table 5).

Discriminant validity

For discriminating between fallers and non-fallers, AUC ranged between 0.65 and 0.67 (Table 6, Appendix 2A), indicating a limited discriminatory ability between fallers and non-fallers for all CBM-versions. For discriminating between self-reported high and low function (LLFDI), AUC ranged between 0.75 and 0.77 (Table 6, Appendix 2B); for ABC, the AUC ranged between 0.68 and 0.71 (Table 6, Appendix 2C). There were no statistically significant differences in discriminative ability, measured using AUCs between the three CBM-versions (Table 6). CBM ≥ 28 was the optimal trade-off between sensitivity and specificity for the LLFDI median split with a sensitivity of 80% and specificity of 65%. For the ABC median split, CBM ≥ 27 was the optimal trade-off with a sensitivity of 73% and specificity of 58%.

DISCUSSION

Measurement properties including ceiling and floor effects, construct and discriminant validity of the s-CBM are comparable to the CBM. Our findings suggest that the s-CBM can be administered in the target group to screen for balance and mobility deficits, fall risk, and risk for functional impairment without notable loss of information compared to the CBM.

Creation of the s-CBM

Comparing the i-CBM and the s-CBM did not show significant differences except for the slightly **better** construct validity between the i-CBM and FAB compared to s-CBM and FAB. However, this finding does not lead to an essential benefit compared to the longer time required for the execution of the i-CBM. Therefore, the focus of the following discussion is on the s-CBM.

Factor 1 of the s-CBM included items performed on one leg ('Unilateral Stance', 'Lateral Foot Scooting', and 'Hopping Forward'), thus representing the construct of 'balance with reduced base of support' [28]. Reducing the base of support is one principal of increasing the level of balance difficulty. This means that the vertical projection of the centre of mass must be maintained in a smaller area to stay in balance, leading to a more challenging balance task execution [65]. Factor 2 included the item 'Walk, Look & Carry' requiring walking on a line with simultaneous fixation of a laterally attached point and carrying bags. This item combines several balance challenges. Walking on a line reduces the base of support and increases the dynamic balance demand. Looking requires rotating the head to fixate the laterally attached point. These head rotations challenge the vestibular system. Carrying weighted bags in both hands reduces the possibility to make compensatory arm movements to control balance and results in a change of the centre of mass due to a different weight distribution. This changed centre of mass must be controlled to maintain the balance during this task. Specifically in young seniors, the ecologically validity of this item might be high as it reflects a demanding everyday life task such as crossing road while turning the head to watch the traffic and simultaneously carrying groceries [28]. The combination of these balance challenges may have led to the retention of this item in the s-CBM as it is able to differentiate balance abilities of young seniors.

Validation of the s-CBM

The analysis revealed no differences between the s-CBM and the CBM in 95% of the psychometric properties. The absence of floor and ceiling effects, which is in line with previous studies for the CBM [20-22] may suggest that the included items in the s-CBM are adequately challenging to detect subtle balance deficits and allow the discrimination between high balance abilities of young seniors using four items only.

The s-CBM had a slightly lower internal consistency than the CBM (0.84 vs. 0.87), suggesting that item elimination reduced some redundancies.

The excellent correlations between the s-CBM and the CBM indicated that no fundamental information of the CBM were lost. These findings suggest that the four remaining items are enough to display the majority of the information of the CBM.

The comparable correlations of the s-CBM and the CBM indicated that the s-CBM still represents the different balance aspects of the CBM, including static ('Unilateral stance'), dynamic ('Lateral Foot Scooting' and 'Walk, Look and Carry'), and proactive ('Hopping Forward') balance control. An exception was the lower correlation between the FAB and the s-CBM compared to the correlation between the FAB and the CBM (0.72 vs 0.80). One possible reason for the slightly lower correlation could be that tasks such as 'Tandem Walking', or turning around the body axis are included in both the FAB and the CBM, but not in the s-CBM. The exclusion of these items could have led to the reduced correlation between the s-CBM and FAB. However, although the correlation was lower, it remained in the same range >0.50, indicating a good correlation with the FAB [66]. The correlation with the ABC was lower than expected for all three CBM-versions. The low correlations could be due to balance confidence in the young seniors being higher compared to older samples [20,67] and close to ceiling effects. The ability to estimate fall risk is a fundamental precondition for balance assessment tools. Previous studies have shown that the challenge to accurately predict falls increases in rather high functioning populations with a low fall incidence [68,69]. All three CBM-versions showed limited ability to discriminate between fallers and non-fallers with AUC below 0.7. One possible reason for this might be that in the presented sample, only 15% of the participants fell in the six month prior to the assessment compared to approximately 30% in a previous study including older adults [20]. In addition to the young senior population, the low fall rate could be related to the defined exclusion criteria, excluding those with substantial physical impairments and severe diseases.

