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Original Research

Creating and Validating a Shortened Version of the Community Balance and Mobility Scale for Application in People Who Are 61 to 70 Years of Age

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Background. The Community Balance and Mobility Scale (CBM) has been shown to be reliable and valid for detecting subtle balance and mobility deficits in people who are 61 to 70 years of age. However, item redundancy and assessment time call for a shortened version.

Objective. The objective was to create and validate a shortened version of the CBM (s-CBM) without detectable loss of psychometric properties.

Design. This was a cross-sectional study.

Methods. Exploratory factor analysis with data from 189 young seniors (aged 61-70 years; mean [SD] age = 66.3 [2.5] years) was used to create the s-CBM. Sixty-one young seniors (aged 61–70 years; mean [SD] age = 66.5 [2.6] 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-m tandem walk, and 30-second chair stand test. Internal consistency (Cronbach α), ceiling effects, and discriminant validity (area under the curve [AUC]) between fallers and nonfallers, and self-reported high and low function (Late-Life Function and Disability Index) and balance confidence (Activities-Specific Balance Confidence Scale), respectively, were calculated.

Results. The s-CBM, consisting of 4 items, correlated excellently with the CBM ($r = 0.97$). 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 α was .84 for the s-CBM, and .87 for the CBM. No CBM-version showed ceiling effects. Discriminative ability of the s-CBM was statistically comparable with 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.

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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 with 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] Falls prevention predominantly 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 quickly administered 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 use in high-functioning young seniors. A study validating the Balance Evaluation Systems Test (BESTest) found that it reaches its limits in high-functioning young seniors as well. The study reported a mean value close to the maximum value and a small SD in the group of 60 to 69-year-olds, indicating a limited ability to differentiate 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 and 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 analyzing the psychometric properties of the CBM in high-functioning young seniors did not find ceiling effects.[21,22] In addition, in 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 high-functioning young seniors.

However, one central drawback is the complexity and duration of administering the CBM, limiting its feasibility in public health approaches. The time taken to administer the CBM is 20 to 30 minutes,[22,24] which might be too long for routine daily use. Also, the extensive equipment needed could 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 $\alpha > .90$ 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 has been repeatedly requested.[20–22,28] The aim of the current study was to create and validate a shortened version of the CBM, while retaining the psychometric properties of 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 to March 2017) were used. For both samples, inclusion criteria were: being retired, being able to walk 500 m without walking aid, and no cognitive impairment (Montreal Cognitive Assessment at least 24 points).[29] Exclusion criteria for both samples were: being too active (moderate-intensity physical activity at least 150 min/wk in the previous 3 months), current participation in an organized exercise class (more than once per week), and severe cardiovascular, pulmonary, neurological, or mental diseases.[30,31] Sample 1 was recruited via mailout 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.

Descriptive, Physical Ability, and Function Measures of Samples 1 and 2

Age, sex, body mass index, falls in the last 6 months, physical measures (Timed Up-and-Go [TUG],[32] habitual gait speed), and self-reported function and participation (Late-Life Function and Disability Index[33]) were collected in a standardized manner.

In addition, all participants were assessed using the original version of the CBM.[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 and Carry," "Descending Stairs," and "Step-up × 1."[24] Six tasks (Unilateral Stance, Lateral Foot Scooting, Hopping Forward, Walking and Looking, Walk, Look and Carry, and Step-up × 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 to 5 correspond to better performance (eg, 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,[34] which enables accurate measurement of foot placement, deviation from a straight line, and speed of the task performance. The equipment required includes an 8-m track with a target laterally mounted on the wall, a stopwatch, a weighted laundry basket (0.9 kg), 2 weighted bags (3.4 kg each), a beanbag, and a staircase (minimum 8 steps).

Measures Used for Validating the s-CBM

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.[35] 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 assesses functional ability by asking the participant to stand up from a chair (height 45 cm), walk 3 m at a comfortable and safe pace, turn around, walk back to the chair, and sit down.[32] The time to complete the test is recorded.

