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ORIGINAL RESEARCH

Sensitivity to Change and Responsiveness of the Original and the Shortened Version of the Community Balance and Mobility Scale for Young Seniors

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Abstract

Objective: To examine sensitivity to change and responsiveness of the Community Balance and Mobility Scale (CBM) and shortened CBM (s-CBM).

Design: Secondary analysis using data of a randomized controlled trial.

Setting: General community.

Participants: Young community-dwelling seniors aged 61-70 years (N=134; mean age, 66.2±2.5y).

Interventions: Participants underwent 12 months of exercise intervention.

Main Outcome Measures: CBM and s-CBM. Sensitivity to change was assessed using standardized response mean (SRM) and paired *t* tests as appropriate. Responsiveness was assessed using 2 minimal important difference (MID) estimates. Analyses were conducted for the full sample and for the subgroups "high-balance" and "low-balance," divided by median split.

Results: Inferential statistics revealed a significant CBM ($P<.001$) and s-CBM ($P<.001$) improvement within the full sample and the subgroups (high-balance: $P=.001$, $P=.019$; low-balance: $P<.001$, $P<.001$). CBM and s-CBM were moderately sensitive to change (SRM, 0.48 vs 0.38) within the full sample. In the high-balance subgroup, moderate SRM values (0.70) were found for the CBM and small values for the s-CBM (0.29). In the low-balance subgroup, moderate SRM values were found for the CBM (0.67) and high values for the s-CBM (0.80). For the full sample, CBM and s-CBM exceeded the lower but not the higher MID value. In the high-balance subgroup, the CBM exceeded both MID values, but the s-CBM exceeded only the lower. In the low-balance subgroup, CBM and s-CBM exceeded both MID values.

Conclusions: The CBM is a suitable tool to detect intervention-related changes of balance and mobility in young, high-performing seniors. Both versions of the CBM scale show good sensitivity to change and responsiveness, particularly in young seniors with low balance.

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An improvement of balance and mobility represents a key aim within intervention studies in older adults.[1] The ability to measure changes over time in balance and mobility is a key psychometric property of assessment tools in these domains. "Sensitivity to change" is defined as the ability of an assessment tool to measure

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changes over time, which can be relevant or meaningful to a therapist, clinician, or patient.[2,3] However, sensitivity to change does not provide information about the quality or direction of changes or its clinical relevance.[4]

Intervention-related changes that are considered clinically relevant or meaningful to participants are referred to as minimal important change, and the ability of an assessment tool to measure a minimal important change[2,3] is defined as "responsiveness." Responsiveness is commonly reported through the minimal important difference (MID),[5,6] which is defined as "the smallest difference in score in the domain of interest which patients perceive as beneficial and which would mandate (...) a change in the patient's management."[7(p408)] Importantly, responsiveness is purpose and population specific.[3] Consequently, specific studies about this measurement property are needed.

Particularly, in physically high-functioning young seniors aged 61-70 years, assessment tools with verified responsiveness are lacking.[8-11] However, sensitive and responsive assessment tools are needed to detect and subsequently treat early balance deficits in young seniors.[12]

The Community Balance and Mobility Scale (CBM) was recently demonstrated as the most appropriate scale in this cohort.[11,13-15] The CMB includes tasks that are adequately challenging and related to daily activities, such as walk, carry, and look, which reflects the ability to cross the road and navigate traffic while carrying shopping bags. The high task challenge of the CBM allows the detection of subtle balance deficits in high-functioning young seniors and in turn helps to design early, preventive interventions. Previous studies have shown excellent measurement properties including inter- and intrarater reliability and high concurrent validity of the CBM for young seniors.[14,15] However, responsiveness has not been demonstrated in this cohort yet.

As the CBM is an extensive and rather time-consuming assessment, a shortened version, the s-CBM, has been recently developed and validated, providing a quick and easy-to-administer screening tool to detect subtle balance deficits in young seniors.[16] In comparison to the CBM, the s-CBM has been reduced by 9 items and consists of 4 items.[16] As for the CBM, although validity has been demonstrated for the s-CBM, responsiveness has not yet been determined.

In summary, the ability to detect changes over time has not been investigated for both the CBM and s-CBM in young seniors. To our knowledge, there is only research on these psychometric properties in a group of patients with stroke,[17,18] showing moderate to good sensitivity to change and responsiveness. However, these results are not transferable to the rapidly growing group of young seniors (baby boomers). The high need to design responsive assessment tools for this specific population justifies the need for the present study.

This study aimed to evaluate the sensitivity to change and responsiveness of the CBM and the s-CBM in a sample of young seniors aged 61-70 years.

