Balance in Personal Care Home Residents: A Comparison of the Berg Balance Scale, the Multi-Directional Reach Test, and the Activities-Specific Balance Confidence Scale

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ABSTRACT

Purpose: This study used the Berg Balance Scale (BBS), the Multi-Directional Reach Test (MDRT), and the Activities-specific Balance Confidence Scale (ABC) to quantify balance of elderly residents of a personal care home. The reliability and construct validity of these measures were also examined. **Methods:** Twenty-one females and 5 males, 74 to 92 years old, participated. Participants completed each balance test once, during 2 testing sessions. Reliability was quantified using intraclass correlation coefficients (ICCs). Construct validity was quantified using Pearson's correlation coefficients (r) and Cronbach's alpha. **Results:** The mean (± sd) scores were: BBS = 41.3 ± 9.0, MDRT (forward = 5.6 ± 3.0 in, backward = 2.9 ± 2.2 in, right = 3.3 ± 2.5 in, left = 3.7 ± 3.1 in), and ABC = 54.0 ± 24.9%. Inter-rater reliability was good for the BBS and MDRT (ICC = 0.88-0.98). Test-retest reliability was moderate to good for all 3 balance tests (ICC = 0.66-0.83). Pearson's correlations between the BBS and MDRT were moderate to good (r = 0.53-0.78), and correlations involving the ABC were fair to moderate (r = 0.41-0.59). Cronbach's alpha was strong (0.80) when only the MDRT and BBS were included. **Conclusions:** Results indicate residents of personal care homes are at high fall risk. The balance tests showed moderate to good reliability for this population. The BBS and MDRT appear to be valid measures of motor ability to maintain balance, while the self-report ABC appears to measure a different component of the balance construct in this population.

*Key Words***:** balance, aging, measurement, falls

INTRODUCTION

An estimated 35 billion, or 12.4% of the US population, are over age 64.[1] Falls in the elderly are a significant concern; one-third of community-dwelling elders fall each year.[2-4] Falls are a significant contributor to accidental deaths in this population.[5-7] As many as 73% of the elderly who have fallen in the past report having a fear of falling, and as many as 46% report a fear of falling even though they do not have a recent fall history.[8-10] Fear may discourage the elderly from being active and the inactivity, in turn, may reduce their functional abilities.

The numerous clinical tests that have been used to assess balance focus on varying aspects of the balance construct. Each clinical test may provide a unique contribution to the complete description of an individual's balance capabilities. For example, the Functional Reach Test (FRT) estimates fall risk by measuring the distance an individual can reach forward with an outstretched arm when the feet are planted on the floor.[11] The Multi-Directional Reach Test (MDRT) is a modification of the FRT and involves the individual reaching forward, backward, right, and left.[12,13] The FRT and MDRT are measures of balance while standing in place. The Berg Balance Scale (BBS) includes 14 scored tasks involving movement that mimic activities of daily living, many of which are positional changes such as sit to stand and turning 360°.[14] The Activities-specific Balance Confidence Scale (ABC) is a self-report measure. It focuses on respondents' self-efficacy related to falling or more simplistically the individuals' beliefs about their capabilities related to falling. This 16-item questionnaire asks subjects to rate their perceived level of confidence in performing various activities, such as walking around the house, up and down stairs, in a crowded mall, across a parking lot, and outside on icy sidewalks.[15]

Balance abilities of the community-dwelling elderly population have frequently been reported in the literature, and have included the clinical balance tests just described.[4,11-23] The psychometric properties of the BBS[14,16,20,24] and the FRT[18,21,22,25] have been reported for the community-dwelling elderly population, and the results have generally been favorable. Little information is available regarding their reliability and validity in other populations, specifically, for residents of personal care homes (PCHs). In addition, little information regarding the reliability and validity of the ABC[15,26] and the MDRT[12,13] exists for community-dwelling elders, and no information exists for residents of PCHs.

Retirement communities, assisted living, and nursing homes are frequently designed to accommodate the special social and physical needs of the older adult population.[27,28] Elderly residents of PCHs live in a setting that is quite different from the community-dwelling elderly. Typically, PCHs offer 24-hour staff availability for assistance with activities of daily living. Residents may live in an apartment-type setting and generally, are more independent than institutionalized elderly, such as those in skilled nursing facilities. Residents of PCHs may be at an increased risk of falls compared to both community-dwelling and institutionalized elderly. Community-dwelling elderly may have a higher level of function and be less affected by age-related balance declines

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than those in PCHs. Institutionalized elderly may have decreased function and be more affected by age-related balance deficits as compared to PCH residents. Individuals who are institutionalized may have a higher level of care and less independence and may be at a reduced risk of falls compared to PCH residents. For example, in a nursing home setting the resident is checked on at regular intervals by nursing personnel. In a PCH, the resident may be functioning at an independent level and not checked on except at meals.

