

Daily Stair Climbing as a Functional Tool in Prehabilitation for Older Adults

Direct Original Research

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Abstract

Introduction: This study examined whether daily stair climbing is associated with lower-limb endurance and physical independence in older adults, evaluating its potential as a practical screening measure.

Methods: Fifty community-dwelling older adults (mean age 75 years; 88% female) completed timed chair-stand tests at two seat heights (TCS14, TCS17) and reported daily individual stair steps (STAIRS). Physical independence was assessed using a modified SF-36 Physical Functioning Scale (MSF36). Associations were analyzed using correlations, age-adjusted regression models, and one-way ANOVA across distribution-based stair-use cohorts (0-1 stair, n = 16; 2-10 stairs, n = 16; 11+ stairs, n = 18).

Results: STAIRS was associated with TCS14 performance ($p = .02$) and MSF36 ($p = .04$) but not with TCS17. Participants reporting ≥ 2 daily stair steps demonstrated higher chair-stand performance across both protocols (TCS14: $F(2,47) = 5.867, p < .001$; TCS17: $F(2,47) = 6.360, p < .001$). Age accounted for 28-29% of TCS variance; inclusion of STAIRS and MSF36 increased explained variance by 12-22%.

Conclusions: The 14-inch protocol demonstrated greater discriminatory ability and may enhance sensitivity for identifying functional differences in higher-functioning older adults. Greater daily stair-step volume was associated with higher chair-stand performance among older adults. Given the cross-sectional design, causality cannot be inferred.

Key Words: timed chair stand, knee extensor endurance, functional mobility

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Introduction

Preserving physical independence in older adults is a primary goal of therapeutic and rehabilitative sciences. Functional decline related to sarcopenia and mobility loss significantly impairs essential daily activities such as stair climbing and chair rising, which require substantial lower-limb strength and coordination.¹⁻³ Stair negotiation imposes biomechanical demands that may exceed available strength reserves in some older individuals.^{4,5} Understanding how habitual lower-limb activity relates to functional performance may help inform practical screening strategies in prehabilitation and mobility preservation contexts.

Prehabilitation aims to enhance physical reserve prior to health decline or surgery and has shown potential benefits for functional outcomes, although evidence remains variable.⁵⁻⁹ Functional assessments such as the 30-second chair stand test capture lower-limb strength and endurance relevant to independence.^{10,11} Stair climbing is accessible, functionally meaningful, and may provide comparable or greater stimulus to muscle power than traditional resistance training.^{9,12-16} Given its accessibility and functional relevance, stair climbing may serve as a practical, low-cost, real-world proxy for lower-limb strength assessment. To address this gap, we utilized pre-existing data aimed to examine broader aspects of mobility and independence in community-dwelling older adults¹⁷ to determine the feasibility of proposing stair use

as a prehabilitation screening tool for this same population. We hypothesized that daily stair climbing would be associated with stair-stand performance and physical independence.

Methods

Participants

Fifty independently living older adults (6 men, 44 women; mean age = 75 ± 7 years) were recruited from community centers, churches, and senior programs in Alabama. Inclusion criteria required independent living and exclusion of recent musculoskeletal, neurological, or cardiovascular conditions aggravated by physical activity. All procedures were approved by the Institutional Review Board for the protection of human subjects for the original study. The sample was 44% African American and 54% Caucasian.

Protocol

Cognitive Assessment

Because participants were asked to recall physical activity data, including their average number of individual stair steps per day (STAIRS), the Mini-Mental State Exam (MMSE) was administered prior to the interview to minimize cognitive-related reporting bias. Of the sample, 80% had no apparent cognitive impairment (MMSE ≥ 24 out of maximum of 30).¹⁹ The mean MMSE score was 25.8 ± 3.9 . We did not exclude participants with lower scores, consistent with Samson et al.¹⁹

Physical Independence

Physical independence was assessed via interview using a previously validated modified SF-36 Physical Functioning scale (MSF36).¹⁸ The MSF36 evaluates health-related limitations across activities ranging from vigorous to basic tasks, and responses were summed to obtain a physical functioning score. A MSF36 score of <85 is associated with a transition to disability.¹⁸ Participants also reported their average number of individual stair steps per day. Self-reported stair steps were used to capture habitual, real-world stair negotiation in a manner consistent with low-cost, clinically feasible screening approaches. Physical assessments followed the interview session.

Chair Stand Tests

The 30-second TCS test is widely recognized as a measure of lower-limb strength and endurance among older adults.^{1,2,7-9,15} An armless, backless, padded chair with adjustable seat heights of 35.6 cm (14 inches) and 43.2 cm (17 inches) was used, positioned against a wall for stability. Participants were instructed to stand up and sit down as many times as possible within 30 seconds, keeping their arms folded across their chest. Six total trials were completed, alternating between chair heights, with two-minute recovery periods between trials. Timing was conducted using a stopwatch, beginning with the standard 17-inch seat height.

