Effects of age and gender on mobility-related physical performance in Taiwanese community-dwelling older adults without physical disability

ORIGINAL ARTICLE

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ABSTRACT

Background. This study examined the effect of age and gender on seven physical performance tests in elderly adults aged 60 to 79 years without physical disability.

Methods. A sample of 230 older adults met the criteria and participated. The performance tests were: grip strength, timed chair stands (TCS), functional reach (FR), usual and fastest gait speed, timed up and go (TUG), and the Berg Balance Scale (BBS). The means and 95% confidence intervals were calculated for these tests.

Results. Men outperformed women on all measures examined except for the TUG and TCS, which showed no gender difference. An age effect was observed for the BBS only.

Conclusions. These values are useful for the clinical interpretation of the physical functional status of community-dwelling older adults.

Key words: Aged; Gait; Hand strength

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INTRODUCTION

Performance tests such as grip strength, functional reach (FR), the Berg Balance Scale (BBS), timed chair stands (TCS), usual and fast gait speed (UGS, FGS), and timed up and go (TUG) have been recommended for use in assessing physical functions (including balance, gait speed, strength, and overall mobility) essential for independent living in the community.[1,2] These performance measures have good validity and reliability when used among community-dwelling older adults.[1,2] Numerous studies have been published concerning the results of physical function testing in older adults.[1-9] However, their reference ranges are developed from Caucasian populations and have been adopted for Asian populations. Because normality depends on anthropometric differences and lifestyle, there is a need to establish the reference range for the population being measured. In addition, maintaining older adults' ability to live independently in the community is one of the priorities of the health care profession. Reporting performance values based on an individual's level of disability (or level of independence) is still rare. Knowing how independent older adults typically perform on these physical performance tests help clinicians to more accurately interpret corresponding test results, categorise functional staging, and improve prognosis.

Development of physical disability in older adults begins with mobility deficit and proceeds to difficulties with instrumental activities of daily living (IADL) and basic activities of daily living (BADL).[10] Older adults without physical disability in mobility, IADL, and ADL constitute the relatively healthy, independent elderly population.[11] Their performance on these tests could serve as reference values for comparison with other elderly in the process of physical and functional decline.

This study aimed to assess mobility-related physical functions of community-dwelling older adults without any physical disability by recourse to

seven physical performance tests (grip strength, TCS, FR, UGS, FGS, TUG, and the BBS). The specific aims of the study were: (1) to examine the gender and age differences in these performance measures and (2) to report means and 95% confidence intervals (CIs) for each age and gender stratum.

METHODS

Participants were recruited by means of flyers and advertisements posted in local community centres. Community-dwelling older adults aged 60 years or older were eligible if they had no physical disability, were independently ambulatory (without use of an assistive device), not suffering any acute pain, and able to lead a normal life. They were not restricted in activity level due to health problems or cognitive limitations, and able to perform the seven performance tests.

All older adults diagnosed as having unstable high blood pressure or heart disease and those advised by their physicians not to exercise because of a medical condition were excluded. All subjects signed the Institutional Review Board–approved informed consent form prior to participation.

Demographics, health status, and physical disability information

Physical disability was assessed by asking participants if they were 'able', 'in need of help', or 'unable' to perform the activities outlined in the Katz ADL scale,[12] the IADL scale,[13] and the gross mobility items.[14] The Katz ADL scale consists of seven activities (eating, dressing, bathing, walking across a small room, moving from bed to chair, grooming, and using the toilet). The activities in the IADL assessment include food preparation, shopping, heavy and light housekeeping, medication use (preparing and taking the correct dose), use of transportation, use of the telephone, and management of money.[13] The two gross mobility items were walking 800 m and climbing 10 stairs.[14] Older adults reporting 'able' on all items in all three domains were included.

