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Timed mobility: description of measurement, performance, and dimensionality among older adults (Timed Mobility of Older Adults)

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Abstract

Purpose: To describe the measurement, performance, and dimensionality of 5 timed mobility activities completed by older adults.

Materials and Methods: Cross-sectional observational study using correlational and factor analysis to examine the dimensionality of 5 timed mobility activities performed by 189 older adults in an outpatient setting.

Results: The times to complete supine-to-sit, 5 repetition sit-to-stand, 8 meter comfortable gait, 4 step ascent, and 4 step descent were correlated significantly with one another ($r = 0.294$ to 0.827 , $p < .001$). The times were also internally consistent ($\alpha = 0.71$) and loaded highly on a single factor (0.587 to 0.888).

Conclusion: The timed measurements of this study were easily obtained. They can be viewed as unidimensional and representative of a single construct of the International Classification of Functioning, Disability, and Health- timed mobility.

Keywords

mobility; outcome measurement; factor analysis; older adults; ICF

Introduction

Mobility, according to the International Classification of Functioning, Disability and Health (ICF), includes “activities” in which an individual moves “by changing position or location or by transferring from one place to another.”[1] Such activities are fundamental to independent living and include transitions from lying to sitting, sitting to standing, and standing in one place to standing in another on both level surfaces and stairs. [2–4] Although

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Disclosure statement

The authors declare no conflicts of interest.

numerous options are available for assessing mobility, time-derived measures have been used and advocated increasingly in recent years- particularly for older adults who are independently mobile and at risk of untoward events (eg, falls, disability, death). [5–10]

Such advocacy notwithstanding, the timing and results of timing multiple mobility activities have not been described for a sample of older adults; neither has the dimensionality of the times required to perform the activities. Such information is necessary if clinicians are to make informed decisions regarding the selection and interpretation of tests. The purpose of this study, therefore, was to describe the timed measurement, performance, and dimensionality of 5 everyday mobility activities completed by older adults. We hypothesized that the times required for the activities would be correlated significantly and representative of a single dimension.

Methods

This study involved the use of baseline mobility data obtained from patients enrolled in the INFINITY study. [11] The INFINITY study, which seeks to determine the effect of 2 levels of ambulatory blood pressure control on longitudinal changes in white matter lesions, cognition, and mobility was approved by University of Connecticut Health Center Institutional Review Board in 2011 (Clinical trials identifier NCT01650402)

Participants

Inclusion in this study required that individuals were adults of at least 75 years with systolic hypertension (office systolic BP > 150 mmHg untreated or > 130 mmHg on multiple antihypertensive drugs) with evidence of elevated ambulatory systolic BP (24 hour mean systolic BP > 140 mmHg). In addition, a screening magnetic resonance imaging (MRI) study was required that showed at least 0.45% of the intracranial volume was occupied by white matter hyperintensity (WMH) lesions. Patients were excluded if they had a Mini-mental status test score of < 24 and if they had a Short Physical Performance Battery (SPPB) score of < 9/12. In addition, participants were excluded if they had a prior history of a clinical stroke, a disease which compromised mobility (e.g Parkinson's disease) or could not ambulate. All participants provided written informed consent prior to the initiation of any study related procedure.

Measures and procedures

Basic descriptive information was obtained from all participants including age, height, mass, and body mass index. Thereafter, their performance on 6 balance tests and 5 digital stopwatch timed mobility tasks was examined. Herein we focus on the timed mobility tests, each of which was performed twice and in the same sequence: supine-to-sit, sit-to-stand (STS), level floor walking, stair ascent, and stair descent. A rest break of 30 seconds was allowed between tests. The best of the 2 measures was used in all analyses.

For supine-to-sit time, participants were asked their directional preference in getting from their backs to sitting on the side of a firm-padded mat-table. They were reclined accordingly (eg, if toward their left side, with their left side toward the side of the mat on which they would sit). They were then instructed that on the command “go” they should “go from lying

to sitting at a comfortable safe speed” using any technique they liked. Timing began on the command “go” and ended when they were in a stable upright position. Timed bed rise has been shown to be a reliable and valid measurement of mobility among younger and older women.[12]

For STS, the height of the mat table was adjusted so participants’ thighs were horizontal while their feet were flat on the floor. They were then told to move forward in anticipation of performing a STS. They were asked to fold their arms over their chests and to stand up. If able to do so during a practice trial, they were instructed after a rest to stand up completely and sit down firmly as fast as possible without delay 5 times. Timing began on the command “go” and ended with completion of the fifth stand up. Each stand-up was counted aloud by the tester. The 5 times STS is well established as a valid and reliable measure of mobility among older adults. [13]