List of abbreviations:

CBM	**Community Balance and Mobility Scale**
CI	**confidence interval**
MID	**minimal important difference**
s-CBM	**shortened Community Balance and Mobility Scale**
SRM	**standardized response mean**

Methods

Study sample and design

This study used data collected within a large European multicenter, 3-arm, feasibility, randomized controlled trial, PreventIT.[19,20] Community-dwelling young seniors aged 61-70 years were recruited within PreventIT in Germany, the Netherlands, and Norway via mail-out after a random draw from local registry data.[19,20] The inclusion criteria were being retired, able to walk 500 m without walking aid, and no cognitive impairment (Montreal Cognitive Assessment[21] ≥24 points). Participants who were too active (moderate-intensity physical activity ≥150 min/wk in the previous 3mo), currently participating in an organized exercise class (>once per week), and/or had severe cardiovascular, pulmonary, neurologic, or mental diseases[19,22] were excluded. The reason for excluding participants being too active was that it was assumed the intervention performed in PreventIT, which was designed to increase physical activity, may be too low of a threshold for already active people.[19,20]

All participants provided written informed consent before participation. Ethical approval was obtained from the respective local institutional review board at each site and was in agreement with the Declaration of Helsinki. The PreventIT trial was registered at Clinical Trial Registration on February 14, 2017 (NCT03065088).

Measures

Within PreventIT, the baseline assessment included demographics, medical history, and physical and cognitive measures.[19,20] Physical measures included Timed Up and Go test, habitual gait speed, 30 second chair stand test, and the CBM.

Timed Up and Go

The Timed Up and Go assesses functional ability and dynamic balance 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.[23] The time to complete the test is recorded.

Habitual gait speed

Habitual gait speed (cm/s), also a dynamic balance task, is assessed while walking a distance of 7 meters. The time to complete is recorded using a stopwatch.[24]

30. second chair stand test

The 30 second chair stand test assesses functional lower extremity strength in older adults.[25] The participant is seated on a chair (45 cm 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.

Community Balance and Mobility Scale (CBM)

The CBM includes 13 static, dynamic, or proactive physical tasks assessed and scored on a 5-point scale in a standardized manner.[26] A score of 0 denotes the inability to perform the task. Scores from 1-5 correspond to better performance (eg, distance covered, time spent, quality of performance). The tasks include: "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 × 1."[26] Six tasks ("Unilateral Stance," "Lateral Foot Scooting," "Hopping Forward," "Walking and Looking," "Walk, Look, & Carry," "Step-Up × 1") are performed bilaterally. 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. The equipment required includes an 8-meter 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).

The CBM showed high reliability and good to excellent construct validity in young seniors.[14,15]

Shortened Community Balance and Mobility Scale (s-CBM)

In addition, from the results of the CBM, sum scores of the s-CBM were calculated. As previously described in detail,[16] for the shortening of the CBM, in the first step, items that could be performed by most of the participants in this cohort without problems were excluded because they gained no additional information about the balance and mobility status of young seniors. In an additional step, the number of items assessing similar balance or mobility constructs were reduced to maintain the content structure of the CBM. Finally, the s-CBM includes these 4 items: "Unilateral Stance," "Lateral Foot Scooting," "Hopping Forward," and "Walk, Look and Carry."[16] All 4 items are performed bilaterally and rated with points from 0-5, leading to a maximum of 40 points. The equipment required includes an 8-meter track with a target laterally mounted on the wall, a stopwatch, and 2 weighted bags (3.4 kg each). Its execution takes only 5-10 minutes.[16]

Compared with the original CBM, this s-CBM showed similar results regarding construct and discriminant validity in young seniors.[16]

Statistical analysis

Data from baseline and 12 months follow-up were used from the participants who performed the original CBM. Means and SDs were calculated for continuous variables and percentages for ordinal variables. All data were normally distributed using skewness and kurtosis as criteria.[27]

Creation of high- and low-balance subgroups

Because the group of young seniors shows a wide range of levels of function and mobility[28] and responsiveness has been found to vary with baseline scores,[29,30] dichotomous subgroups (high- vs low-balance subgroup) were formed for the CBM and s-CBM based on the median split of the baseline scores of the CBM and s-CBM. Because separate median splits were built for the CBM and the s-CBM, respectively, participants could have been classified as high-performer in the CBM and low-performer in the s-CBM and vice versa. These subgroups allowed comparisons of sensitivity to change and responsiveness metrics between participants with high and low functional abilities.[31] For the comparisons of the descriptive data and the functional outcome measures between the subgroups paired *t* tests and chi-square tests (sex) were performed.