Subjects were interviewed for demographics (age, gender, weight, and height) and health status information. Health status was assessed by determining the number of comorbidities (such as high blood pressure, heart disease, diabetes, arthritis, pulmonary or respiratory disease, and eye or hearing disorders), height, weight, body mass index, self-perceived health status (healthier, the same, or worse as compared to peers), depression, and mental status. Depression and mental status were assessed using the Chinese version of the Geriatric Depression Scale (CT-GDS)[15] and the Chinese version of the Mini Mental Status Examination (C-MMSE),[16] respectively. The CT-GDS consists of 30 items and has a score range of 0 to 30, whereas the C-MMSE consists of 11 items with 30 responses and has a score range of 0 to 30.

Physical performance tests

The following performance tests—FR, the BBS, TUG, UGS, FGS, TCS, and grip strength—were administered in random order by a physical therapist and a student. The physical therapist was responsible for giving standardised commands and recording the results, whereas the student closely monitored participants to prevent falls and injuries during testing.

The FR test was performed with the subject standing with the shoulder adjacent to a yardstick and shoulder flexed forward to 90°.[17] Subjects were asked to reach forward as far as possible with the outreached arm without taking a step or lifting the heels from the floor. The difference (in centimeters) between the initial arm length and the maximal reach length was recorded. The BBS consists of 14 different items, and the rater followed the standardised assessment and scoring criteria of each item.[18] Each item in the BBS is scored 0 to 4; therefore the total score ranged from 0 to 56. The TUG test records the time (in seconds) required for a subject to stand up from a chair (43 cm in height), walk 3 meters forward as quickly and safely as possible, turn around, return to the chair, turn around, and sit down. Timing of the test began at the word 'go' and stopped when the subject sat back down on the chair.[19] The UGS and FGS were measured as the time (in seconds) required to walk straight across a distance of 15.24 meters at their usual and fastest speeds, respectively, twice at each speed consecutively. The speed (meters per second) of this walking was calculated and used for data analysis. The TCS test measured the time (in seconds) required to stand up from a chair (43 cm in height) five times as quickly and safely as possible. The test was performed if the subject could stand up

Table 1
Demographics and health status of participants (n=230)

Demographics	Mean±SD or No. (%) of participants
Age (years)	69.5±5.5
Height (m)	1.6±0.1
Weight (kg)	63.3±8.4
Body mass index (kg/m^2)	24.9±2.8
Mini Mental Status Examination	26.7±2.4
Geriatric Depression Scale	6.3±5.5
Age-group (years)	
60-69	100 (43.5)
70-79	130 (56.5)
Gender	
Male	110 (47.8)
Female	120 (52.2)
Self-perceived health status	
Healthier	95 (41.3)
Same	114 (49.6)
Less healthy	21 (9.1)
No. of comorbidities	1.9 (1.1)

once successfully from the chair with arms crossed against the chest. The timing began with the subject sitting on the chair with the arms crossed against the chest. At the prompt 'go', the subject began to stand and sit repeatedly. Timing was stopped when the subject stood upright for the fifth time.[7] Dominant hand grip strength was measured using a regularly calibrated Jamar hand grip strength dynamometer (Sammons Preston, Jackson [MI], US) set at the second handle position, as recommended by the American Society of Hand Therapists.[20] Subjects were required to sit with the arm positioned by the side of the upper trunk and the elbow flexed to 90°. Subjects were directed to exert a maximal grasp within 5 seconds. The average of two trials was used for data analysis.

The intra-rater reliabilities of each of the measures (except the BBS) were determined in a subgroup of 77 Taiwanese community-dwelling older adults and found to be excellent (intraclass correlation coefficients $[ICC]_{(3,1)}$ range, 0.89-0.96). The inter-rater reliability of the BBS in Taiwanese community-dwelling older adults was previously determined to be good ($ICC_{2,1}$=0.87).[21]

Statistical analysis

The demographics and health status of the participants were summarised. The mean, standard deviation, and 95% CI for each of the seven performance test results were calculated for each 10-year age and gender stratum. The age and gender effects on the performance measure were examined by two-way analysis of variance (ANOVA). Differences were considered statistically significant if the P-value was smaller than 0.01. All statistical analyses were performed with SPSS V12.0 (SPSS, Chicago [IL], US).