The goals of this study were: (1) to use the BBS, the MDRT, and the ABC to describe balance in elderly residents of a PCH; (2) to quantify the test-retest reliability of the 3 balance tests and the inter-rater reliability of the BBS and MDRT in this population; and (3) to examine the construct validity of these balance measures in this population.

METHODS

Participants

Twenty-one women and 5 men ranging in age from 74 to 92 years (mean age = 85.3, sd = 4.9 years) were recruited from one PCH in rural western Pennsylvania. A sample of convenience was employed. One of the researchers collaborated with the PCH administrator to allow access to the facility and participant recruitment. To recruit participants, the study was highlighted on the monthly activity calendar, fliers were distributed to residents, and PCH aides asked residents to participate. All participants read and signed an informed consent form, which was approved by Slippery Rock University's Institutional Review Board, prior to participating in the study.

Inclusion criteria for participants were: (1) an age of at least 65 years, (2) capability of flexing and holding the shoulder at 90° of flexion or abduction for the MDRT, and (3) ability to stand for each component of the test without the use of an assistive device. Exclusion criteria were the inability to understand the informed consent or to stand without an assistive device for approximately 3 minutes. No one who volunteered was excluded based on these criteria.

Participants completed a medical history form to gather information about their past medical and social history, medications, and their history of falls. Most participants (69%) reported taking 3 or more medications daily. Specifically, 1 individual (4%) reported taking only 1 daily medication, 6 persons (23%) reported taking 2 medications, 10 persons (38%) reported taking 3 or 4 medications, and 8 persons (31%) reported taking 5 or more medications daily. One individual declined to provide the information. Many of the participants were given their medications by the PCH personnel and were unable to provide details of their specific medications.

Through a brief verbally administered survey, participants were asked about their history of falls and fear of falling. Approximately half of the participants (52%) reported that they did not fall in the past year (Table 1). Twenty-four percent fell once and 24% reported falling from 2 to 5 times in the past year. Approximately half of those persons who reported that they did not fall in the past year also reported having a fear of falling. Forty-two percent of those who reported falling in the past year denied a fear of falling.

Table 1. Number of Participants Falling or Having Fear of Falling Sorted by Number of Falls

Number of Falls	Participants N (%)	Participants with Fear
0	13 (52%)	6
1	6 (24%)	2
2	1 (4%)	1
3	3 (12%)	2
4	1 (4%)	1
5	1 (4%)	1

Participation was encouraged by paying the residents $5 for each testing session they completed. The investigators also conducted a falls risk assessment and prevention workshop for all residents and staff of the PCH after data collection was complete. Finally, participants were given the option of having a letter written to their primary care physician summarizing the results of their balance testing and, when appropriate, recommending appropriate interventions or referrals.

Data Collection Protocol

All data collection took place in a multipurpose community room at the PCH. Participants were administered the BBS, MDRT, and the ABC once on each of 2 separate testing sessions. Testing sessions were 1 to 2 weeks apart. Instructions on how to perform each test were scripted and kept consistent across participants for all tests. The order of administration of the BBS, MDRT, and ABC was random. Participants were instructed to request rest breaks as needed.

Six trained investigators participated in the data collection. The chief investigator was a licensed physical therapist with over 20 years of experience with the elderly population. She trained the other data collectors, who were all second and third year Doctor of Physical Therapy students. Training included reading about each of the 3 tests, practicing the skills, viewing and discussing videos of 3 patients, and clinical practice using the tests by the third year students. Two of the 6 investigators simultaneously scored participants when performing the BBS and MDRT. The specific investigators who scored each test were not consistent across participants.

Each of the 14 items of the BBS were scored as an integer from 0 to 4, with 0 indicating that the individual could not perform the test or required maximum assistance and 4 indicating that the individual had no difficulty. The maximum score is 56. A score below 45 has been shown to indicate an increased risk of falls in the elderly.[14,16,29]

The MDRT was chosen for this study instead of the FRT since elderly adults fall in all directions, not just forward.[30] In addition, several researchers have provided evidence that stability in the lateral directions is important in assessing an individual's overall postural stability.[17,23,31-33] The MDRT was administered by asking participants to reach as far as possible 3 times in each direction in the following order: forward, backward, right, and left. The average of the 3 trials in each direction was used in subsequent analyses. A yardstick was mounted on the wall and adjusted to the height of each participant's acromion and the excursion of the distal tip of the 3rd digit was recorded. Participants were not permitted to lift

their heels or any portion of their feet off the floor. They asked questions if they did not understand the instructions, but they were not given practice attempts.