Despite the urgent need for quick and sensitive balance screening tools in young seniors, such tools do not exist. The presented approach is an important step forward towards a feasible tool for this specific population. More specifically, feasibility increased in two ways. First the s-CBM can be completed in approximately 10 minutes, compared to 20-30 minutes needed for the CBM. Second, administration of the s-CBM is more practical as it requires less equipment. Only the eight-meter track with a target laterally mounted on the wall, two weighted bags, and a stopwatch are needed. While performing the

CBM, no adverse events occurred despite the challenging balance manoeuvres. In accordance with the CBM manual [24], all assessors were well trained in the CBM assessment following the safety instructions.

Limitations

Females were overrepresented in sample 2 (70.6%) compared to the general population aged 60-70 years where 51.7% are female [70]. However, sample 2 was too small to perform a stratified analysis for gender. A future study with a larger sample size is recommended to confirm the present results. In humanities, the explained variance commonly lies between 50-60% [53]. The variance explained in the present study, 44%, places it in the lower third of studies with comparable sample sizes, variables, and number of factors [71]. The CBM tries to quantify balance and mobility using distance, time, and performance quality measurements such as the time possible to stand on one leg without compensatory movements [72]. However, balance and mobility abilities are composed of many functionally different aspects and are highly influenced by for example the environment, such as uneven ground, or attentional demands, such as talking to someone while navigating traffic, which cannot be completely mapped by laboratory-based measurements [72].

The cross-sectional study design did not allow the determination of the responsiveness of the s-CBM. However, for the use of the scale in intervention studies, responsiveness is important. Longitudinal studies should evaluate this measurement property. As the current study focused on community-dwelling young seniors between 60 and 70 years of age, excluding those with substantial functional impairment, the results may not generalize to other settings (e.g. rehabilitation, hospital) or other populations. In addition, further studies should be performed in a general young senior sample with larger sample sizes to allow validation of the CBM's fall prediction accuracy in young seniors.

CONCLUSION

The created s-CBM is a feasible and quick to administer screening tool which can be used in large-scale studies and health promotion in young seniors. The majority of the psychometric properties of the s-CBM did not show notable differences compared to the CBM. However, further studies should confirm the validation in a larger sample. In addition, the results highlight the need for future research to design accurate screening tools for primary fall prevention for adults aged 60-70 years.

Conflict of interest

The authors completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

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Table 1: Descriptive characteristics of both samples used for development and validation

	Development (sample 1) (n=189)	Validation (sample 2) (n=61)	p-value
Age (years)	66.3 (2.5)	66.5 (2.6)	.731
Gender			
Women	52.4% (n=99)	68.9% (n=42)	.026*†
Body Mass Index	27.2 (4.5)	28.0 (5.9)	.444
Faller	15.3% (n=29)	18.0% (n=11)	.688†
Mobility measures			
Community Balance & Mobility Scale (points)	65.5 (12.3)	65.6 (12.5)	.746
Timed up and Go (s)	8.7 (1.6)	8.9 (1.9)	.339
Habitual gait speed (m/s)	1.5 (0.2)	1.3 (0.2)	<.001*
Self-reported confidence			
Late Life Function & Disability Index – Function	25.8 (11.5)	25.2 (11.8)‡	.333

unpaired t-tests for analyzing differences between groups for continuous measures ; *p<.05;
†:chi^2-test for dichotomous measures; ‡n=46;

