



NORMAL VERSUS FAST TIMED UP AND GO IN OLDER ADULTS WITH LOW PHYSICAL PERFORMANCE: ASSOCIATIONS WITH HANDGRIP STRENGTH AND MUSCLE-RELATED ANTHROPOMETRIC MARKERS

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ABSTRACT. The Timed Up and Go (TUG) test is widely used to assess functional mobility in older adults, but it remains unclear whether the fast condition provides more clinically relevant information than the normal condition in those with low physical performance. This study compared normal TUG (TUGN) and fast TUG (TUGF) between older adults with low and normal physical performance and examined their associations with handgrip strength and muscle-related anthropometric markers.

This cross-sectional analytical study included 98 community-dwelling older adults aged 60 years and above. Participants were classified into low and normal physical performance groups using the Five Times Sit-to-Stand Test (FTSTS), with a cut point of ≥ 12 s. Functional mobility was assessed using TUGN and TUGF. Handgrip strength (HGmax), calf circumference, and femur circumference were also measured. Group comparisons and correlation analyses were performed.

Forty-three participants (43.9%) were classified as having low physical performance. Compared with the normal group, the low physical performance group was older and demonstrated significantly poorer TUGN (12.12 ± 3.34 vs. 10.28 ± 1.29 s, $p = 0.001$), poorer TUGF (10.13 ± 3.18 vs. 7.98 ± 0.94 s, $p < 0.001$), lower HGmax (19.03 ± 5.94 vs. 22.59 ± 5.41 kg, $p = 0.003$), and lower calf circumference (29.86 ± 4.97 vs. 32.35 ± 2.86 cm, $p = 0.005$). TUGF showed consistently stronger correlations than TUGN with FTSTS ($r = 0.579$ vs. 0.477), HGmax ($r = -0.488$ vs. -0.348), and calf circumference ($r = -0.628$ vs. -0.554) (all $p < 0.001$).

Both TUG conditions reflect strength-related functional status in community-dwelling older adults; however, fast TUG showed stronger associations with FTSTS, handgrip strength, and calf circumference, suggesting that it may better reflect low strength-related functional performance than normal TUG.

Keywords. Timed Up and Go; Older adults; Physical performance; Handgrip strength; Five Times Sit-to-Stand Test; Calf circumference.

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1. INTRODUCTION

Preserved functional mobility is essential for independent living in older adults because it supports safe transfers, ambulation, and participation in daily activities. Among these tasks, repeated sit-to-stand movement is particularly important, as it requires adequate lower-extremity strength, postural control, and coordination. The Five Times Sit-to-Stand Test (FTSTS) is therefore widely used as a practical performance-based measure of lower-limb function and mobility in older populations. In the Asian Working Group for Sarcopenia 2019 (AWGS 2019), a 5-time chair stand time of 12 seconds or longer is classified as low physical performance, supporting its clinical use as a simple screening criterion in older adults [1, 2].

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The Timed Up and Go (TUG) test is one of the most frequently used clinical tests of functional mobility in older adults. Originally described by Podsiadlo and Richardson, the test requires an individual to stand up from a chair, walk 3 meters, turn, return, and sit down again, thereby integrating transitional movement, walking, and dynamic balance in a single timed task [3]. Subsequent work has emphasized that the TUG reflects more than gait speed alone and serves as a broader indicator of lower-extremity function, mobility, and fall-related performance [4]. In community-dwelling older adults, poorer performance on both TUG and FTSTS has also been linked to future disability and fall risk, reinforcing their relevance as clinically meaningful functional measures [5, 6].

Although TUG is usually performed at a habitual pace, a fast TUG condition may reveal different aspects of function. Performing the test as quickly as safely possible is likely to place greater demands on force generation, balance control, and movement coordination than the normal-paced condition. This distinction may be especially important in older adults with low physical performance, because chair-transfer components are embedded at both the beginning and end of the TUG sequence, with a sit-to-stand transition at the start and a stand-to-sit transition at the end. Accordingly, comparing normal TUG and fast TUG may help clarify which condition better reflects strength-related functional status in older adults with impaired chair-stand performance.

In addition to FTSTS, handgrip strength is widely recognized as a simple and valid indicator of muscle strength in older adults. AWGS 2019 defines low handgrip strength as <28 kg in men and <18 kg in women, and continues to recommend grip strength as a core component of sarcopenia-related assessment [2]. Standardized grip-strength measurement procedures have also been recommended to improve comparability across clinical and epidemiological studies [7]. When advanced body composition assessment is unavailable, anthropometric measures may provide supportive information; notably, AWGS 2019 recommends calf circumference for case-finding, and Thai data support its utility as a screening tool for low skeletal muscle mass in community-dwelling older adults [2, 8]. However, circumferential measures are better interpreted as muscle-related anthropometric markers rather than direct indicators of muscle quality.