For each activity questioned via the ABC, participants indicated their level of confidence on a scale from 0% to 100%, with higher scores indicating increased confidence. The scores across the 16 tasks were averaged and this average was used in subsequent analyses.

Data Analysis

Descriptive statistics were used to summarize balance scores and differences in scores between sessions and raters. Intraclass correlation coefficients were used to quantify inter-rater reliability of the BBS and MDRT and test-retest reliability of the BBS, MDRT, and ABC. ICC model(1,1) was used since the raters scoring each test were not kept consistent across sessions or participants.[34,35] Pearson's correlations coefficients were used to quantify the linear relationship among the BBS, 4 MDRT directions, and the ABC. Cronbach's alpha was used to quantify internal consistency and determine whether these balance tests were measuring similar or different aspects of the balance construct. The Statistical Package for the Social Sciences (version 10.0) was used for analysis.

RESULTS

There was a wide range of scores for the BBS, the 4 MDRT directions, and the ABC. The average BBS score (41.3) and MDRT forward reach (5.6 in) fell below the cut-off scores previously reported to indicate an increased risk of falls[14,16,18,29] (Table 2). Fifty-four percent of participants fell below the BBS cut-off of 45, and 58% reached forward less than 6 inches. On average, the least distance reached was in the backward direction (2.9 in) and the right and left lateral reaches averaged 3.3 inches and 3.7 inches, respectively. The ABC scores averaged 54%, with a wide range from 12.2% to 100%.

Inter-rater reliability was good for the BBS (ICC = 0.88) and all 4 directions of the MDRT (ICC=0.91 to 0.98) (Table 3). (Inter-rater reliability of the ABC was not investigated.) Test-retest reliability was also good for the BBS (ICC = 0.77) and moderate to good for the 4 directions of the MDRT (ICC = 0.66 to 0.83). The ABC had moderate test-retest reliability (ICC = 0.70).

Pearson's correlation coefficients indicated that the weakest linear relationships among the balance tests involved the ABC (r = 0.41 to 0.59) (Table 4). The BBS and the 4 MDRT directions were all moderately to highly correlated with each other (r = 0.53 to 0.80). The BBS had stronger correlations with the forward and backward MDRT directions (0.78 and 0.77) than the lateral directions (0.53 and 0.63).

The Cronbach's alpha was very small when all balance tests were included (alpha = 0.06). When the ABC was deleted, leaving only the BBS and 4 separate MDRT directions, internal consistency was strong (alpha=0.80) (Table 5). The highest degree of internal consistency (alpha=0.89) was obtained when only the 4 MDRT directions were included.

DISCUSSION

The primary goal of this study was to describe balance in a sample of elderly individuals living in a personal care home, a generally uninvestigated population. These results provide

Table 2. Descriptive Statistics of Balance Scores for the Berg Balance Scale (BBS), Multi-Directional Reach Test (MDRT) and Activities-Specific Balance Confidence Scale (ABC)*

Balance Measure	Mean	Standard Deviation	Range	95% Confidence Interval for Mean	Participants Below Cut-Off** Cut-Off N (%)
BBS	41.3	9.0	25 – 55	37.7 – 44.9	<45 14 (54%)
MDRT forward (in)	5.6	3.0	0 – 11.7	4.4 – 6.8	≤ 6 in 15 (58%) < 10 in 25 (99%)
MDRT backward (in)	2.9	2.2	0 – 7.3	2.0 – 3.8	
MDRT right (in)	3.3	2.5	0 – 10.5	2.3 – 4.2	
MDRT left (in)	3.7	3.1	0 – 10.2	2.6 – 4.9	
ABC (%)	54.0	24.9	12.2 – 100.0	43.9 – 64.0	

* Values are for the first rater, first session. (n=26)
**A score below 45 indicates an increased risk of falls for BBS.[14,16,29] For the Functional Reach test (similar to MDRT forward), a score below 6 inches predicted recurrent falls, called "high risk", while under 10 inches indicates a "moderate risk" for falling.[18]

Table 3. Reliability of Berg Balance Scale (BBS), Multi-Directional Reach Test (MDRT) and Activities-Specific Balance Confidence Scale (ABC), Indicated by Intraclass Correlation Coefficients (ICC[1,1])*

	Absolute Difference Between Raters	Inter-rater ICC(1,1)	Absolute Difference Between Sessions	Test-retest ICC(1,1)
BBS	2.7	0.88	4.6	0.77
MDRT forward	0.4 in	0.98	1.4 in	0.75
MDRT backward	0.5 in	0.96	1.4 in	0.71
MDRT right	0.7 in	0.94	1.9 in	0.66
MDRT left	1.0 in	0.91	1.4 in	0.83
ABC	—-	—-	14.5 %	0.70

* Inter-rater comparisons are between the two raters for only the first testing session. Test-retest comparisons are between the two testing sessions for only the first rater. Inter-rater reliability of the ABC was not investigated in this study. Absolute differences were averaged across participants.