Sensitivity to change

Sensitivity to change was assessed using standardized response mean (SRM) and paired *t* tests for the full sample and for the dichotomous subgroups.

SRM was calculated by dividing the mean change score by the SD of this mean change score.[32] The mean change score is defined as the delta between baseline and reassessment scores. The confidence intervals for SRM were estimated using bias-corrected and accelerated bootstrap.[33] SRM can be interpreted as follows: <0.2 as trivial, 0.2 to <0.5 as small, 0.5 to <0.8 as moderate, and ≥0.8 as large.[34] Moderate and high SRMs were considered to indicate sufficient sensitivity to change.[18] Paired *t* tests were computed to examine whether a significant change from baseline to reassessment had occurred. Alpha level was set at $P<.05$.

Responsiveness

Responsiveness can be reported either using an anchor-based or a distribution-based method. The anchor-based method links the change in the outcome measure to a meaningful external anchor, the criterion standard.[35] However, no criterion standard is available for the specific group of young seniors. Distribution-based methods, which have been recommended when anchor-based methods are not feasible,[6] are based on statistical properties of the scale and are commonly reported through the minimal important difference (MID).[5,6] To be considered as minimal important change, the mean change score of an assessment tool should equal or exceed its MID. MID values were calculated using 2 commonly used effect size estimates: 0.3 × baseline SD (SD_b) and 0.5 × SD_b.[5,36] The 0.5 × SD_b is the standard value for reporting minimal clinically important differences showing a medium effect.[5,37] However, even smaller effects (0.3 × SD_b) can be clinically meaningful.[36] Therefore, both values were reported.

All analyses were performed using IBM SPSS[a] for the full sample and both subgroups.

Results

The full sample included 134 participants (66 female; 49.3%) with a mean age of 66.2±2.5 years (table 1). Habitual gait speed of the full sample was on average 1.3±0.2 m/s, indicating little gait impairment.[38] On average, the Timed Up and Go was completed in 8.7±1.6 seconds, and 13.4±3.2 repetitions were achieved during the 30 second chair stand test, indicating that our sample has good mobility and strength.[25,39] Mean value of the CBM was 65.2±12.7 out of possible 96 points and 25.8±7.3 out of possible 40 points for the s-CBM.

A wide range of baseline scores were recorded for the CBM (17-90 points), the Timed Up and Go (5.7-16.0s), habitual gait speed (0.7-1.9 m/s), and the 30 second chair stand test (7-29 repetitions). High- and low-balance subgroups were well matched with no significant difference between the subgroups ($P=.50$-0.92) with regard to the descriptive variables and baseline functional strength measure (30 second chair stand) (see table 1). There were significant differences ($P<.005$) between the subgroups regarding CBM, s-CBM, and the dynamic balance measures (Timed Up and Go, habitual gait speed), which was due to the group subdivision based on the median split using the CBM and s-CBM, respectively (see table 1).

Table 1 Descriptive characteristics of the participants (n=134)

Measure	n	Descriptive Variables		Physical Measures				
		Age (y)	Sex (Female), n (%)	CBM (Points)	s-CBM (Points)	Timed Up and Go (s)	Habitual Gait Speed (m/s)	30 Second Chair Stand Test (Repetitions)
Full sample	134	66.2±2.5	65 (48.5)	65.2±12.7	25.8±7.3	8.7±1.6 (n=131)	1.3±0.2	13.4±3.2
CBM								
High-balance subgroup (baseline CBM ≥67 of 96)	70	66.3±2.9	35 (50.0)	74.1±5.6*	30.9±3.6*	8.1±1.1* (n=67)	1.4±0.2*	13.4±3.4
Low-balance subgroup (baseline CBM <67 of 96)	64	66.2±2.1	30 (46.9)	55.6±11.1*	20.2±6.2*	9.2±1.9*	1.3±0.2*	13.3±3.1
s-CBM								
High-balance subgroup (baseline s-CBM ≥26 of 40)	70	66.1±2.8	33 (47.1)	73.7±6.1*	31.1±3.2*	8.3±1.1* (n=68)	1.6±0.2*	13.2±3.2
Low-balance subgroup (baseline s-CBM <26 of 40)	64	66.4±2.1	32 (50.0)	56.0±11.5*	19.9±6.0*	9.1±1.9* (n=63)	1.4±0.2*	13.5±3.3

NOTE. Values shown are mean ± SD unless otherwise specified.
* Significant difference between the high- and low-balance subgroups using paired *t* tests and chi-square tests (sex) ($P<.05$).