RESULTS

A total of 366 older adults (248 able, 77 mildly disabled, and 41 moderately to severely disabled) were interviewed. Of 248 able older adults eligible for the study, only three women and 15 men were in the 80+ age-group. Thus, data for 230 older adults were analysed and their characteristics are presented in **Table 1**.

The means, standard deviations, and 95% CI of the seven tests for each age and gender stratum are presented in **Table 2**. The results of the two-way ANOVA indicated that there was no significant age (60-69 and 70-79 years) by gender (male and female) interaction effect across all performance measures. The effect of gender was significant on almost all performance measures, with men outperforming

Table 2
Means and standard deviations of the seven performance tests for each age and gender stratum

Performance tests*	Age-group (years)	Male			Female		
		No.	Mean (SD)	95% CI	No.	Mean (SD)	95% CI
BBS†‡	60-69	34	55.6 (1.1)	55.2-55.9	65	54.9 (1.9)	54.5-55.4
	70-79	75	54.6 (1.6)	54.2-55.0	55	53.8 (2.4)	53.2-54.5
Grip strength‡	60-69	20	35.5 (5.2)	33.2-37.7	38	24.6 (4.1)	23.3-25.9
	70-79	63	33.8 (5.8)	32.4-35.3	44	23.8 (5.3)	22.2-25.3
UGS‡	60-69	34	1.43 (0.79)	1.36-1.49	65	1.28 (0.14)	1.24-1.31
	70-79	75	1.38 (0.23)	1.33-1.43	55	1.29 (0.17)	1.24-1.33
FGS‡	60-69	33	1.78 (0.22)	1.71-1.86	64	1.57 (0.13)	1.53-1.60
	70-79	73	1.74 (0.26)	1.68-1.80	55	1.53 (0.19)	1.48-1.58
FR‡	60-69	34	33.3 (4.7)	31.7-34.9	65	32.1 (4.5)	31.0-33.2
	70-79	75	33.1 (5.6)	31.8-34.3	55	29.4 (4.6)	28.1-30.6
TUG	60-69	33	7.5 (1.0)	7.1-7.8	64	7.9 (1.2)	7.6-8.2
	70-79	73	8.2 (2.9)	7.5-8.8	55	8.4 (1.3)	8.0-8.7
TCS	60-69	30	9.1 (2.1)	8.4-9.9	63	9.5 (2.0)	9.0-9.9
	70-79	68	9.0 (2.3)	8.4-9.5	52	9.3 (1.9)	8.8-9.8

* BBS denotes Berg Balance Scale, UGS usual gait speed, FGS fastest gait speed, FR functional reach, TIG timed up and go, and TCS timed chair stands
† Significant effect of age in the ANOVA analysis
‡ Significant effect of gender in the ANOVA analysis

women, except for the TUG and TCS. The effect of age was significant only for the BBS, in which the younger group (aged 60-69) outperformed the older group (aged 70-79). Thus, the BBS was the only measure that showed a significant effect on age and gender, whereas the TCS and TUG had no significant effect on either age or gender.

DISCUSSION

Our participants' performances declined with age, but the difference was not significant except for the BBS. This may be because only two age-groups (60-69 versus 70-79 years) were compared, and both consisted of relatively healthy, independent participants, such that individual differences were reduced. Nonetheless, gender difference was still significant across most performances; the TCS and TUG were the only two performance measures that showed no significant age and gender difference.

These performance tests assessed an individual's physical capacity to perform tasks associated with daily living. The means and 95% CI were similar to the criterion-related reference values reported in studies using adverse health outcomes such as death, disability, or falls as external criteria.[3,6,8,9,22,23] However, grip strength, FGS and FR were inferior in our population as compared to those reported by others,[1,4,17,24] whereas performances pertaining to TCS and TUG were superior.[25,26] This difference may be a reflection of racial/cultural and lifestyle differences in the study populations. Studies comparing physical performance-based measures between different racial groups have indicated that Caucasian women have greater strength than their Asian counterparts, at least in part due to larger body size.[27,28] Gait speed and FR are related to body height.[24,29] Previous research has also noted that Japanese women required less time to complete a tandem walk test and five chair stands, but longer to perform hand and foot reaction time tests, compared with Caucasian women.[27,28] A summary of these findings is presented in **Table 3**.