Habitual and fast gait speed (cm/s) is assessed while walking a distance of 7 m. The time to complete is recorded using a stopwatch.[36]

The 3 Meter Tandem Walk (3MTW) assesses dynamic balance ability.[37] Participants are asked to complete it with as few errors as possible.[37] Errors are defined as stepping next to the given line or heel-toe distance greater than 8 cm. The number of errors is recorded.

The 8 Level Balance Scale is an extended version of the Short Physical Performance Battery.[38] 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.[37] The best task performed for 15 seconds is rated.

The 30 seconds chair stand test assesses functional lower extremity strength in older adults.[39] The participant is seated on a chair (45 cm height) without arms. On cue the participant rises 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 and Disability Index (LLFDI) is a self-reported questionnaire to assess function and disability in different activities performed in the community.[33,40,41] 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.[42] 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 criteria,[43] and the CBM was therefore treated as a continuous scale[25] and summarized as mean and SD. Number and percentage were used for dichotomous measures.

Creation of the s-CBM

To create the s-CBM, an established procedure including descriptive item analysis[44] followed by the analysis of the structural validity of the CBM based on an exploratory factor analysis (EFA) was used.[44–46] In line with previous approaches for scale-shortening,[47,48] an intermediate version (i-CBM) was created, which was further shortened (s-CBM) based on the highest item-factor correlations.[49] 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.[44] Items with extreme floor or ceiling values, defined as greater than 50% of the participants achieving the lowest or highest value, were excluded from further analysis.[50] A difficulty index (mean value/maximum value) was calculated for each remaining item.[51] Items with a difficulty index greater than 0.8 or less than 0.2 were excluded from further analysis,[51] 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, for example, "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 greater than 10:1 was applied for the EFA.[52] The Kaiser-Meyer-Olkin coefficient was determined and a value exceeding 0.5 was considered suitable for EFA.[53,54] A significant Bartlett test ($P < .05$) for sphericity was deemed suitable for EFA.[53,54] The data were then subjected to a principal axis analysis with oblique rotation.[44] Parallel analysis[52,55] was used to estimate the final number of factors obtained from the principal axis analysis.[56] 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.[57]

Within each factor, a rotated factor loading for a sample size of at least 100 would need to be at least 0.512 to be considered statistically meaningful.[58] Therefore, items with loading of at least 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.[45,47,59] The remaining items constituted the s-CBM.

Validation of the s-CBM and i-CBM

Sample 2 was used for validating the s-CBM and i-CBM compared with the CBM. Sum scores of the 3 CBM versions were calculated and used for the validation. Mean, SD, and floor and ceiling effects were calculated for all CBM versions.

Internal consistency. Internal consistency of the 3 CBM versions was assessed by Cronbach α. Values greater than 0.70 indicated acceptable homogeneity of the items within the total scale,[60] whereas values greater than 0.90 indicated redundancies.[27]

Construct validity. Pearson correlation coefficients were calculated for analyzing the construct validity between the 3 CBM versions and between each CBM version and other established assessments.[61] Correlation coefficients of $r = 0.10$-0.30 were classified as small, 0.30-0.50 as medium, and greater than 0.50 as large.[62] To compare the construct validity of the different CBM versions, values lying in the same range, for example, between 0.30 and 0.50, were classified as comparable.[21]

Comparing the CBM versions, large correlations (>0.50) between the s-CBM and i-CBM, respectively, and the CBM were expected. In addition, high correlations between the 3 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 to be 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.[63]

Discriminant validity. The discriminant validity between fallers and nonfallers and self-perceived high and low functioning was assessed using the area under the receiver operating characteristic curve (AUC) with 95% confidence intervals (CIs). AUC was computed for fallers (≥1 fall) vs nonfallers. 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.[64] The optimal trade-off between sensitivity and specificity is the point on the ROC curve that is closest to the upper lefthand corner of the graph. Statistical differences between the AUCs of the 3 CBM versions were analyzed using χ^2 tests.[65]

Analyses were performed using IBM SPSS (version 24.0; IBM Inc, Armonk, NY, USA) and STATA 14.2 (StataCorp, College Station, TX, USA). Alpha level was set at $P < .05$.

