Functional Performance in Community Living Older Adults

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ABSTRACT

Purpose: Routinely, physical therapists use a variety of physical performance tests to determine functional status of older adults. Whereas many commonly used instruments have been evaluated for some aspects of reliability and validity, few studies report typical performance for community living older adults, especially those who are 80 years and older and use an assistive ambulatory device. The aim of this study was to determine reference values of 7 functional tests for older adults by decade of age, gender, and assistive device use. **Methods:** Seventy-six older adults (age 66-101 years) participated in functional assessment clinics that included measures of comfortable gait speed, fast gait speed, Berg Balance Scale, Timed Up and Go, timed sit to stand, 6 minute walk, and Physical Performance Test. **Results:** For each functional test administered, means, standard deviations, and confidence intervals are presented by age, gender, and assistive device use. Regression analyses suggest that age and assistive device use are important factors in performance on functional tests. **Conclusion:** This study reports typical functional status of community living older adults. Such information may be useful in describing functional limitations and monitoring change in physical performance of older adults.

INTRODUCTION

Physical therapists use a variety of clinical measures to determine effectiveness of rehabilitation interventions and to inform discharge decisions. An older adult's ability to safely and effectively perform functional tasks necessary for daily living is influenced by his/her ambulatory status, postural control and stability, functional mobility, functional lower extremity strength, dynamic balance, and overall endurance. To gain a complete 'picture' of an older patient's functional status, therapists often use several different measures.

Ambulatory status can be quantified with measures of comfortable gait speed (CGS) and fast gait speed (FGS).[1] Gait speed at 'usual or comfortable' self-selected pace and at 'as fast as safely possible' self-selected pace have been found to provide meaningful measures of ambulatory capacity in both healthy and frail older adults.[2-5] The reliability of gait speed measures, whether made with a stopwatch or electronic walkways such as the GAITRite system (CIR Systems Inc., Clifton, NJ), is well established.[6-14] There is some indication that the difference between fast and comfortable gait speed may be an indicator of functional decline.[6,8,15] Several studies have reported reference values for gait speed in older adults.[6-8,16-18] Most of these reports, however, were based on small samples or included few participants over 80 years old.

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The Berg Balance Scale (BBS)[19-23] is a commonly used measure of postural control and stability. This 14-item performance based instrument includes tasks such as standing with feet together, reaching forward, picking up an object from the floor, and turning to look over each shoulder. An individual's stability is rated, using timed or other clearly defined criteria, on a scale from 0 (unable/unsafe) to 4 (completely independent/efficient/ safe). The overall BBS score, attained by summing the ratings of the 14 individual test items, can range from 0 to 56 points. A skilled evaluator can complete the test in 15 to 20 minutes. Evidence supports the test's internal consistency,[19] intrarater and interrater reliability,[19,22] content validity,[19] construct validity,[20,21] and predictive validity for determining fall risk of older adults.[22,24,25] There is also increasing evidence of the BBS's responsiveness following rehabilitation intervention for frail elders as well as individuals with neuromuscular impairment.[26,27]

The Timed Up and Go (TUG) test provides a measure of functional mobility in older adults.[28-31] Functional mobility entails motor skills essential for independent living, such as rising from and controlling descent into a seated position (eg, to/from bed, toilet, or chair), quickly walking a short distance (eg, to answer a ringing telephone), and changing direction while walking. The TUG protocol[28] assesses performance of these basic motor tasks. The therapist measures the time it takes a person to stand from a standard armchair, walk 3 meters, turn 180°, walk back to the chair, and sit down. Testers can also describe or rate quality and/or safety of transition phases during the test.[32] Podsiadlo and Richardson[28] demonstrated high intratester and intertester reliability of TUG scores. Construct validity is supported by correlation of TUG scores with BBS scores, gait speed, postural sway, step length and step frequency, and Barthel Index scores.[28,32,33] Also, TUG times of more than 16 seconds have been shown to be predictive of increased risk of falling in community-dwelling older adults.[30] Although the TUG is used sometimes to assess effectiveness of rehabilitation interventions, its responsiveness needs further clarification.[6,29-31] At present, variation in testing protocol and inclusion criteria (such that healthy and frail older adults are included in the sample) make it difficult to interpret some published norms.[34] Steffan et al[6] reported reference values for TUG times based on performance of 96 community-dwelling individuals, 61–89 years of age. Whereas there were 35 or more individuals in the 60-69 and 70-79 year old subgroups, there were only 23 individuals aged 80-89, and no persons over the age of 90 years.