Table 2: Item difficulty

Item	**mean (SD)**	**range**	**floor effect (%)**	**ceiling effect (%)**	**difficulty index**
Unilateral Stance left	3.16 (1.53)	0-5	5.3	22.2	0.63
Unilateral Stance right	3.19 (1.54)	0-5	5.3	22.8	0.64
Tandem Walking	3.64 (1.50)	0-5	2.6	44.4	0.73
180° Tandem Pivot	3.09 (1.39)	0-5	4.8	15.9	0.62
Lateral Foot Scooting left	3.21 (1.34)	0-5	3.7	13.8	0.64
Lateral Foot Scooting right	3.26 (1.37)	0-5	6.3	15.3	0.65
Hopping Forward left	2.87 (1.57)	0-5	6.9	15.9	0.57
Hopping Forward right	2.97 (1.54)	0-5	7.9	15.3	0.59
Crouch and Walk	3.47 (1.10)	1-5	0.0	16.9	0.69
Lateral Dodging	2.80 (0.73)	0-5	1.1	1.1	0.56
Walking & Looking left	3.30 (1.11)	0-5	0.5	11.1	0.66
Walking & Looking right	3.36 (1.07)	0-5	0.5	10.6	0.67
Running with Controlled Stop	2.89 (0.95)	0-5	2.6	7.9	0.58
Forward to Backward Walking	4.11 (0.98)	1-5	0.0	42.3	**0.82**
Walk, Look and Carry left	3.70 (1.29)	0-5	1.6	35.4	0.74
Walk, Look and Carry right	3.65 (1.26)	0-5	1.6	30.2	0.73
Descending Stairs (+Bonus)	5.54 (1.01)	0-6	1.6	**69.3**	**0.93**
Step-Up x 1 left	3.61 (0.95)	0-5	1.6	7.4	0.72
Step-Up x 1 right	3.72 (0.87)	0-5	1.1	8.5	0.74

Given are mean (standard deviation), minimum and maximum value, floor and ceiling effects, and difficulty index (mean / maximum) for each item of the Community Balance & Mobility Scale; ceiling effects >50% and difficulty index >.80 in bold

Table 3: Tasks included in the s-CBM (adapted from Howe/Inness 1998)

CBM tasks	**notes**	**initial**	**points**	**time**
1) UNILATERAL STANCE 0 unable to sustain 1 2.00 to 4.49 sec 2 4.50 to 9.99 sec 3 10.00 to 19.99 sec 4 ≥ 20.00 sec 5 45.00 sec, steady and coordinated	“Look straight ahead.” Test is over if stance foot moves from start position or raised foot touches ground.	left		
		right		
2) LATERAL FOOT SCOOTING 0 unable 1 1 lateral pivot 2 2 lateral pivots 3 **≥** 3 lateral pivots but < 40 cm 4 40 cm in any fashion and/or unable to control final position 5 40 cm continuous, rhythmical motion with controlled stop	Test is over if patient hops or opposite foot touches down.	left		
		right		
3) HOPPING FORWARD 0 unable 1 1 to 2 hops, uncontrolled 2 2 hops, controlled but unable to complete 1meter 3 1 meter in 2 hops but unable to sustain landing (touches down**)** 4 1 meter in 2 hops but difficulty controlling landing (shops or pivots) 5 1 meter in 2 hops, coordinated with stable landing	Test is over if opposite foot touches down.	left		
		right		
4) WALK, LOOK AND CARRY 0 unable to walk and look e.g. stops 1 performs but loses visual fixation at or before 4 meter mark 2 performs but loses visual fixation after 4 meter mark 3 perform and maintains visual fixation between 2-6 meter mark but protective step 4 perform and maintains visual fixation between 2-6 meter mark but veers 5 performs straight path, steady and coordinated ≤ 7.00 sec	„Walk at your usual pace.“	left		
		right		

Table 4: Mean scores, standard deviation, floor and ceiling effects for the s-, i-, and CBM (n=61*)*

	s-CBM	**i-CBM**	**CBM**
mean (standard deviation)	26.2 (7.5)	40.4 (9.8)	65.7 (12.4)
minimum	5	10	28
maximum	39 (40)	58 (60)	86 (96)
floor effect	0%	0%	0%
ceiling effect	0%	0%	0%
Cronbach's alpha	.84	.85	.87
correlation with CBM (r)	.97	.98	

Given are the mean (standard deviation), minimum and maximum, floor and ceiling effects, Cronbach's alpha (internal consistency), and the Pearson correlation coefficient of the s- and i-CBM with the CBM; CBM: Community Balance & Mobility Scale