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Table 1.
Descriptive Characteristics of Both Samples Used for Development and Validation[a]

Characteristic	Development (Sample 1) (n = 189)	Validation (Sample 2) (n = 61)	P
Age, y	66.3 (2.5)	66.5 (2.6)	.731
Gender: Women	52.4 (n = 99)	68.9 (n = 42)	.026[b,c]
Body mass index, k/mg$_2$	27.2 (4.5)	28.0 (5.9)	.444
Faller, %	15.3 (n = 29)	18.0 (n = 11)	.688[c]
Mobility measures			
Community Balance and 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[b]
Self-reported confidence			
Late Life Function and Disability Index—Function	25.8 (11.5)	25.2 (11.8)[d]	.333

[a]Unpaired *t* tests for analyzing differences between groups for continuous measures. Unless otherwise noted, values are mean (SD).
[b]$p < .05$.
[c]χ^2 test for dichotomous measures.
[d]n = 46.

Results

Descriptive results of samples 1 and 2 are shown in Table 1. In sample 1, the mean [SD] age was 66.3 [2.5] years, and 52.4% (n = 99) were female (Tab. 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 (Tab. 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 than sample 1 (70.6% vs 52.4%; $P = .020$).

Creation of the s-CBM 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 cutoff of 0.8. Based on these criteria these 2 items were excluded from further consideration.

Structural validity. The Kaiser-Meyer-Olkin coefficient (0.79) and Bartlett test ($P < 0.001$) verified the sampling adequacy for the principal axis analysis. After oblique rotation, parallel analysis showed a 2-factor structure (Suppl. Appendix 1, available at https://academic.oup.com/ptj). Factor 1 with an eigenvalue of 4.19 explained 32.2% of variance, and factor 2 with an eigenvalue of 1.55 explained a further 11.9%. The total variance explained was 44.1%.

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

These 7 items formed the i-CBM, of which 5 ("Unilateral Stance," "Lateral Foot Scooting," "Hopping Forward," "Walking and 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, whereas factor 2 represents dynamic balance with an additional visual target.[28]

When further reducing the number of items, the ratio of the items in factors 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 4 items, which are all performed bilaterally (Tab. 3). Therefore, a maximum score of 40 points is achievable on the s-CBM.

Validation of the s-CBM and i-CBM

Mean, SD, minimum and maximum scores, and floor and ceiling effects for all CBM versions are presented in Table 4. No floor or ceiling effects were found for the 3 CBM versions.

Internal consistency. Internal consistency (Cronbach α) was .87 for the entire CBM, .85 for the entire i-CBM (factor 1: .83; factor 2: .77), and .84 for the entire s-CBM (factor 1:

Table 2.
Item Difficulty[a]

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-degree 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 and Looking left	3.30 [1.11]	0-5	0.5	11.1	0.66
Walking and 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 × 1 left	3.61 [0.95]	0-5	1.6	7.4	0.72
Step-up × 1 right	3.72 [0.87]	0-5	1.1	8.5	0.74

[a]Values are mean [SD], minimum and maximum value, floor and ceiling effects, and difficulty index (mean/maximum) for each item of the Community Balance and Mobility Scale. Ceiling effects >50% and difficulty index >0.80 are in bold.

.81; factor 2: .71) (Tab. 4). All values ranged between the recommended values of .70 and .90 (references 60 and 27, respectively).

Construct validity. The majority of the correlations between the referenced balance and mobility measures and the 3 CBM versions, respectively, did not show significant differences (Tab. 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 3 CBM versions either (Tab. 5).