Functional lower extremity strength and dynamic balance capability can be measured by rapid timed sit to stand

(TSS).[35-37] The inability to rise from a chair without use of armrests is often used as an indicator of physical frailty.[37] Rising from a chair or bed is a challenging motor task for many older adults, especially those with impairments of musculoskeletal and/or neuromuscular systems.[38] Important contributors to successful chair or bed rise include strength of hip and knee extensors, muscular endurance, and efficient postural responses for control of the center of mass during this transitional activity.[39,40] Two methods commonly used to quantify TSS performance are (1) measuring the time it takes to complete 5 rapid chair rise cycles (sit to stand to sit), and (2) counting the number of chair rise cycles completed in a fixed time period.[41] Lord et al[42] reported time to complete 5 chair rise cycles for 669 community-dwelling men and women aged 75-93. Although 17% of the participants used an assistive device for ambulation, the authors did not report whether the use of an assistive device was associated with TSS scores. Guralnik and colleagues[35,43] studied over 5000 older adults and demonstrated the predictive validity of 5 chair rise cycles (along with standing balance and gait speed) as an indicator of functional decline.

Counting the number of cycles completed in a set period is an alternative when testing older adults who are unable to complete 5 chair rise cycles. Jones et al[44] proposed a protocol of counting the number of sit to stand cycles completed in 30 seconds. Those investigators demonstrated that the 30 second chair stand protocol has test-retest reliability, concurrent validity with leg press strength, and ability to detect differences between subgroups based on age and physical activity level. In a study using Jones' protocol, however, participants reported muscle fatigue and subsequent soreness the day following testing.[45] Also of note, a study examining determinants of rising from the floor for older adults found all participants (50-90 years old) were able to complete 5 chair rise cycles, although time to complete the 5 cycles increased substantially with age.[46]

The 6 minute walk test (6MW)[47-50] provides a measure of exercise tolerance and endurance. In 1968, Cooper[51] described a protocol to assess physical fitness that measured the total distance walked in a 12-minute period. In 1976, McGavin et al[52] used this protocol to assess exercise tolerance in patients with chronic bronchitis. Since that time, the protocol has been standardized to a 6-minute period, and is now widely used to assess exercise tolerance in adults with cardiac and respiratory conditions.[53,54] The 6MW has been used also as a measure of functional exercise capacity in older adults.[55] Test-retest reliability of the 6MW is well documented.[6,48,55,56] Several studies of patients with cardiorespiratory diagnoses have established construct and concurrent validity of the 6MW as a measure of exercise capacity by correlating distance walked with peak oxygen uptake.[48,53,56,57] In addition, the 6MW has been shown to discriminate between healthy older adults and those with class II and III heart failure,[58] and to predict hospitalization and mortality in patients with left ventricular dysfunction and advanced lung disease.[59-61] Enright and Sherrill[50] established gender-specific reference equations for the 6MW based on performance of 290 healthy adults aged 40-80 years. Troosters et al[62] and Steffan et al[6] reported normal values of the 6MW for healthy older adults.

The Physical Performance Test (PPT),[63] developed by Rueben and Siu in 1990, is a commonly used measure of overall functional ability of older adults. Short and long versions of the PPT consist of 7 and 9 functional tasks, respectively. Test items on the short form include writing a sentence, simulated eating, lifting a book and placing it on a shelf, donning and doffing a jacket, picking up a penny from the floor, turning 360° while standing, and walking 50 ft (15.2 m). The 9 item scale adds 2 stair-climbing activities. Individual test items are rated between 0 and 4 points. For most test items, the rating is based on time it takes to perform the task. The overall PPT score is obtained by totaling individual item scores. Evidence exists to support the PPT's interrater reliability, concurrent validity with established measures of physical function, construct validity as a measure of physical function status, and predictive validity for mortality or nursing home placement.[63-66] Brown et al[67] used the 9 item PPT to identify frailty in community living older adults. Individuals were classified as moderately frail, mildly frail, or not frail for PPT scores in the ranges of 17-24, 25-31, and 32-36, respectively. The PPT scores also have been used to assess risk of falling[68] and the efficacy of exercise to reduce frailty and improve function in older adults.[67-69] Increasingly, the PPT is being used as a component of comprehensive geriatric assessment.[70-73] Yet, typical performance on the PPT for relatively healthy, community living older adults is not well documented.