For level ground walking participants walked a 10 meter course. The course involved a 1.0 meter acceleration zone, an 8.0 meter timed zone, and a 1.0 meter deceleration zone. Participants were instructed to walk the entire course at a “comfortable safe speed.” If they typically walked with a device (eg, cane) indoors, they were allowed to use the device during their walk. Timing began when a participant’s mid-axillary line crossed the 8.0 meter start line and ended when a participant’s mid-axillary line crossed the 8.0 meter finish line. Walking speed is known to be a valid and reliable measure of mobility among older adults. [14]

For stair ascent participants stood 15.0 cm from the front edge of the first step of a 4 step case (each step 15.2 cm high). They were instructed to ascend the steps at a comfortable safe speed. They were permitted, but not encouraged, to place both feet on a step and use 1 or 2 handrails. Moreover, they were told not to turn when arriving at the top of the stairs. Timing began on the command “Go.” Timing ceased when the trail foot touched down on the fourth step (platform).

For stair descent participants stood 15.0 cm from the edge of the top step (platform) of a 4 step case (each step 15.2 cm high). They were instructed to descend the steps at a comfortable safe speed. They were permitted, but not encouraged, to place both feet on a step and use 1 or 2 handrails. Moreover, they were told not to turn when arriving at the bottom of the stairs. Timing began on the command “Go.” Timing ended when the trail foot touched down on the floor. Stair negotiation time is known to be a valid and reliable measure of mobility among older adults.[8,15]

Data analysis

Analysis of performance data and dimensionality were conducted using SPSS (18.0) and MedCalc. The distribution of performance times was examined for normalcy. To better allow comparisons across settings and studies where timed walking distances and stair height and number vary, gait times were converted to horizontal speeds (8 meters/time) and stair times were converted to vertical speeds (61 cm/time). Times and speeds were then summarized using standard descriptive statistics. Dot plots were used to compliment the descriptive

statistics for task times. Dimensionality was examined using Pearson correlations, Cronbach's alpha, and factor analysis.

Results

One hundred ninety-nine individuals were enrolled. Of these 5 were excluded because they did not complete one of the 5 study tests (most often STS). Five others were excluded because their performance time for 1 or more activities was both 4.0 standard deviations above the mean and twice the value of the mean. Consequently, the final sample used to address the study purposes included 90 men and 99 women. Table 1 shows the demographics and performance variables for the 189 participants included in the analysis.

Together, the mobility tasks, including pauses between tasks, required less than 8 minutes to complete. The distribution of times for completing the 5 individual mobility tasks is shown in figure 1. Of the 5 tasks, supine-to-sit demonstrated the greatest variability in time to complete. As no demographic explained more than 7.0% of the variance in any performance variable, participant performance was not broken down for different strata or adjusted for covariates.

The correlations between the mobility performance times (Table 2) ranged from 0.294 to 0.827, but all were highly significant ($p < 0.001$). The only correlation that was strong (> 0.800) was that between the times for ascending and descending stairs. The Cronbach's alpha for the performance variables was 0.711. All loaded highly on a single factor- timed mobility (loadings = 0.586 to 0.888). The variables had an eigen value of 2.925, which explained 58.5% of the variance in a primary underlying factor- timed mobility. As only one component was extracted, no rotation was performed.

Discussion

Although timing has been advocated broadly as one way of quantifying mobility performance, we were not aware of any study describing the measurement, performance, and dimensionality of multiple everyday mobility activities performed by older adults. We describe herein specific procedures for the timed measurement of 5 mobility tasks and provide a summary of the 189 participants' performance times for 5 mobility tasks.

The mean time for supine to sit in our study in our study (2.7 s) was comparable to the mean time reported by Alexander et al for 22 healthy young controls (2.6 s), but shorter than the mean time they reported for 29 older adults living in congregate housing (4.4 s). [5] It should be noted, however, that both we and Alexander et al used a firmly padded table rather than a bed; thus the times we report may not reflect the potentially longer time to rise from a softer surface. The mean time for 5 STSs in our study (10.1 s) was less than, but within 1 standard deviation of, the means Bohannon derived for 70–79 year olds (12.6 s) and 80–89 year olds (12.7 s) in a 2006 meta-analysis. [16] The mean gait speed in our study (96.2 cm/s) was comparable to the means derived for 80–99 year old men (96.8 cm/s) and women (94.3 cm/s) reported by Bohannon and Andrews in a 2011 meta-analysis. [17] The mean stair ascent speed in our study (17.9 cm/s) was generally lower than, but within a standard deviation of, the means (16.8 – 21.8 cm/s) derived from summary data reported by Oh-Park

et al. [8] The mean descent speed in our study (18.2 cm/s) was sometimes lower but at other times higher, than the means (14.6–23.6 cm/s) reported by Oh-Park et al. [8] However, with one exception our mean was within a standard deviation. Differences in the means between studies might be a function of the populations studied, but they may also be the result of stair configurations and timing specifics.