Discriminant validity. For discriminating between fallers and nonfallers, AUC ranged between 0.65 and 0.67 (Tab. 6; Suppl. Appendix 2A, available at https://academic.oup.com/ptj), indicating a limited discriminatory ability between fallers and nonfallers for all CBM versions. For discriminating between self-reported high and low function (LLFDI), AUC ranged between 0.75 and 0.77 (Tab. 6; Suppl. Appendix 2B); for ABC, the AUC ranged between 0.68 and 0.71 (Tab. 6; Suppl. Appendix 2C). There were no statistically significant differences in discriminative ability, measured using AUCs between the 3 CBM versions (Tab. 6). A CBM of at least 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, a CBM of at least 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 with 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 with 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 with s-CBM and FAB. However, this finding does not lead to an essential benefit compared with the longer time

Table 3.
Tasks Included in the s-CBM[a]

CBM Tasks	Notes	Initial	Points	Time
1) UNILATERAL STANCE 0 Unable to sustain 1 2.00 to 4.49 s 2 4.50 to 9.99 s 3 10.00 to 19.99 s 4 ≥20.00 s 5 45.00 s, 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 1 m 3 1 m in 2 hops but unable to sustain landing (touches down) 4 1 m in 2 hops but difficulty controlling landing (shops or pivots) 5 1 m 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 (eg, stops) 1 Performs but loses visual fixation at or before 4-m mark 2 Performs but loses visual fixation after 4-m mark 3 Performs and maintains visual fixation between 2-6-m mark but protective step 4 Performs and maintains visual fixation between 2-6-m mark but veers 5 Performs straight path, steady and coordinated ≤7.00 s	"Walk at your usual pace"	Left Right		

[a]Adapted from Howe and Inness.[24] CBM = Community Balance and Mobility Scale; s-CBM = shortened version of CBM.

Table 4.
Mean Scores, SD, Floor and Ceiling Effects for the s-CBM, i-CBM, and CBM (n = 61)[a]

Parameter	s-CBM	i-CBM	CBM
Mean (SD)	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 α	.84	.85	.87
Correlation with CBM (r)	0.97	0.98	

[a]Values are the mean (SD) minimum and maximum [maximal value of each scale], floor and ceiling effects, Cronbach α (internal consistency), and the Pearson correlation coefficient of the s-CBM and i-CBM with the CBM. CBM = Community Balance and Mobility Scale; i-CBM = intermediate version; s-CBM = shortened version.

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 1 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 1 principle of increasing the level of balance difficulty. This means that the vertical projection of the center of mass must be maintained in a smaller area

Table 5.
Correlation Coefficients Between s-CBM, i-CBM, and CBM and Other Established Assessments for Balance and Mobility[a]

Assessment	s-CBM			i-CBM			CBM		
	r	95% CI	*P*	*r*	95% CI	*P*	*r*	95% CI	*P*
Fullerton Advanced Balance Scale	0.72[b,c]	0.55-0.83	<.001	0.79	0.66-0.88	<.001	0.80	0.67-0.88	<.001
Timed Up-and-Go[d]	−0.44	−0.64 to −0.19	.001	−0.42	−0.62 to −0.16	.003	−0.45	−0.65 to −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
3-Meter Tandem Walk (errors)	−0.67	−0.80 to −0.48	<.001	−0.68	−0.81 to −0.50	<.001	−0.68	−0.81 to −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-s 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[d]	−0.54	−0.71 to −0.31	<.001	−0.53	−0.70 to −0.30	<.001	−0.56	−0.72 to −0.34	<.001
Activities-Specific Balance Confidence Scale[d]	0.22	−0.08 to 0.48	.152	0.23	−0.07 to 0.49	.124	0.23	−0.07 to 0.49	.128

[a]Pearson correlation coefficient *r* + 95% CI; n = 51. CBM = Community Balance and Mobility Scale; CI = confidence interval; i-CBM = intermediate version of CBM; LLFDI = Late-Life Function and Disability Index; *r* = Pearson correlation coefficient; s-CBM = shortened version of CBM.
[b]Significant difference ($P < .05$) of correlation coefficients compared with the CBM.
[c]Significant difference ($P < .05$) of correlation coefficients compared with the i-CBM.
[d]n = 46.