Sensitivity to change

Within the full sample, the comparison of the baseline and the 12-month scores revealed a significant improvement in the CBM ($P<.001$) as well as the s-CBM ($P<.001$) (table 2). Moderate SRMs were found for the CBM (0.65; 95% confidence interval [CI], 0.41-0.88) and the s-CBM (0.55; 95% CI, 0.34-0.72) (see table 2, fig 1).

Within the high-balance subgroup, significant improvements in both scales were found (see table 2). Moderate SRM values were shown for the CBM (0.70; 95% CI, 0.38-0.98), whereas for the s-CBM, small SRM values were found (0.29; 95% CI, 0.01-0.57).

Within the low-balance subgroup, moderate SRM values (0.67; 95% CI, 0.30-0.96) were shown for the CBM and high SRM values for the s-CBM (0.80; 95% CI, 0.50-1.10) (see table 2, fig 1).

Responsiveness

For the full sample, comparing the mean change score with the MID values, the mean change score of the CBM and the s-CBM exceeded only the $0.3 \times SD_b$ value, not the $0.5 \times SD_b$ value (see table 2).

In the high-balance subgroup, the mean change score of the CBM exceeded both the $0.3 \times SD_b$ and the $0.5 \times SD_b$ values. In contrast, the mean change score of the s-CBM exceeded only the $0.3 \times SD_b$ value, showing the limited responsiveness of the s-CBM in the high-balance subgroup.

In the low-balance subgroup, the mean change scores of the CBM and the s-CBM exceeded the $0.3 \times SD_b$ and the $0.5 \times SD_b$ values, indicating similar responsiveness of the CBM and the s-CBM in this subgroup (see table 2).

Discussion

To our knowledge, this study is the first evaluating sensitivity to change and responsiveness of the CBM and s-CBM in young seniors aged 61-70 years. Within the full sample, the CBM and s-CBM showed moderate sensitivity to change over time and responsiveness for detecting minimal important differences. A comparison with other balance and mobility assessment tools is not possible in the specific group of young seniors because, to our knowledge, there are no other studies available in this specific group. However, studies in older adults even showed small sensitivity to change for established balance assessment tools such as the Berg Balance Scale or the Performance-Oriented Mobility Assessment,[31] reinforcing the suitability of CBM and s-CBM in this group. In addition, comparing the small responsiveness for the CBM and s-CBM exceeding the $0.3 \times SD_b$ value, even lower responsiveness was found for the other established assessment tools, which did not exceed any of the values.[31]

In the high-balance subgroup, the CBM showed higher sensitivity to change as well as responsiveness compared to the s-CBM. This discrepancy between the CBM and the s-CBM can be explained by the different number of items included in both scales. In comparison to the CBM, the s-CBM items have been reduced by almost 70%. In this subgroup, the reduced item number of the s-CBM negatively affected sensitivity to change and responsiveness. The higher number of items of the CBM has led to a higher sensitivity of change and better responsiveness of the CBM in the high-balance subgroup. Differences found between both scales contrast previous study findings on the comparison of

Table 2 Sensitivity to change and responsiveness of the CBM and s-CBM after 12 months for the full sample and by subgroups of lower and higher baseline scores

Measure	n	Baseline, Mean ± SD	12 Months Follow-up, Mean ± SD	Change Score, Mean ± SD	SRM	MID ($0.3 \times SD_b$)	MID ($0.5 \times SD_b$)	*P* Value
CBM								
Full sample	134	65.23±12.67	71.33±13.68	6.10±9.32	0.65 (0.41; 0.88)	3.80*	6.34	<.001
High-balance subgroup (baseline CBM ≥67 of 96)	70	74.06±5.62	78.79±7.43	4.73±6.72	0.70(0.38; 0.98)	1.69*	2.81*	<.001
Low-balance subgroup (baseline CBM <67 of 96)	64	55.58±11.10	63.17±14.33	7.59±11.38	0.67(0.30; 0.96)	3.33*	5.55*	<.001
s-CBM								
Full sample	134	25.76±7.35	28.57±7.44	2.81±5.15	0.55 (0.34; 0.72)	2.21*	3.68	<.001
High-balance subgroup (baseline s-CBM ≥26 of 40)	70	31.13±3.17	32.30±4.53	1.17±4.07	0.29(0.01; 0.57)	0.95*	1.59	.019
Low-balance subgroup (baseline s-CBM <26 of 40)	64	19.89±5.99	24.48±7.87	4.59±5.63	0.80(0.50; 1.10)	1.80*	3.00*	<.001

NOTE. SRM was calculated by dividing the mean change score by the SD of this mean change score.
Abbreviation: SD_b, standard deviation of the baseline score.
* Indicates the mean change score exceeded the corresponding MID.