Although there is growing evidence of validity and reliability for many of these clinical assessment measures, there are very few reports of usual performance (norms) for older adults, especially those 80 years and older or for those who typically use an assistive device for ambulation.[6] Without evidence about usual performance in community living older adults, the therapist's ability to interpret results of functional tests for clinical decision making and discharge planning is not well grounded.[74-77] This shortfall has been recognized in the American Physical Therapy Association's Clinical Research Agenda.[78] Item 2 asks, "What is the usefulness of information derived from examination (history, review of systems, tests and measures) for prognosis?" Further, item 2.1 asks, "What measures are currently used for prognosis?" and "What factors are used by physical therapists to determine their recommendations of settings to which patients are discharged?" The purpose of this study was to describe typical functional status of community living older adults by determining reference values for CGS, FGS, BBS, TUG, TSS, 6MW, and PPT specific to decade of age, gender, and assistive device use.

METHOD

This study was approved by the Institutional Review Board of Sacred Heart University, Fairfield, CT, Human Subjects Committee of the University of Hartford, West Hartford, CT, and 3030 Park Health Systems, Fairfield, CT.

Participants

A convenience sample of 76 older adults, 22 men (28.9%) and 54 women (71.1%), from the southern Connecticut area

volunteered to participate in this study. Participants ranged in age from 66 to 101 years old (mean age = 82.7 ± 7.9 years). Volunteers were recruited by means of flyers, an informational meeting, and direct solicitation. All study participants were community dwelling and independently ambulatory at a FIM locomotor score of 6 or 7. Exclusion criteria are listed in Table 1. Each participant provided written informed consent before taking part in the study.

Table 1. Criteria for Excluding Individuals from Study Participation

- Unstable or limiting cardiac disease (eg, angina)
- History of myocardial infarction, coronary artery bypass or other cardiac surgery within the previous 6 months
- Respiratory conditions requiring oxygen supplementation or frequent use of inhalers
- History of neurological disease (eg, Stroke, Parkinson disease) with residual impairment
- History of fracture within the previous 6 months (especially spinal or hip fracture)
- Severely limiting arthritis, joint instability, or back pain
- Total joint replacement within the previous 6 months
- Abdominal surgery within the previous 6 months
- Documented dementia or significant clinical depression
- Surgery, chemotherapy, or radiation therapy for cancer within the previous 6 months
- Acute illness or injury on the day of the functional assessment clinic

Procedure

Individuals expressing an interest in participating in the study filled out a health history form. The health history form was used to gather descriptive information about study participants and to screen for inclusion and exclusion criteria.[19] Volunteers who met the inclusion criteria and reported none of the exclusion criteria were scheduled for data collection on a subsequent day. The CGS, FGS, BBS, TUG, TSS, 6MW, and PPT were administered to each individual in a single session of a functional assessment clinic held in the community room of an independent living complex for older adults in Bridgeport, Connecticut. Clinics were held on 3 separate days within a 2 week period to accommodate interested persons. The clinic consisted of a cycle of 8 numbered stations with different assessments taking place at each station. In addition to 6 functional tests stations (comfortable and fast gait speed were performed at the same station), 2 stations were used to administer health status and fall history/fear of falling questionnaires. High physically demanding stations alternated with questionnaire and less physically demanding assessments to allow rest periods and minimize fatigue.

On the day of the clinic, participants checked in at a registration table and were directed to one of the 8 assessments stations. After assessment was completed at the station to which they were initially assigned, participants were directed to the next station in the numbered cycle, subsequently rotating through all 8 stations. Unless noted otherwise below, participants performed 1 trial of each functional test. Participants were encouraged to rest as needed between the different functional tests and between trials of the same test. Typically, participants rested 3 to 5 minutes between stations and, for those stations in which multiple trials were performed, 2 to 3 minutes between trials. Either a physical therapist or a physical therapist student under the supervision of a therapist administered the functional tests. All examiners were trained in one of the standardized testing procedures, including instructions given to study participants. For each measure, the designated examiner assessed all participants.