In this study, stringent criteria were adopted to define physical disability by including a more sensitive indicator of mobility disability, along with traditional indicators such as IADL and ADL.[10] Older adults who are independent in all three domains (mobility, IADL, and ADL) have better health status and physical function.[11] Thus, our participants represent the population of relatively healthy, independent older adults. Their performance on these measures could serve as a preliminary reference for comparison with other older populations (such as older adults with different disabilities, those admitted

Table 3
Means and 95% confidence intervals for the seven performance tests based on significant gender effect and reference values in the literature

Performance tests*	Gender	Mean (SD)	95% CI	Reference values
Grip strength	Male (n=83)	34.2 (5.7)	33.0-35.4	Male[4]: 60-64 years old: 41.7 (36.8-46.7) 65-69 years old: 41.7 (35.4-47.9) 70-74 years old: 38.2 (32.0-44.5) Female[4]: 60-64 years old: 25.9 (22.2-29.6) 65-69 years old: 25.6 (22.5-28.8) 70-74 years old: 24.2 (20.7-27.8)
	Female (n=82)	24.1 (4.8)	23.1-25.2	
UGS	Male (n=109)	1.40 (0.22)	1.36-1.44	Male[1]: 60-69 years old: 1.59 (1.46-1.73) 70-79 years old: 1.38 (1.25-1.52) Female[1]: 60-69 years old: 1.44 (1.33-1.55) 70-79 years old: 1.33 (1.23-1.43)
	Female (n=120)	1.28 (0.15)	1.25-1.31	
FGS	Male (n=106)	1.76 (0.25)	1.71-1.80	Older adults with FGS in the lowest quartile (male: <1.8m/s, female: <1.45m/s) are five times more likely to become disabled 6 years later compared to those in the highest quartile (male: ≥2.37m/s, female: ≥1.97m/s).[6] Male[1]: 60-69 years old: 2.05 (1.89-2.22) 70-79 years old: 1.83 (1.58-2.09) Female[1]: 60-69 years old: 1.87 (1.73-2.00) 70-79 years old: 1.71 (1.63-1.84)
	Female (n=119)	1.55 (0.16)	1.52-1.58	
FR	Male (n=109)	33.1 (5.30)	32.1-34.1	A FR score below 25.4 cm indicates a significant fall risk. Individuals who reach less than 15.24 cm are four times more likely to fall than those who reach more than 45.7 cm.[17]
	Female (n=120)	30.8 (4.7)	30.0-31.7	
TUG	Total (n=225)	8.0 (1.9)	7.8-8.3	92% of community elderly women and only 9% of institutionalised elderly women performed the TUG (48 cm chair height) in less than 12s.[3]
TCS	Total (n=213)	9.2 (2.1)	8.9-9.5	Older adults with TCS in the lowest quartile (≥16.7s) are 4.1 times more likely to become disabled compared to those in the highest quartile (≤11s).[22] American females[25,28] 65-69 years old: 11.4±0.0 70-74 years old: 12.4±0.0 75-79 years old: 13.2±0.0

* UGS denotes usual gait speed, FGS fastest gait speed, FR functional reach, TUG timed up and go, and TCS timed chair stands

to hospitals or institutionalised). Clinicians could then more accurately interpret test results, assess the effectiveness of intervention programmes, and make decision. Future study on a random sample is warranted to report the reference values of these performances for clinical use.

In summary, this is the first study to report physical function in a cohort of Taiwanese/Chinese community-dwelling older adults without any physical disability (even without the more sensitive indicator, mobility disability) using seven commonly used performance tests. Preliminary information was provided regarding the performance values for each test. Our means and 95% CIs were similar to those reported in the literature, but with racial/cultural and lifestyle differences for some measures (the FGS, grip strength, FR, TUG, TCS).

ACKNOWLEDGEMENT

This study was partially supported by research grants (NSC92-2314-B-277-003) from the National Science Council of Taiwan.

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