Table 4. Pearson's Correlation Coefficients among the Berg Balance Scale (BBS), Multi-Directional Reach Test (MDRT) and Activities-Specific Balance Confidence Scale (ABC) (n=26)

	MDRT forward	MDRT backward	MDRT right	MDRT left	ABC
BBS	0.78	0.77	0.53	0.63	0.50
MDRT forward		0.69	0.72	0.68	0.48
MDRT backward			0.59	0.80	0.43
MDRT right				0.65	0.59
MDRT left					0.41

* All's r's statistically significant at p<.05, and all except ABC vs. MDRT backward and MDRT left are significant at p<.01.

Table 5. Internal Consistency of Berg Balance Scale (BBS), Multi-Directional Reach Test (MDRT) and Activities-Specific Balance Confidence Scale (ABC), measured by Cronbach's Alpha (n=26) (alpha=0.06).

	Item-Total Correlation	Alpha if Item Deleted *
ABC	0.56	0.80
BBS	0.51	0.03
MDRT forward	0.50	0.05
MDRT backward	0.46	0.05
MDRT right	0.60	0.05
MDRT left	0.43	0.05

* Alpha is maximized at 0.89 if only four MDRT directions are included.

evidence that elderly individuals living in the personal care environment have reduced balance capabilities compared to older adults living independently in the community (Table 6).[11-13] A comparison of their scores with previously published cut-off scores shows them to be at increased risk of falls.

Newton was the first to administer the MDRT, and did so in a sample of 251 community-dwelling elderly individuals living in an inner city.[12] She also administered the BBS to this sample.[12,13] The BBS indicated that the community-dwelling elderly, on average, were not at increased risk for falls, as evidenced by comparing their mean score with previously published cut-off scores. The PCH residents tested in this study, however, were found to be at increased risk for falls. Similarly, the MDRT-forward results for the community-dwelling elderly indicated a 'moderate risk' for falling, while these results for PCH residents indicated a 'high risk' for falling. The protocol in this study differed from Newton's introduction of the MDRT.[12,13] The yardstick was mounted on a wall in this study, while Newton mounted it on a tripod away from the wall. It would be expected that allowing participants to stand next to a wall might result in increased scores; however, these participants had reduced scores compared to the community-dwelling elderly. In addition, Newton analyzed the average of 2 trials in each direction and did not report whether participants practiced the reaches before data were collected. We averaged 3 trials and did not permit practice attempts.

Table 6. Comparison of Berg Balance Scale (BBS), Multi-Directional Reach Test (MDRT) and Activities-Specific Balance Confidence Scale (ABC) Results in Community-Dwelling Older Adults and Residents of Personal Care Homes. All values are means.

Balance Measure	Personal Care Homes* n=26 avg age=85	Community Dwelling† n=251 avg age=74
BBS	41.3	48.6
MDRT forward (in)	5.6	8.9‡
MDRT backward (in)	2.9	4.6
MDRT right (in)	3.3	6.9
MDRT left (in)	3.7	6.6
ABC (%)	54.0	—

*Current study.
† Newton, 1997.[12] Newton, 2001.[13]
‡Duncan et al. measured Functional Reach, similar to the MDRT forward reach, in 20 males and 14 females who were all community-dwelling and 70 to 87 years old.[11] Mean functional reach was 13.2 (sd = 1.6) inches for males and 10.5 (sd = 3.5) inches for females.

Another goal of the study was to examine the reliability of the balance tests investigated. Inter-rater reliability was especially high for each MDRT direction (ICC = 0.91 to 0.98) and quite good for the BBS (ICC = 0.88). Instructions for completing each balance test were kept consistent across participants, which may have contributed to the high inter-rater reliability. The inter-rater reliability in this study, therefore, primarily reflects how different raters scored the BBS and MDRT rather than other aspects of administering the tests, such as giving the instructions to participants. Test-retest reliability was moderate to good (0.77 for BBS, 0.66 to 0.83 for MDRT), but not as high as inter-rater reliability. Factors affecting reliability of the MDRT and BBS, therefore, appear to be more related to the subject's repeated performance of the test rather than inconsistencies among raters. It is unknown whether this is true for the ABC as well, since inter-rater reliability of this test was not investigated.