Table 5: Correlation coefficients between s-CBM, i-CBM, and CBM and other established assessments for balance and mobility (Pearson correlation coefficient r + 95% CI; n=51)

	s-CBM			**i-CBM**			**CBM**		
	r	95% CI	p	r	95% CI	p	r	95% CI	p
Fullerton Advanced Balance Scale	0.72†‡	0.55; 0.83	<.001	0.79	0.66; 0.88	<.001	0.80	0.67; 0.88	<.001
Timed up and Go*	-0.44	-0.64; -0.19	.001	-0.42	-0.62; -0.16	.003	-0.45	-0.65; -0.20	.001
habitual walking pace	0.43	0.18; 0.63	.001	0.41	0.15; 0.62	.001	0.45	0.20; 0.65	<.001
fast walking pace	0.57	0.35; 0.73	<.001	0.58	0.36; 0.74	<.001	0.61	0.40; 0.76	<.001
3m tandem walk (errors)	-0.67	-0.80; -0.48	<.001	-0.68	-0.81, -0.50	<.001	-0.68	-0.81, -0.50	<.001
8 Level Balance Scale	0.32	0.05; 0.55	.022	0.36	0.09; 0.58	.010	0.34	0.07; 0.56	.014
30 sec chair stand	0.31	0.04; 0.54	.029	0.29	0.02; 0.52	.041	0.30	0.03; 0.53	.033
LLFDI – functional scale*	-0.54	-0.71; -0.31	<.001	-0.53	-0.70; -0.30	<.001	-0.56	-0.72; -0.34	<.001
Activities-Specific Balance Confidence Scale*	0.**22**	-0.**08**; 0.**48**	**.152**	0.**23**	-0.**07**; 0.**49**	**.124**	0.**23**	-0.**07**; 0.**49**	**.128**

*n= 46; CBM: Community Balance & Mobility Scale; CI: confidence interval; LLFDI: Late-Life Function & Disability Index; r: Pearson correlation coefficient
† significant difference (p<.05) of correlation coefficients compared to the CBM
‡ significant difference (p<.05) of correlation coefficients compared to the i-CBM

Table 6: Area under the curve and comparison of the areas under the curve for the s-CBM, i-CBM, and CBM

	area under the curve (95% CI)			comparison of the areas under the curve (X^2; p)		
	s-CBM	**i-CBM**	**CBM**	**s-CBM / CBM**	**i-CBM / CBM**	**s-CBM / i-CBM**
Falls in the previous six months						
Faller vs. non-faller	0.66 (0.44; 0.87)	0.67 (0.47; 0.87)	0.65 (0.44; 0.87)	$X^2(1)=0.03$; p=0.86	$X^2(1)=0.77$; p=0.38	$X^2(1)=0.22$; p=0.64
Late-Life Function & Disability Index-Function*						
High vs. low function	0.75 (0.61; 0.89)	0.77 (0.64, 0.91)	0.79 (0.66; 0.92)	$X^2(1)=2.19$; p=0.14	$X^2(1)=0.79$; p=0.37	$X^2(1)=0.60$; p=0.44
Activities-Specific Balance Confidence Scale*						
High vs. low confidence	0.68 (0.52; 0.84)	0.69 (0.53; 0.84)	0.71 (0.56; 0.86)	$X^2(1)=0.98$; p=0.32	$X^2(1)=1.30$; p=0.25	$X^2(1)=0.08$; p=0.78

*n=46; CBM: Community Balance & Mobility Scale; CI: confidence interval; comparison of the areas under the curve using X^2-test