Given these considerations, comparing normal and fast TUG in older adults classified by FTSTS-defined physical performance may provide useful insight into the functional meaning of different TUG conditions. Therefore, this study aimed to compare normal TUG and fast TUG between older adults with low physical performance and those with normal physical performance, as defined by FTSTS, and to examine the associations of both TUG conditions with handgrip strength and muscle-related anthropometric markers. We hypothesized that older adults with low physical performance would demonstrate poorer TUG performance, lower handgrip strength, and less favorable anthropometric profiles than those with normal physical performance, and that fast TUG would show slightly stronger associations with these strength-related variables than normal TUG.

2. METHODS

2.1. Study design and participants. This study employed a cross-sectional analytical design to compare normal and fast Timed Up and Go (TUG) performance between older adults with low and normal physical performance and to examine the associations of both TUG conditions with handgrip strength and muscle-related anthropometric markers. The study was conducted among community-dwelling older adults aged 60 years and above.

Participants were eligible for inclusion if they: (1) were aged 60 years or older; (2) lived independently in the community; (3) were able to walk independently with or without a customary assistive device; (4) were able to understand and follow verbal instructions; and (5) agreed to participate voluntarily in the study. Participants were excluded if they had an unstable medical condition or acute illness at the time of assessment, severe musculoskeletal, neurological, cardiovascular, or vestibular disorders that could

interfere with safe performance of the tests, severe pain that limited mobility, or inability to complete the assessment protocol safely.

Sample size was estimated using G*Power for correlation analysis. Assuming a two-tailed test, an alpha level of .05, a statistical power of .80, and an expected effect size of $r = 0.30$, the minimum required sample size was 85 participants. After adding 15% to account for possible dropout or incomplete data, the final target sample size was 98 participants.

Ethical approval was obtained from the University of Phayao Human Ethics Committee (HREC-UP-HSST 1.2/088/67). All participants received an explanation of the study procedures and provided written informed consent before participation. The study was conducted in accordance with the Declaration of Helsinki.

2.2. Measurements. At study entry, all participants underwent a structured interview and baseline assessment. Demographic and health-related data were collected, including age, sex, underlying medical conditions, medication use, and mobility-related history. Body weight and height were measured using standard procedures, and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Resting vital signs, including blood pressure and pulse rate, were assessed before physical performance testing to ensure participant safety.

After the baseline assessment, participants completed the study measurements in a standardized sequence administered by trained assessors. All assessors received standardized training in test administration before data collection. To reduce inter-rater variation, the assessors followed the same written protocol and demonstration procedure for all measurements. Adequate rest was provided between tests to minimize fatigue and maintain safety throughout the assessment procedure.

2.3. Five times sit-to-stand test. The Five times sit-to-stand test (FTSTS) was used to classify participants according to physical performance status. Participants were instructed to rise from a standard chair with a seat height of 45 cm and sit down five times as quickly as possible without using their upper extremities whenever feasible. The total time required to complete the test was recorded in seconds using a stopwatch. FTSTS is widely used as a practical performance-based measure of lower-limb function and physical performance in older adults [1]. Based on the Asian Working Group for Sarcopenia 2019 (AWGS 2019) recommendation, participants with FTSTS times of 12 seconds or longer were classified as having low physical performance, whereas those with times of less than 12 seconds were classified as having normal physical performance [2].

2.4. Handgrip strength. Handgrip strength was assessed as an indicator of muscle strength using a hand dynamometer. Measurement was performed under standardized conditions following recommendations for grip-strength assessment in clinical and epidemiological studies [7]. Participants were assessed in the standing position with the shoulder adducted and neutrally rotated, elbow flexed at 90°, forearm in neutral position, and wrist in slight extension. Grip strength was measured in the dominant hand, and three trials were performed with a rest period of approximately 30 seconds between trials. The highest value obtained was recorded as maximum handgrip strength (HGmax). Handgrip strength is widely accepted as a simple and valid measure of muscle strength in older adults and is recommended by AWGS 2019 as a core strength indicator in sarcopenia-related assessment [2, 7].

2.5. Calf and femur/thigh circumferences. Calf circumference and femur/thigh circumference were measured as muscle-related anthropometric markers using a non-elastic measuring tape. Measurements were obtained at standardized anatomical sites with participants in a relaxed standing position. Calf circumference was measured at the point of maximal circumference of the lower leg. Femur/thigh circumference was measured at the midpoint between the inguinal crease and the proximal border of the patella. Calf circumference has been recommended by AWGS 2019 as a practical case-finding measure for possible sarcopenia and low skeletal muscle mass in older adults [2]. In the present study, calf

and femur/thigh circumferences were analyzed as supportive muscle-related anthropometric markers rather than direct indicators of muscle quality.