Comfortable gait speed and FGS were measured with the use of a GaitRite system. The GaitRite system consists of a 3.66 m (12 ft) walkway and software for calculating various gait parameters. For CGS trials, participants were instructed to "walk at a usual, comfortable pace." For FGS trials, participants were instructed to walk "as fast as you safely can." Participants used their assistive devices during gait speed testing if they used a device routinely during daily ambulatory activities. Participants began walking 3 m before the beginning of the GaitRite mat, continued across the walkway, and stopped walking 3 m beyond the end of the gait mat. GaitRite software was used to calculate gait speed for that portion of the walk that took place on the gait mat. Participants performed 3 trials each of CGS and FGS.

The 14 test items of the BBS were administered and scored in accord with established procedures. Standardized methods of administering and rating the BBS have been described elsewhere.[21,22]

For the TUG test, a 45.7 cm (18 in) high orange traffic cone was placed 3 m from the front edge of a chair. Participants were instructed to move as quickly as safely able in rising from the chair, walking around the traffic cone and returning to sitting. A stopwatch was used to time how long it took participants to complete the TUG task. Each participant performed 2 trials of TUG.

For TSS, a stopwatch was used to determine time to complete 5 sit to stand to sit cycles. Participants were instructed not to use the armrests of the chair. Some participants, however, were unable to rise from sitting without using hands for support. In which case, they performed TSS using the armrests of the chair. Participants performed 2 trials of TSS, with a 3 minute rest period between trials.

The 6MW was conducted along an 82.3 m hallway outside the community room. Participants started walking at the hallway midpoint, then continued walking from end to end for the duration of the test. An examiner used a stopwatch to monitor the 6 minute test period and a measuring wheel to record total distance covered. Participants were instructed to walk at their usual or comfortable pace. Participants who needed to stop during the 6 minute testing period rested by standing in place or sitting in one of the chairs that had been positioned along the hallway. The stopwatch continued to run during any rest periods taken.

The 7 item version of the PPT was administered and scored in accord with established procedures.[63,67]

Data Analysis

SPSS for Windows 10.0 (SPSS, Inc., Chicago, Ill.) was used for all analyses. Intraclass correlation coefficients (ICCs) were

calculated to verify reliability of measures for tests on which more than one trial was completed. The ICCs for measures of CGS, FGS, TUG, and TSS were .95, .97, .95, and .82, respectively. The mean of the 3 trials at each gait speed, the mean of the 2 TUG trials, and the mean of the 2 TSS trials were calculated and used in all subsequent analyses. Means, standard deviations, and 95% confident intervals were calculated by decade of age, gender, and assistive device use for each functional test. Separate multiple regressions were used for CGS, FGS, BBS, TUG, TSS, 6MW, and PPT to examine the relationship between age, gender, assistive device use, and functional test score.

RESULTS

On the health history form, the majority of participants rated their health status as good (48.6%), very good (29.2%), or excellent (4.2%). The most common medical conditions reported included hypertension (52.8%), osteoarthritis (37.5%), various cardiac diseases (34.7%), previous cancers (31.9%), urinary system dysfunction (23.6%), digestive system problems (19.4%), and dizziness and vertigo (16.7%). The majority of participants (89.9%) reported using one or more prescription medications, with 59.7% of participants reporting taking 3 or more prescription medications daily. Mean prescription medication use was 3.2 ± 2.4 prescriptions. For over-the-counter medication use, 86.1% of participants reported daily use of one or more products, with 29.3% taking 3 or more products daily. Mean over-the-counter medication use was 1.8 ± 1.5 products.

When asked to rate the quality of their vision (scale: poor, fair, good, very good, excellent), 75% of participants described their vision as good or better, with 63.9% using corrective lenses (typically tri-focals) all the time. Slightly more than half of participants (51.4%) reported previous surgery for cataract removal, whereas 11.1% reported being treated for glaucoma and 16.7% for macular degeneration. When asked to rate quality of their hearing, 68.1% described their hearing as good or better; 23.8% of participants routinely used hearing aides. When asked to rate their balance, 58.3% of participants reported good, very good, or excellent balance. However, many reported being moderately worried (27.8%) or very worried (34.7%) about falling. Overall, 31.6% of participants reported one or more falls in the previous 6 month period. Reported falls increased with age from 16.7% in the 60-69 group, 26.3% in the 70-79 group, 32.4% in the 80-89 group, and 41.2% in the 90-101 age group.