Until now, the dimensionality of multiple timed mobility tasks has not been described. Researchers have investigated the association between gait speed and stair negotiation times. However, their studies focused on patients with stroke and did not include other mobility tasks (eg, supine to sitting). [18,19] We found significant bivariate correlations between the times of all 5 of the mobility tasks we measured. Moreover, we found a high Cronbach's alpha and the identification of a single dominant factor through factor analysis. This validates the ICF classification scheme for activities in which mobility involves "changing position or location" or "transferring from one place to another." [1] This unidimensionality means that older adults performing one activity quickly would be expected to perform other activities quickly as well. It also means that a sense of an individual's mobility performance can be gained from any one of the activities measured and that it may be legitimate to generate a composite mobility score using the times for the tasks we measured. [20]

This study has several limitations. First, participants were from a convenience sample of adults- all of whom were at least 75 years old, had hypertension and demonstrated white-matter lesions. The results therefore may not generalize to older adults less than 75 years of age, who are not hypertensive, and do not have white matter lesions. This acknowledged, most older adults are hypertensive [21] and have at least some white matter lesions. [22] Second, for all activities except STS, a single repetition served as the source of the criterion timed measurement. For STS, we used the frequently employed 5 repetition STS time. We thought this advisable as the time recorded for a single repetition tends to be less reliable than that recorded for multiple repetitions. Finally, our study focused on only one dimension of mobility performance- time. Other dimensions such as exertion are certainly important and worthy of investigation as well.

In conclusion, this study of 5 mobility activities completed by older adults showed that the times to complete the activities were correlated significantly and representative of a single construct- mobility. The results provide support for the ICF framework and classification of activity.

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IMPLICATIONS FOR REHABILITATION

- For patients who are independent in mobility, timing offers a means of differentiating the performance of individual patients.
- As the times to complete 5 mobility activities are interrelated, mobility is supported as a rehabilitation construct and patients who are faster at one activity should be expected to be faster at another.

Figure 1.

Dot plot of times associated with 5 mobility activities: supine-to-sit (Bed), 5 time sit-to-stand (STS), 8 meter gait (Gait), ascending 4 steps (StepU), descending 4 steps (StepD).

Table 1.

Demographics and Timed Mobility for the Study Population

Variable	Mean (SD)	Minimum-Maximum	Coefficient of Variation (%)
Age, y	80.5 (4.1)	74.0–97.0	5.1
Body mass index, kg/m ²	27.7 (5.0)	18.0–46.0	18.1
Supine-to-sit time, s	2.7 (1.1)	1.2–7.6	40.8
Five sit-to-stand time, s	10.1 (2.6)	4.8–20.6	25.7
Gait(8 m) time, s	7.7 (1.9)	4.2–13.6	24.7
Gait speed, cm/s	96.2 (23.3)	53.0–170.0	24.7
Four stair ascent time, s	3.5 (0.7)	1.8–6.3	20.0
Four stair ascent speed, cm/s	17.9 (3.6)	9.7–33.9	20.1
Four stair descent time, s	3.6 (1.0)	1.8–8.6	27.8
Four stair descent speed, cm/s	18.2 (4.6)	7.1–33.9	25.3

Table 2.

Correlations (p values) between mobility times, age, body mass index (BMI), and sex

	Age	BMI	Sex	Supine-to-sit	Sit-to-stand	Gait	Stair ascent
Supine-to-sit	0.173 (.018)	0.180 (.013)	0.026 (.720)				
Sit-to-stand	−0.053 (.468)	0.210 (.004)	0.017 (.813)	0.334 (.001)			
Gait	0.065 (.371)	0.245 (.001)	0.251 (.001)	0.294 (.000)	0.371 (.000)		
Stair ascent	0.141 (.053)	0.184 (.011)	0.185 (.011)	0.385 (.000)	0.378 (.000)	0.653 (0.000)	
Stair descent	0.109 (.134)	0.256 (.000)	0.175 (.016)	0.392 (.000)	0.407 (.000)	0.617 (.000)	0.827 (.000)