2.6. Timed up and Go test. Functional mobility was assessed using the Timed Up and Go (TUG) test. Following the original protocol, participants were instructed to stand up from a standard chair with a seat height of 45 cm, walk 3 meters, turn around, walk back to the chair, and sit down again while the time required to complete the task was recorded in seconds [3]. Two TUG conditions were evaluated in this study.

For the normal TUG (TUGN) condition, participants were instructed to perform the test at their usual comfortable and safe walking pace. For the fast TUG (TUGF) condition, participants were instructed to complete the test as quickly as possible while maintaining safety. Each condition was performed three times, and the mean value of the three trials was used in the analysis. A rest interval of approximately 60 seconds was allowed between trials. TUG has been described as a multidimensional measure of functional mobility that reflects not only gait performance, but also transitional movement and dynamic balance [3, 4].

2.7. Other variables. Additional variables collected during the study were recorded relevant for participant description and interpretation of the findings. These variables were used primarily to characterize the study sample and support the interpretation of functional and anthropometric outcomes.

2.8. Statistical analysis. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean $\pm$ standard deviation (SD), whereas categorical variables were summarized as frequency and percentage. Participants were classified into low physical performance and normal physical performance groups according to FTSTS performance using the AWGS 2019 cut point of ≥ 12 seconds. To address the first study objective, between-group comparisons were performed for age, sex, BMI, TUGN, TUGF, HGmax, calf circumference, and femur/thigh circumference. Independent-samples t tests were used for normally distributed continuous variables, whereas Mann-Whitney U tests were used when normality assumptions were not satisfied. Chi-square tests were used for categorical variables. To address the second study objective, correlation analyses were performed to examine the associations of TUGN and TUGF with FTSTS, HGmax, calf circumference, and femur/thigh circumference. Pearson's correlation coefficient was used for normally distributed variables, whereas Spearman's rank correlation coefficient was used when appropriate. The strength of the correlations was compared descriptively to determine whether TUGF showed stronger relationships with strength-related variables than TUGN. For analyses involving calf circumference and femur/thigh circumference, observations with a recorded value of 0 were excluded from analyses of that variable only. A two-tailed p value of $< .05$ was considered statistically significant for all analyses.

3. RESULTS

A total of 98 community-dwelling older adults were included in the study. Based on FTSTS performance, 43 participants (43.9%) were classified as having low physical performance (FTSTS ≥ 12 s), whereas 55 participants (56.1%) were classified as having normal physical performance. Participants with low physical performance were older than those with normal physical performance (70.23 ± 7.33 vs. 66.51 ± 4.78 years, $p = 0.005$). No significant between-group differences were observed for sex distribution ($p = 0.723$) or body mass index (22.18 ± 3.35 vs. 22.27 ± 3.47 kg/m², $p = 0.902$) (Table 1).

For the mobility outcomes, both TUG conditions differed significantly between groups. The low physical performance group had longer TUGN times than the normal physical performance group (12.12 ± 3.34 vs. 10.28 ± 1.29 s, $p = 0.001$). TUGF was also longer in the low physical performance group (10.13 ± 3.18 vs. 7.98 ± 0.94 s, $p < 0.001$) (Table 1). For strength-related variables, HGmax was

lower in the low physical performance group than in the normal group (19.03 ± 5.94 vs. 22.59 ± 5.41 kg, $p = 0.003$). After excluding invalid zero values from variable-specific analyses, calf circumference was also lower in the low physical performance group (29.86 ± 4.97 vs. 32.35 ± 2.86 cm, $p = 0.005$), whereas femur circumference did not differ significantly between groups (33.83 ± 2.59 vs. 34.54 ± 2.69 cm, $p = 0.206$) (Table 1).

Correlation analyses showed that both TUG conditions were significantly associated with FTSTS, HGmax, and calf circumference (Table 2). TUGN was correlated with FTSTS ($r = 0.477$, $p < 0.001$), HGmax ($r = -0.348$, $p < 0.001$), and calf circumference ($r = -0.554$, $p < 0.001$), but not with femur circumference ($r = -0.176$, $p = 0.094$). TUGF showed correlations with FTSTS ($r = 0.579$, $p < 0.001$), HGmax ($r = -0.488$, $p < 0.001$), calf circumference ($r = -0.628$, $p < 0.001$), and femur circumference ($r = -0.227$, $p = 0.030$) (Table 2).