The MDRT test-retest reliability reported by Newton for community-dwelling elderly was considerably lower for the backward, right, and left directions than that reported here (ICC = 0.093-0.095 vs. 0.66-0.83).[13] This may be because Newton quantified test-retest reliability between 2 successive reaches, while we compared the 2 averages of 3 reaches. However, it is unclear why test-retest reliability reported by Newton for the forward direction was higher than that reported here (ICC = 0.94 vs. 0.75).

The convergent validity demonstrated by the moderate to good correlations between the BBS and MDRT was expected since these instruments both measure psychomotor skills. The divergent validity demonstrated by the lower correlations of the ABC with the BBS and MDRT was also expected. Again, it appears that the BBS and MDRT are valid measures of the psychomotor component of the balance construct, and the ABC is a potential valid measure of self-reported balance confidence.

Not surprisingly, results of the Cronbach's alpha analysis indicated that the ABC is measuring a different construct than the BBS and MDRT directions. Cronbach's alpha also indicated the BBS and separate MDRT directions are both measuring similar aspects of balance. This makes sense, as both measure psychomotor skills, but the BBS measures balance abilities while performing several tasks while the MDRT is a measure of standing balance only. The high Cronbach's

alpha when only the 4 MDRT directions were included suggests that any of the 4 directions could be used to examine balance in terms of reaching ability. One or several directions may be chosen in a particular situation depending on the specific task, or primary reach directions, of interest. Other studies have suggested that directions in addition to forward reaching should be used to more closely examine an individual's balance ability for specific tasks.[13,23]

Administering the ABC to this population proved to be problematic. The elderly participants in this study often did not perform all the tasks listed on the ABC and, therefore, they were unable to rate their confidence. For example, item 16 of the ABC questions the confidence level of the individual walking outside on icy surfaces. One participant was from a sunny climate and had not experienced walking on an icy surface in recent years.

Generalizability of these results is limited due to the small sample size. In addition, all participants resided in the same PCH, which was in rural western Pennsylvania. A larger study incorporating more PCHs would improve the generalizability of these results, as the profile of residents in a PCH may differ based on the level of service provided and location of the facility.

Some participants appeared at times to not understand our instructions when reaching forward during the MDRT. Some individuals would reach more upwards than forward and then sweep their arm down while reaching, finally resting their arm nearly at their side. They had a difficult time understanding that we wanted to measure their reach distance while they were holding still. Although we are confident that the MDRT measures we recorded here were taken while in relatively static stance, since we were there to ensure that the protocol was eventually carried out, the difficulty that some residents had raises an issue regarding the validity of these balance tests in the PCH population. Lower scores of these participants compared to community-dwelling elderly may be partially due to PCH residents' difficulty in performing the tests rather than truly poorer balance. Fear of falling while performing the BBS and MDRT also may contribute to underestimated balance capabilities of PCH residents. In addition, variability in rest periods due to the arrival of many participants at the same time may result in better or worse performance with the BBS and MDRT.

Future research should improve generalizability by including elderly in several PCHs, by increasing the sample size studied, and by investigating gender effects on balance abilities and confidence in this population. The validity of the 3 balance tests investigated here could be further examined to verify the results presented and to determine if the BBS and MDRT can identify potential fallers in this population. Finally, information potentially gained from a self-report tool can be valuable in the overall assessment of an individual's risk of falling. However, it would be useful to further examine each individual item of the ABC or to develop a new self-report tool more appropriate for residents of PCHs.

CONCLUSIONS

Individuals residing in PCHs appear to be at increased risk of falling compared to community-dwelling elders. The BBS, MDRT, and ABC all appear to be reliable tools when administered to this population. The BBS and MDRT both appear to be valid measures of psychomotor balance skills, with the 4 MDRT directions all being acceptable indicators of specifically reaching ability. The ABC may be a valid measure of balance confidence, but it was difficult to administer in this population.

GRANT SUPPORT

The authors thank the Research Committee of the Pennsylvania Physical Therapy Association for funding this study.

ACKNOWLEDGEMENTS

The authors acknowledge residents of The Orchard in Butler, Pennsylvania, Cheri Fester, Resident Coordinator and Karen McCarrier, Community Director of The Orchard. Finally, appreciation is extended to Jamie Chichy, Katherine Gruver Lee, and Kimberly Meek who assisted with data collection.

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