Nearly half of the participants (47.4%) reported they were able to walk unlimited distances; 25% reported they could walk up to 1/2 mile before needing to rest; however, 27.6% reported having difficulty with distances over 150 feet. None of the participants in the 60-69 and the 70-79 age groups routinely used an assistive device during ambulation. In the 80-89 group (n=34), 5 participants (14.7%) routinely used a straight cane, and 5 participants (14.7%) routinely used a rolling/cardiac walker. In the 90-101 group (n=17), 5 participants (29.4%) typically used a straight cane, and 5 participants (29.4%) used a rolling/cardiac walker.

All participants in the 60-69 and all but one participant in the 70-79 age group (n=19) were able to rise from a chair without using the armrests. In contrast, 6 of 34 participants (17.6%) in the 80-89 group, and 4 of 17 participants (23.5%) in the 90-101 group were unable to rise to a standing position unless they used armrests for support.

Tables 2 through 8 present the descriptive statistics for each functional test by gender, age, and assistive device use. For each functional test, a regression was conducted with the continuous variable age, and two categorical variables, gender and assistive device use. In all 7 regressions, age and assistive device use were significant predictors of functional test performance ($p < .05$). However, gender was not a significant predictor ($p < .05$) for any of the 7 functional tests. Accordingly, age and assistive device use, but not gender, were included in the regression equations presented in Table 9. The variables age and assistive device use accounted for between 37% (TSS) and 71% (BBS) of the variance in the functional test scores.

Table 2. Comfortable Gait Speed: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device (in Meters per Second)

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	1.26	—	0.84 – 1.67
	Female	5	1.24	0.12	1.05 – 1.42
	Overall	6	1.24	0.10	1.13 – 1.35
70-79	Male	9	1.25	0.23	1.11 – 1.39
	Female	10	1.25	0.18	1.11 – 1.38
	Overall	19	1.25	0.20	1.15 – 1.34
80-89	Male	10	0.88	0.24	0.75 – 1.01
	Female	24	0.80	0.20	0.72 – 0.89
	No Device	24	0.91	0.16	0.84 – 0.98
	Device	10	0.63	0.17	0.52 – 0.74
	Overall	34	0.82	0.21	0.75 – 0.90
90-101	Male	2	0.72	0.14	0.43 – 1.02
	Female	15	0.71	0.23	0.60 – 0.82
	No Device	7	0.88	0.23	0.76 – 1.01
	Device	10	0.59	0.10	0.48 – 0.70
	Overall	17	0.71	0.22	0.60 – 0.82

Table 3. Fast Gait Speed: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device (in Meters per Second)

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	1.96	—	1.37 – 2.56
	Female	5	1.81	0.17	1.55 – 2.08
	Overall	6	1.84	0.17	1.67 – 2.02
70-79	Male	9	1.94	0.26	1.74 – 2.14
	Female	10	1.80	0.26	1.61 – 1.99
	Overall	19	1.86	0.27	1.73 – 1.99
80-89	Male	10	1.29	0.38	1.10 – 1.48
	Female	24	1.20	0.29	1.08 – 1.33
	No Device	24	1.38	0.22	1.28 – 1.47
	Device	10	0.88	0.23	0.73 – 1.03
	Overall	34	1.23	0.32	1.12 – 1.34
90-101	Male	2	1.27	0.13	0.85 – 1.69
	Female	15	1.05	0.32	0.90 – 1.21
	No Device	7	1.29	0.33	1.11 – 1.47
	Device	10	0.93	0.20	0.78 – 1.08
	Overall	17	1.08	0.31	0.92 – 1.24