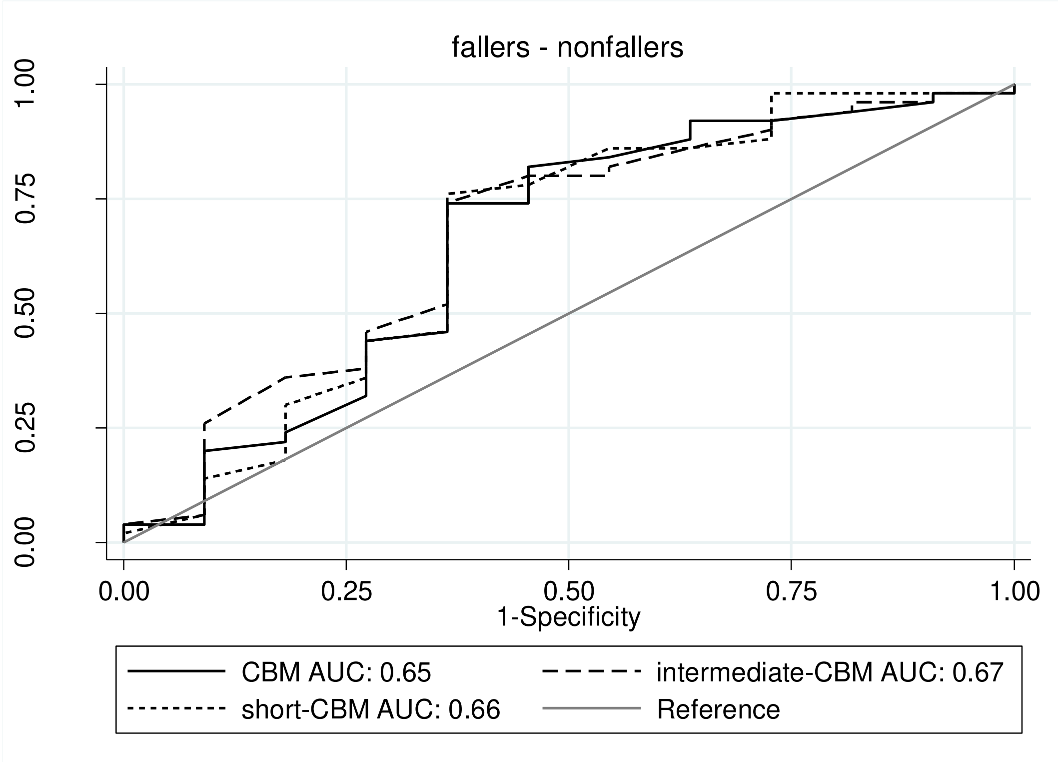
Appendix 1: Results of exploratory factor analysis; principal axis analysis with oblique rotation

Item	**Factor 1**	**Factor 2**
Unilateral Stance	**0.627**	-0.060
Tandem Walking	**0.545**	-0.119
180° Tandem Pivot	**0.530**	0.014
Lateral Foot Scooting	**0.701**	0.025
Hopping Forward	**0.806**	-0.016
Crouch and Walk	0.378	0.018
Lateral Dodging	0.299	0.255
Walking & Looking	-0.043	**0.639**
Running with Controlled Stop	0.333	0.257
Walk, Look and Carry	-0.064	**0.818**
Step-Up x 1	0.269	0.257

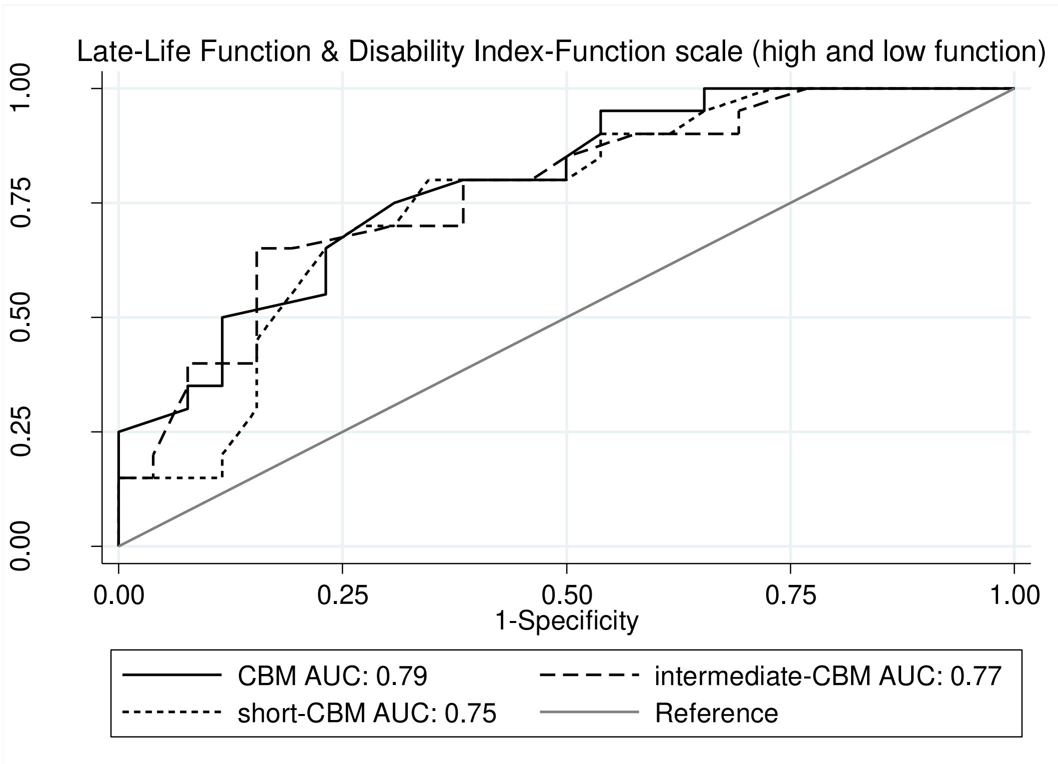
Given are the factor loadings of the single items on one of the two factors identified with the exploratory factor analysis. Factor loadings >0.512 in bold; items included in the i-CBM in bold; items included in the s-CBM underlined