4. DISCUSSION

This study compared normal and fast Timed Up and Go performance in community-dwelling older adults classified by FTSTS-defined physical performance and examined their associations with handgrip strength and muscle-related anthropometric markers. The main findings were threefold. First, older adults with low physical performance, defined by an FTSTS time of 12 seconds or longer, demonstrated significantly poorer performance on both TUG conditions than those with normal physical performance. Second, both TUGN and TUGF were significantly associated with FTSTS, handgrip strength, and calf circumference. Third, TUGF consistently showed stronger associations than TUGN across these strength-related variables, indicating that the fast condition may be more sensitive to reduced strength-related functional status in older adults. This overall pattern is clinically plausible because FTSTS involves repeated sit-to-stand transitions, whereas TUG combines a sit-to-stand transition with walking, turning, and a stand-to-sit transition, lower-extremity force production, and dynamic postural control, while fast-paced testing is likely to impose greater performance demands than habitual-paced testing [1, 3, 4].

The between-group differences in both TUG conditions support the functional relevance of the FTSTS-based classification used in the present study. According to the Asian Working Group for Sarcopenia 2019, a 5-time chair stand time of 12 seconds or longer indicates low physical performance in older adults [2]. In our sample, participants classified as having low physical performance also showed significantly longer TUG times, suggesting that impaired chair-rise performance is accompanied by broader limitations in functional mobility. This interpretation is consistent with the original concept of the TUG as a simple measure of basic functional mobility and with later work emphasizing that the TUG reflects a combination of gait, balance, and transitional movements rather than walking speed alone [3, 4]. It is also aligned with prospective evidence showing that poorer performance on both FTSTS and TUG is associated with a higher risk of future disability in community-dwelling older adults [6].

One of the most important findings was that TUGF showed stronger associations than TUGN with FTSTS. This result suggests that fast TUG may capture an aspect of functional reserve that is less apparent during usual-paced performance. When older adults are asked to complete the TUG as quickly as safely possible, performance is likely to depend more strongly on rapid force generation, coordination, and the ability to control transitions efficiently. In contrast, normal TUG may reflect habitual mobility behavior, which can be influenced by self-selected pacing, caution, and compensatory strategies. Herman et al. (2011) argued that the TUG is “more than meets the eye” because it involves several distinct but overlapping mobility components, and the present findings support that view by suggesting that changing test pace may alter how strongly the test reflects strength-related function. A similar interpretation is supported by prior work showing that TUG and FTSTS are both commonly used to assess balance impairment and lower-limb weakness in older adults, including Thai community settings [9].

The associations with handgrip strength are also noteworthy. Handgrip strength is widely accepted as a practical indicator of overall muscle strength and is a core component of sarcopenia-related assessment in AWGS 2019 [2]. Standardized measurement is important because grip strength is sensitive to testing position and protocol, but when measured appropriately it provides a valid and reliable estimate of muscle strength in clinical and epidemiological studies [7, 10]. In the present study, poorer TUG performance was associated with lower HGmax, and again the association was stronger for TUGF than for TUGN. Although grip strength is measured in the upper limb, this relationship is not unexpected. Lower handgrip strength may reflect broader decline in neuromuscular capacity and reduced physiological reserve, which can also affect transitional mobility and walking-related tasks. This interpretation is supported by recent evidence showing that weak handgrip strength and slow TUG time are independently associated with adverse outcomes, including hospitalization-related burden, in community-dwelling older adults [11].

The anthropometric findings were more nuanced. Calf circumference was significantly lower in the low physical performance group and was moderately correlated with both TUG conditions, whereas femur circumference showed weaker and less consistent associations. This pattern is plausible. Calf circumference has been recommended by AWGS 2019 as a simple case-finding measure for possible sarcopenia in Asian older adults, and Thai studies have supported its usefulness as a screening indicator of low skeletal muscle mass [2, 8, 12]. In contrast, femur or thigh circumference is influenced not only by muscle tissue but also by subcutaneous fat and body build, which may reduce its specificity as an indicator of muscle-related function in field-based studies. Therefore, the stronger relationship between TUG and calf circumference than between TUG and femur circumference in the present study appears reasonable and supports the decision to interpret these variables as muscle-related anthropometric markers rather than direct indicators of muscle quality.