Table 6.
AUC and Comparison of the AUCs for the s-CBM, i-CBM, and CBM[a]

Assessment	AUC (95% CI)			Comparison of the AUCs (χ^2, *P*)[b]		
	s-CBM	i-CBM	CBM	s-CBM/CBM	i-CBM/CBM	s-CBM/i-CBM
Falls in the previous 6 mo Faller vs nonfaller	0.66 (0.44–0.87)	0.67 (0.47–0.87)	0.65 (0.44–0.87)	$\chi^2(1) = 0.03$, $P = .86$	$\chi^2(1) = 0.77$, $P = .38$	$\chi^2(1) = 0.22$, $P = .64$
Late-Life Function and Disability Index—Function[c] High vs low function	0.75 (0.61–0.89)	0.77 (0.64–0.91)	0.79 (0.66–0.92)	$\chi^2(1) = 2.19$, $P = 0.14$	$\chi^2(1) = 0.79$, $P = .37$	$\chi^2(1) = 0.60$, $P = .44$
Activities-Specific Balance Confidence Scale[c] High vs low confidence	0.68 (0.52–0.84)	0.69 (0.53–0.84)	0.71 (0.56–0.86)	$\chi^2(1) = 0.98$, $P = .32$	$\chi^2(1) = 1.30$, $P = .25$	$\chi^2(1) = 0.08$, $P = .78$

[a]AUC = area under the curve; CBM = Community Balance and Mobility Scale; CI = confidence interval; i-CBM = intermediate version of CBM; s-CBM = shortened version of CBM.
[b]Comparison of the AUCs using χ^2 test.
[c]n = 46.

to stay in balance, leading to a more challenging balance task execution.[66] Factor 2 included the item "Walk, Look and 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 center of mass due to a different weight distribution. This changed center of mass must be controlled to maintain the balance during this task. Specifically in young seniors, the ecological validity of this item might be high because it reflects a demanding everyday life task such as crossing a road while turning the head to watch the traffic and simultaneously carrying groceries.[28] The combination of these balance challenges could have led to the retention of this item in the s-CBM because it can 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] suggests 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 4 items only.

The s-CBM had a slightly lower internal consistency than the CBM (.84 vs .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 was lost. These findings suggest that the 4 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 with 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 greater than 0.50, indicating a good correlation with the FAB.[67] The correlation with the ABC was lower than expected for all 3 CBM versions. The low correlations could be due to balance confidence in the young seniors being higher compared with older samples[20,68] 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 of accurately predicting falls increases in high-functioning populations with a low fall incidence.[69,70] All 3 CBM versions showed limited ability to discriminate between fallers and nonfallers, with AUC below 0.7. One possible reason for this might be that in the presented sample, only 15% of the participants had fallen in the 6 months prior to the assessment compared with 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 2 ways. First the s-CBM can be completed in approximately 10 minutes, compared with the 20 to 30 minutes needed for the CBM. Second, administration of the s-CBM is more practical because it requires less equipment. Only the 8-m track with a target laterally mounted on the wall, 2 weighted bags, and a stopwatch are needed. While performing the CBM, no adverse events occurred despite the challenging balance maneuvers. 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 with the general population aged 60 to 70 years, where 51.7% are female.[71] 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% and 60%.[54] 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.[72] The CBM tries to quantify balance and mobility using distance, time, and performance quality measurements such as the time for which it is possible to stand on 1 leg without compensatory movements.[73] 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.[73]

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. Because the current study focused on community-dwelling young seniors between 60 and 70 years of age, excluding those with substantial functional impairment, the results might not generalize to other settings (eg, rehabilitation, hospital) or other populations. In addition, further studies should be performed in a general young senior sample with larger sample sizes to enable 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 that 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 with 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 to 70 years.

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Ethics Approval

Ethical approval was obtained from the respective local institutional review board at each site and was in agreement with the Declaration of Helsinki. All participants provided written informed consent prior to participation.

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Disclosures

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

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