Table 4. Berg Balance Scale Scores: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	51.0	—	35.3 – 66.7
	Female	5	54.6	0.5	47.6 – 61.6
	Overall	6	54.0	1.5	52.4 – 55.6
70-79	Male	9	53.9	1.5	48.7 – 59.1
	Female	10	51.6	2.6	46.6 – 56.6
	Overall	19	52.7	2.4	51.5 – 53.8
80-89	Male	10	41.8	12.2	36.8 – 46.8
	Female	24	42.1	8.0	38.9 – 45.3
	No Device	24	46.3	4.2	44.1 – 48.5
	Device	10	31.7	10.0	28.3 – 35.1
	Overall	34	42.0	9.2	38.8 – 45.3
90-101	Male	2	40.0	1.4	28.9 – 51.1
	Female	15	36.9	9.7	32.8 – 40.9
	No Device	7	45	4.2	40.9 – 49.1
	Device	10	31.8	7.6	28.4 – 35.2
	Overall	17	37.2	9.1	32.5 – 41.9

Table 5. Timed Up and Go Scores: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device (in Seconds)

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	7.3	—	-2.4 – 17.0
	Female	5	8.1	0.9	3.7 – 12.4
	Overall	6	7.9	0.9	7.0 – 8.9
70-79	Male	9	6.8	1.1	3.6 – 10.1
	Female	10	8.5	2.8	5.4 – 11.6
	Overall	19	7.7	2.3	6.6 – 8.8
80-89	Male	10	13.5	6.3	10.4 – 16.5
	Female	24	13.6	5.5	11.7 – 15.6
	No Device	24	11.0	2.2	9.4 – 12.5
	Device	10	19.9	6.4	17.5 – 22.3
	Overall	34	13.6	5.6	11.6 – 15.5
90-101	Male	2	23.4	9.2	16.6 – 30.3
	Female	15	17.0	5.3	14.5 – 19.5
	No Device	7	14.7	7.9	11.8 – 17.5
	Device	10	19.9	2.5	17.5 – 22.3
	Overall	17	17.7	5.8	14.7 – 20.7

Table 6. Timed Sit to Stand Scores: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device (in Seconds)

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	8.4	—	-3.6 – 20.5
	Female	5	12.7	1.8	7.3 – 18.1
	Overall	6	12.0	2.4	9.5 – 14.4
70-79	Male	9	11.6	3.4	7.6 – 15.6
	Female	10	13.0	4.8	9.2 – 16.8
	Overall	19	12.3	4.2	10.3 – 14.3
80-89	Male	10	16.7	4.5	12.9 – 20.5
	Female	24	17.2	5.5	14.8 – 19.7
	No Device	24	16.0	4.9	13.7 – 18.2
	Device	10	19.8	4.9	16.3 – 23.3
	Overall	34	17.1	5.2	15.3 – 18.9
90-101	Male	2	19.5	2.3	11.0 – 28.0
	Female	15	22.9	9.6	19.8 – 26.0
	No Device	7	18.0	7.0	13.8 – 22.2
	Device	10	25.7	9.2	22.2 – 29.2
	Overall	17	22.5	9.0	17.9 – 27.2

Table 7. Six Minute Walk Distances: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device (in Meters)

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	497.7	—	295.5 – 700.0
	Female	5	405.0	110.0	314.5 – 495.4
	Overall	6	420.4	105.4	309.8 – 531.1
70-79	Male	9	475.3	93.0	407.9 – 542.8
	Female	10	406.4	94.8	342.4 – 470.3
	Overall	19	439.0	97.9	391.9 – 486.2
80-89	Male	9	319.6	79.7	252.2 – 387.0
	Female	24	281.8	122.7	240.5 – 323.1
	No Device	24	327.9	102.1	290.8 – 365.1
	Device	9	196.6	82.2	135.9 – 257.3
	Overall	33	292.1	112.7	252.2 – 332.1
90-101	Male	2	295.7	14.6	152.7 – 438.7
	Female	15	261.4	81.1	209.2 – 313.6
	No Device	7	324.4	70.3	255.6 – 393.3
	Device	10	224.2	50.9	166.6 – 281.7
	Overall	17	265.5	76.8	226.0 – 304.9

Table 8. Physical Performance Test Scores: Means, Standard Deviations, and Confidence Intervals by Age, Gender, and Use of Assistive Device