From a clinical perspective, the present findings suggest that both TUGN and TUGF are useful for reflecting strength-related functional status in community-dwelling older adults, but TUGF may provide slightly more informative data when the goal is to identify low physical performance or reduced functional reserve. In practice, the choice of test condition may depend on the purpose of assessment. If the goal is to reflect habitual mobility, the normal condition remains appropriate. However, if the aim is to detect subtle decline in strength-related performance, the fast condition may offer additional value. This interpretation should still be made cautiously. Although TUGF consistently showed stronger correlations, the differences were relative rather than dramatic, and both conditions remained significantly associated with key functional variables. In other words, fast TUG may be more sensitive, but normal TUG is still clinically meaningful. This balanced interpretation is also consistent with systematic reviews showing that both TUG and FTSTS are useful but context-dependent tools in older adults, especially when used for mobility screening and fall-related assessment rather than as stand-alone diagnostic tests [1, 5].

Several limitations should be acknowledged. First, the cross-sectional design prevents any causal or prognostic interpretation. It cannot be determined whether poorer TUG performance contributes to low physical performance or whether both arise from the same age-related decline. Second, the classification of low physical performance was based solely on FTSTS, which was appropriate for the present objective but does not represent the full range of physical performance measures used in geriatric assessment. Third, calf and femur circumferences are indirect anthropometric measures and should not be interpreted as equivalent to direct measures of muscle mass or muscle quality. Fourth, this study included community-dwelling older adults from a specific setting, which may limit generalizability to frailer or institutionalized populations. Future studies should examine whether the stronger associations observed for TUGF are also reflected in longitudinal outcomes such as disability, falls, or sarcopenia-related endpoints, and whether fast TUG provides incremental value over normal TUG in broader screening frameworks.

5. CONCLUSION

In conclusion, both normal and fast TUG were associated with FTSTS-defined physical performance, handgrip strength, and calf circumference in community-dwelling older adults. However, fast TUG showed consistently stronger associations than normal TUG, suggesting that it may serve as a more responsive indicator of strength-related functional impairment in older adults with low physical performance.

TABLE 1. Participant characteristics and comparison between low and normal physical performance groups defined by the Five Times Sit-to-Stand Test

Variable	Total (<i>n</i> = 98)	Low PP (<i>n</i> = 43)	Normal PP (<i>n</i> = 55)	<i>p</i> -value
Age, years	68.14 ± 6.28	70.23 ± 7.33	66.51 ± 4.78	0.005*
Female, <i>n</i> (%)	77 (78.6)	35 (81.4)	42 (76.4)	0.723
BMI, kg/m ²	22.23 ± 3.40	22.18 ± 3.35	22.27 ± 3.47	0.902
FTSTS, s	11.33 ± 2.47	13.90 ± 1.15	9.33 ± 0.75	<0.001*
TUGN, s	11.09 ± 2.57	12.12 ± 3.34	10.28 ± 1.29	0.001*
TUGF, s	8.92 ± 2.45	10.13 ± 3.18	7.98 ± 0.94	<0.001*
HGmax, kg	21.03 ± 5.90	19.03 ± 5.94	22.59 ± 5.41	0.003*
Calf circumference, cm	31.25 ± 4.11	29.86 ± 4.97	32.35 ± 2.86	0.005*
Femur circumference, cm	34.24 ± 2.66	33.83 ± 2.59	34.54 ± 2.69	0.206

Note: Data are mean ± standard deviation unless otherwise indicated. PP, physical performance; low PP was defined as FTSTS ≥ 12 s. * *p* < 0.05.

TABLE 2. Correlations of normal and fast Timed Up and Go with FTSTS, handgrip strength, and muscle-related anthropometric markers

Measure	Statistic	TUGN (<i>r</i>)	TUGF (<i>r</i>)
FTSTS	<i>r</i>	0.477	0.579
	<i>p</i> -value	<0.001*	<0.001*
	95% CI	0.307 to 0.617	0.433 to 0.695
HGmax	<i>r</i>	−0.348	−0.488
	<i>p</i> -value	<0.001*	<0.001*
	95% CI	−0.513 to −0.158	−0.627 to −0.322
Calf circumference	<i>r</i>	−0.554	−0.628
	<i>p</i> -value	<0.001*	<0.001*
	95% CI	−0.686 to −0.393	−0.738 to −0.488
Femur circumference	<i>r</i>	−0.176	−0.227
	<i>p</i> -value	0.094	0.030*
	95% CI	−0.370 to 0.031	−0.414 to −0.027

* *p* < 0.05. CI, confidence interval.

STATEMENTS AND DECLARATIONS

No potential conflict of interest relevant to this article was reported.

Ethical approval was obtained from the University of Phayao Human Ethics Committee (HREC-UP-HSST 1.2/088/67). All participants received an explanation of the study procedures and provided written

informed consent before participation. The study was conducted in accordance with the Declaration of Helsinki. Data of this research is available from the corresponding author upon reasonable request.

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