Appendix 2: Area under the curve (AUC) for all CBM-versions differentiating fallers and non-fallers

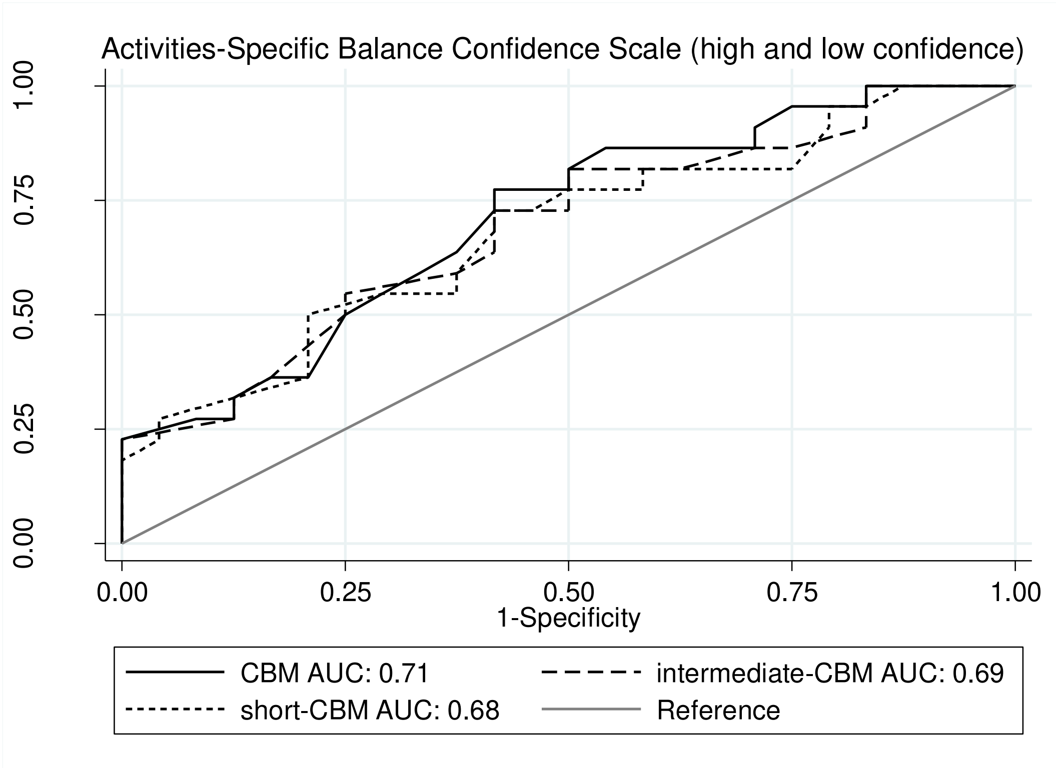
A



B



C



Activities-Specific Balance Confidence Scale (high and low confidence)
0.00
0.25
0.50
0.75
1.00
0.00
0.25
0.50
0.75
1.00
1-Specificity
CBM AUC: 0.71
intermediate-CBM AUC: 0.69
short-CBM AUC: 0.68
Reference

1