Age (y)	Group	N	Mean	SD	CI
60-69	Male	1	26.0	—	17.9 – 34.1
	Female	5	26.4	0.9	22.8 – 30.0
	Overall	6	26.3	0.8	25.5 – 27.2
70-79	Male	9	24.6	1.7	21.9 – 27.2
	Female	10	25.1	0.9	22.5 – 27.7
	Overall	19	24.8	1.3	24.2 – 25.5
80-89	Male	10	20.4	4.8	17.8 – 23.0
	Female	24	19.5	3.8	17.9 – 21.2
	No Device	24	21.3	3.2	19.9 – 22.7
	Device	10	16.1	3.6	13.9 – 18.3
	Overall	34	19.8	4.1	18.4 – 21.2
90-101	Male	2	16.5	6.4	10.8 – 22.2
	Female	15	16.2	6.0	14.1 – 18.3
	No Device	7	18.9	6.4	16.2 – 21.5
	Device	10	14.4	4.8	12.2 – 16.6
	Overall	17	16.2	5.8	13.3 – 19.2

Table 9. Results of Regression Analyses in Which Age and Assisted Device Use are Employed to Explain Functional Test Performance of 76 Older Adults

Equation	R	R^2	p
CGS = 2.57 - .02 A - .28 D	.79	.63	< .001
FGS = 3.55 - .02 A - .46 D	.79	.62	< .001
BBS = 82.94 - .42 A - 13.75 D	.84	.71	< .001
TUG = -9.19 + .24 A + 7.82 D	.77	.60	< .001
TSS = -10.20 + .31 A + 5.55 D	.61	.37	< .001
6MW = 762.26 - 4.81 A - 121.97 D	.64	.41	< .001
PPT = 45.29 - .28 A - 5.06 D	.74	.55	< .001

CGS = Comfortable gait speed.
FGS = Fast gait speed.
BBS = Berg balance scale.
TUG = Timed up and go.
TSS = Timed sit to stand.
6MW = Six minute walk.
PPT = Physical performance test.
A = Age (in years).
D = Assistive device (No device = 0, Assistive device = 1).

DISCUSSION

This paper provides reference values for 7 commonly used functional tests for older adults. The prevalence of health conditions, medication use, and previous falls in this sample are similar to those reported in previous clinical and epidemiological studies.[35,37,43,65,71] Mean gait speeds for men and women in the 70-79 age group were within ± 0.14 m/sec of those reported by Steffan et al[6] and Bohannon.[8] For participants in the 80-89 age group who did not use an assistive device, our measures of CGS and FGS were as much as 0.3 m/s slower than gait speeds reported by Steffan and colleagues.[6] As might be expected, CGS and FGS for participants who routinely used an assistive device were 0.3 to 0.4 m/sec slower than age-matched peers who ambulated without a device.

Whereas BBS scores in the younger groups of this sample are similar to those reported by Steffen et al,[6] performance of the 80-89 year old group was nearly 10 points lower, although variability in performance (as indicated by standard deviation) was much greater. In this sample, mean BBS scores for those in the 80-89 and 90-101 age groups were equal to (for those who did not use an assistive device) or under (for those who typically used an assistive device) the score most often used as a clinical threshold for risk of falling.[21,22,24]

The TUG scores for participants who did not use an assistive device were comparable to those reported by Steffen et al.[6] Mean TUG times for participants who typically used assistive devices was 4 seconds greater than the threshold TUG time associated with higher risk of falls.[30]

Timed sit to stand times for participants in the 70-79 age group were similar to times for 71-79 year olds reported by Guralnik et al.[43] The TSS scores for participants aged 80-89 and 90-101 who did not use an assistive device were comparable to times reported by Lord et al[42] for 85-89 and 90+ age groups, respectively. Also consistent with our results, Lord et al reported no difference in TSS times for men and women.

Distances for 6MW were shorter than those reported by Troosters et al[62] and Steffan et al,[6] but greater than those previously reported for patients with cardiovascular and cardiorespiratory disease.[54-61]

Brown et al[67] classified degree of frailty (none, mild, moderate) based on the 9 item (36 point maximum) PPT. Re-calculation of boundaries for the 7 item (28 point maximum) PPT based on Brown's classification scheme suggests scores of less than 19.4 points indicate moderate frailty, and scores between 19.4 and 24.8 points indicate mild frailty. For this sample, those in the 80-89 age group who typically used an assistive device, as well as most participants in the 90-101 age group, would be classified as moderately frail.