Statistical Analysis

Descriptive statistics summarized participant demographics and key variables. Pearson correlations evaluated associations between STAIRS, TCS scores, and MSF36. Separate regression models (age entered first, then STAIRS and MSF36) predicted TCS outcomes. Participants were grouped into stair-use cohorts (0-1, 2-10, ≥ 11 stairs/day) based on the natural distribution of reported stair counts, yielding approximately equal group sizes. One-way ANOVA compared TCS performance and activity indices across stair-use cohorts. Statistical significance was defined as $p < .05$. Data was analyzed using SPSS v29.

Results

Descriptive demographic and performance characteristics, including chair stand scores and physical function are presented in Table 1. Participants were generally classified as overweight, with some physical activity limitations.

After investigating physical activity and functional independence relationships, daily individual stair steps (STAIRS) showed significant positive correlations with the number of timed chair stands completed at the 14-inch seat height (TCS14; $r = 0.32, p = .02$) and the level of health-related limitations in physical activity (MSF36; $r = 0.29, p = .04$). While the 17-inch height is the standard assessment protocol for timed chair stands, it did not significantly correlate with STAIRS (TCS17; $p = .06$) but was strongly correlated with functional independence (MSF36; $r = 0.54, p < .001$). Complete correlation data are presented in Table 2.

Table 1. Participant demographic, performance, and functional independence data by ethnicity.

	Caucasian (n = 27)	African-American (n = 22)	Other (n = 1)	Total (n = 50)
Age (years)*	77 ± 6.7	71 ± 6.4	78	75 ± 7.0
Gender (mins)				
Males	2	3	1	6
Females	25	19	-	44
BMI (kg•m ⁻²)*	29.1 ± 5.6	30.3 ± 6.5	24.8	29.6 ± 6.0
TCS 14 (reps)*	6.9 ± 4	7.8 ± 5	11	7.42 ± 4
TCS 17 (reps)*	10.5 ± 4	11.6 ± 5	14	11.12 ± 5
Stairs (individual stair steps)*	8.2 ± 9	18.6 ± 25	15	12.7 ± 18
Modified SF36-PF*	73 ± 23	72 ± 23	100	73.2 ± 23

TCS 14= Timed chair stands 35.6cm (14in), TCS 17= Timed chair stands 43.2cm (17in)

*Data are Means ± SD

Table 2. Pearson correlation coefficients and (*p*-values) between test variables (n = 50).

	TCS14	TCS17	STAIRS	MSF36
TCS14	-			
TCS17	.81 (< .001)***	-		
STAIRS	.32 (.02)*	.26 (.06)	-	
MSF36	.44 (.001)**	.54 (< .001)***	.29 (.04)*	-

TCS 14= Timed chair stands 35.6cm (14in), TCS 17= Timed chair stands 43.2cm (17in), STAIRS= number of individual stair steps reported, MSF36= Modified SF36

* Significant P < .05

** Significant P < .01

*** Significant P < .001

Regression analyses demonstrated that age alone accounted for 28-29% of the variance in TCS performance. Adding STAIRS explained an additional 8% of the variance in TCS14 performance. However, including the physical function assessment (MSF36) improved the explanation by 12-22%. The final regression models for both TCS14 and TCS17 performance are shown in Table 3.

Table 3. Regression equations for timed chair stands accounting for age.

	Regression Equation	R ²	R ² Change	<i>p</i> - value	Std. Error of the Estimate
TCS14					
Age	-.35 (age)+ 34.21	.28	-		3.99
Age, STAIRS	-.34 (age)+ .07(stairs)+ 32.30	.37	.08*	.01	3.78
Age, MSF36	-.34 (age)+ .08(MSF36)+ 26.96	.46	.17***	< .001	3.49
Age, STAIRS, MSF36	-.33 (age)+ .04(stairs)+ .07(MSF36)+ 26.67	.49	.12**	.002	3.42
TCS 17					
Age	-.39(age)+ 40.25	.29	-		4.22
Age, STAIRS	-.37(age)+ .06(stairs)+ 38.63	.35	.05	.05	4.10
Age, MSF36	-.37(age)+ .11(MSF36)+ 30.70	.56	-.00	.37	3.34
Age, STAIRS, MSF36	-.36(age)+ .02(stairs)+ .10(MSF36)+ 30.54	.57	.22***	< .001	3.35

R2 Change is calculated from the age model

*Significant p < .05

** Significant p < .01

*** Significant p < .001

When participants were grouped into distribution-based stair-use tertiles (0–1, 2–10, ≥11 stairs/day), analysis of variance (ANOVA) revealed significantly higher TCS14 and TCS17 performance in the moderate and high stair-use groups compared with the low-use group (P < 0.01). The 14-inch protocol demonstrated greater discrimination among groups, indicating stronger sensitivity to functional differences in lower-limb endurance. Mean group performance values and 95% confidence intervals are illustrated in Figure 1.