the CBM and s-CBM regarding the measurement properties validity and reliability. In this previous study, the shortening of the CBM did not influence reliability and validity of the s-CBM in cross-sectional analyses showing comparable results with the original CBM version when detecting subtle balance deficits in young seniors.[16]

Previous studies have reported limited utility of balance and mobility assessments such as the Berg Balance Scale, the Performance-Oriented Mobility Assessment, or the Dynamic Gait Index for high-balance subgroups.[31] No significant change in any of these assessments could be found, which in turn led to a limited sensitivity to change in this high-balance subgroup.[31] In addition, none of the MID values were exceeded by these assessment tools in the high-balance subgroup. The authors traced these findings to the limited task challenge of these scales for the high-balance subgroups and point out the limited suitability of these tests in this subgroup.[31] Thus, specifically, in young seniors with high-balance ability, the CBM should be applied for an optimal detection of intervention related changes over time.

In the low-balance subgroup, high sensitivity to change was predominantly seen in the s-CBM, whereas only moderate sensitivity to change was seen for the CBM. These differences are due to the items included in the CBM compared with the s-CBM. As stated above, the CBM includes highly challenging tasks, which might be too challenging for people in the low-balance subgroup. This leads to a limited sensitivity to change over time for the CBM as the more challenging assessment. In line with our study findings, a previous study also reported moderate to large SRM values for the more basic assessment tools, Berg Balance Scale, Performance-Oriented Mobility Assessment, and Dynamic Gait Index in the low-balance subgroup of older adults.[31] Analyzing the responsiveness of these scales showed that in the low-balance subgroup both MID values could be exceeded for all assessments.[31] This is in line with our results of the CBM and s-CBM showing high responsiveness of both scales in the low-balance subgroup.

Also, for the CBM mixed findings based on the baseline ability were shown in previous studies assessing sensitivity to change and responsiveness of the CBM in the specific group of patients with stroke,[17,18] which found different results dependent on the baseline ability. For more disabled patients with subacute stroke (48h-4mo after stroke) moderate SRM (SRM, 0.5) were shown,[18] whereas patients 3-8 months after stroke demonstrated high SRM (SRM, 0.83).[17] In general, these findings confirm that sensitivity to change and responsiveness are dependent on the target group and level of balance and mobility performance.[29-31]

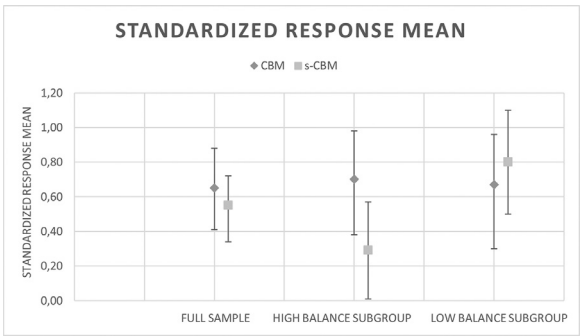

Fig 1 SRM of the CBM and s-CBM in the full sample, high-balance subgroup, and low-balance subgroup.

Study limitations

The current study focused on community-dwelling young seniors between 61-70 years of age, excluding those with substantial functional impairment and those being too active (≥150 min/wk). Therefore, the results may not be generalized to other settings (eg, rehabilitation, hospital) or other populations. In addition, the findings are based on an intervention study design in which half of the study participants received an active intervention. Therefore, findings should be confirmed in new studies.

SRM and *t* tests share the limitation that they do not relate changes in the measure to corresponding changes on an external clinical or health status measure at the individual level.[34] The use of an anchor-based method may have strengthened the validity of the MID estimates. However, there is no criterion standard for the

group of young seniors available with which our results could have been compared. Nevertheless, distribution-based methods are recommended to estimate MID when anchor-based methods are not available[6] and are widely used to determine MID.[31,40,41] In addition, distribution-based and anchor-based estimates were found to show convergence.[6,40]

Conclusions

In summary, our results show moderate to high sensitivity to change and good responsiveness for the CBM and the s-CBM, indicating the scales' usefulness as a functional capacity assessment for assessing changes occurring over a certain period of time in intervention studies.[18]

The CBM should especially be applied in young seniors with high-balance ability for an optimal detection of intervention-related changes over time because the reduced item structure of the s-CBM negatively affects sensitivity and responsiveness in this high-balance subgroup. In contrast, in young seniors with low-balance ability, both the CMB and the s-CBM were shown to be sensitive and responsive.

Supplier

a. SPSS, version 26.0; IBM Inc.

Keywords

Aged; Patient outcome assessment; Postural balance; Rehabilitation

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