This age-referenced information about typical performance on functional measures for community living older adults should be useful to health professions in characterizing functional limitations. Comparison of a patient's performance to the mean and standard deviation of a community-dwelling age-referenced group may be a useful indicator of progress, readiness for discharge, or need for additional assistance or home care. For measures such as CGS, FGS, BBS, 6MW, and PPT, where higher scores indicate better function, performance one or more standard deviations below an age-referenced mean may be a clinically meaningful 'functional threshold.' For measures such as TUG and TSS, where lower scores indicate better function, performance one or more standard deviations above an age-referenced mean may also be a clinically meaningful 'functional threshold.'

Regression analyses indicated that age and assistive device use were important predictors of performance on the 7 functional tests administered in this project. These findings highlight the importance of using age-specific and assistive device-specific reference values when attempting to characterize functional performance of older adults. In contrast, gender was not a significant factor in determining performance on these tests. Mean values are presented by gender in the reference tables because previous studies have reported gender to be an important factor in functional test performance.[6-8,50] One explanation for these disparate findings is that, with advancing age and among older adults using assistive devices, differences due to gender may be minimal or nonexistent.

Of note, for participants in the 80-89 age group who did not use an assistive device, our measures of performance on CGS, FGS, BBS, and 6MW indicated poorer performance than values reported by Steffan et al.[6] These differences may be a result of the more stringent inclusion criteria used by Steffan et al.[6] For example, participants in that study had to be able to stand or walk for 6 minutes "...without shortness of breath, chest pain, or joint pain in the legs, neck, or back that would limit performance of the 6MW."[6(p132)] The authors reported that none of their participants "complained of fatigue or asked for a rest during the session," which consisted of performing 6MW, CGS, FGS, BBS, and TUG tests. In contrast, 5 of the 26 participants in our study who were 80 years or older and did not use an assistive device stopped to rest at least once during the 6MW test. Also, Steffan et al's[6] exclusion of smokers and individuals with a history of dizziness could account for some of the differences in performance scores. We believe that the participants in our study reflect the continuum of health status and physical function of community dwelling older adults.

The present study makes 2 important contributions to the existing literature by: (1) providing reference values for adults over the age of 90 and (2) providing reference values for older adults who use an assistive ambulatory device. Many investigators have excluded older adults who use assistive ambulatory devices from participating in their studies. Probably, that decision was made to promote group homogeneity for establishing normative values. It is not uncommon, however, for an older adult to be discharged from a hospital or rehabilitation setting using an assistive device. Use of an assistive device does not necessarily preclude the ability to function safely and independently at home or in the community. Reference values derived from performance of individuals who do not use an assistive device may overestimate typical performance of community dwelling older adults who do use an ambulatory device. Accordingly, therapists and other professionals involved in rehabilitation and discharge planning need reference values for commonly

used functional tests that reflect typical performance of community dwelling older adults who use assistive devices.

There are several limitations to this study. We used a convenience sample, and therefore, the individuals who volunteered to participate in our study may not be representative of all community dwelling older adults. In addition, the small number of individuals in the 60-69 year old group limits our ability to generalize to others in that age range. The health history form asked participants to self-report Alzheimer's disease, clinical depression, or other mental health problems. Because cognitive impairment and depression may have impacted physical function,[80-83] use of instruments such as the Folstein Mini-Mental State Examination[84] and the Geriatric Depression Scale[85,86] might have provided more definitive information about mental status. Participants were excluded if they had total hip or knee arthroplasty within the previous 6 months. We do not know how many participants had joint surgery earlier than 6 months prior, and whether those individuals had any residual deficits that impacted their physical performance. Finally, although efforts were made to minimize fatigue, completing all 7 functional tests within one session could have affected performance.

CONCLUSION

This study presents reference values for 7 commonly use functional tests for older adults, namely CGS, FGS, BBS, TUG, TSS, 6MW, and PPT. Importantly, this paper reports values for adults over 90 years of age and for older adults who use an assistive ambulatory device. Age and assistive device use accounted for significant percentages of the variance observed in functional test scores.

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