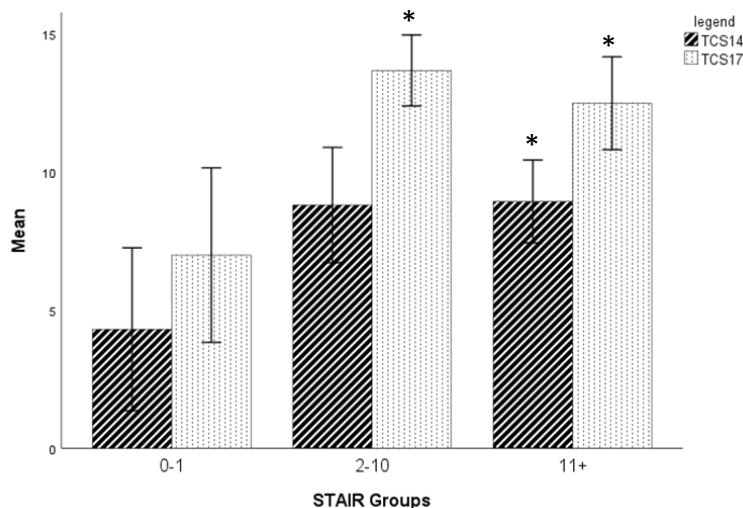


Figure 1. Mean data for daily individual stair-step volume and physical performance measures for all subjects (n=50) with 95% confidence intervals.

No significant differences were observed in TCS performance by gender or ethnicity.

Discussion

The present study found that self-reported daily stair climbing is positively associated with lower-limb endurance and overall physical activity among independently living older adults. Even modest daily stair steps, consistent with the moderate to high stair-use groups, were linked to better chair-stand performance and higher MSF36 activity levels. These findings suggest that stair climbing may reflect aspects of muscular endurance and physical independence among community dwelling older adults

The correlation between stair use and TCS14 performance suggests that frequent stair negotiation may be associated with greater lower-limb strength and endurance. However, the present cross-sectional data do not establish directionality. The 14-inch TCS protocol demonstrated greater discriminatory ability than the standard 17-inch test, likely due to its higher biomechanical demand and sensitivity to endurance differences. The lower 14-inch seat height increases knee and hip extensor demand relative to the standard 17-inch protocol, potentially challenging individuals who may appear functionally intact under less demanding conditions. In applied settings, this may improve sensitivity for detecting early declines in muscular endurance among higher-functioning older adults. This aligns with previous research showing that lower seat heights elicit greater muscle activation and provide a more challenging strength assessment for older adults.^{3,15,16} However, clinical implementation should consider safety and individual capability.

Although stair climbing accounted modestly to the total variance in performance at approximately 8%, this finding aligns with the multifactorial nature of mobility in aging, which is influenced by neural coordination, balance, and comorbidities. Importantly, the relationship between stair use and chair-stand performance remained significant after adjusting for age, highlighting the behavioral contribution of daily activity to endurance maintenance. Notably, the combination of MSF36 and the TCS17 protocol increased predictive capacity by 21%, suggesting that functional self-report paired with objective performance testing may offer a feasible composite measure for prehabilitation assessment.

Clinical and Functional Implications

Previous research has established chair-stand performance and stair negotiation as indicators of lower-limb strength and functional independence.^{3,9,13-16} However, few studies have examined whether habitual daily stair exposure itself relates to performance-based measures in community-dwelling older adults. The present findings extend this literature by suggesting that even naturally occurring stair-step volume may distinguish functional endurance levels. Stair climbing offers practical advantages as a screening measure in therapeutic and prehabilitation settings. It reflects real-world physical behavior, requires no equipment, and can be easily self-reported or tracked with wearable devices. Participants reporting two or more daily stair steps demonstrated meaningful differences in functional performance, suggesting a pragmatic benchmark for clinicians to identify older adults at risk of mobility decline. Incorporating stair-

use assessment with chair-stand testing could enhance early detection of reduced endurance and support targeted interventions to preserve independence.

These findings extend evidence that everyday physical behaviors, including stair climbing, contribute to muscular strength and endurance maintenance.^{1,11} Encouraging older adults to incorporate stair use, when safe and feasible, may complement structured exercise programs and counteract the functional consequences of sedentary behavior.

This study was limited by its small, predominately female sample. The predominance of female participants may limit generalizability to older men, who may differ in lower-limb strength profiles and habitual activity patterns. This study also relied on self-reported daily stair steps, which may introduce recall error or misclassification, potentially attenuating or inflating observed associations. To reduce cognitive-related reporting bias, the Mini-Mental State Examination was administered prior to recall, and most participants demonstrated intact cognitive status. Because the design was cross-sectional, causality and directionality cannot be inferred. Additionally, stair-use tertiles were derived from the natural distribution of the sample and should be interpreted as exploratory rather than predefined clinical thresholds. Future longitudinal studies using objective monitoring are needed to clarify temporal relationships.

Conclusions

Daily stair climbing is associated with higher chair-stand performance and physical activity levels in older adults. The 14-inch chair-stand test provides a sensitive measure for identifying functional differences, and together with these metrics offer a feasible, low-cost prehabilitation screening approach to help preserve independence and prevent mobility decline.

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Conflict of Interest. The authors declare no conflicts of interest.

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