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Effect of Various Functional Capacity Tests on Cardiorespiratory Parameters - A Brief Review

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ABSTRACT

INTRODUCTION: Cardiovascular diseases (CVDs) remain a major global health burden, emphasizing the need for effective assessments of functional fitness to prevent risk and optimize intervention strategies. Traditional methods such as the Six-Minute Walk Test (6MWT) are widely used, but alternative tests may offer efficient, space-conscious options. This review evaluates functional capacity tests, including the 2-Minute Step Test (2MST), 2-Minute Walk Test (2MWT), 3-Minute Walk Test (3MWT), and various Sit-to-Stand (STS) protocols, to assess their validity, responsiveness, and clinical applicability.

OBJECTIVE: This study aims to explore the reliability and practicality of submaximal functional capacity tests as alternatives to the 6MWT, with a focus on their correlation with cardiorespiratory fitness, mobility, and endurance across diverse populations.

METHOD: A structured literature review was conducted using PubMed, Google Scholar, and Research Gate. Relevant keywords included "2MST," "2MWT," "3MWT," "STS tests," and "cardiorespiratory parameters." Studies were evaluated based on research design, outcome measures, correlation coefficients, and limitations.

RESULTS: Findings indicate that STS tests effectively assess functional impairment in COPD patients, with high reliability in haemodialysis populations. The 2MST correlates strongly with mobility and endurance markers and serves as a practical substitute for the 6MWT in space-constrained environments. Shorter walk tests, such as 2MWT and 3MWT, demonstrate predictive value for VO_2 max and functional decline in chronic disease patients.

CONCLUSION: Different type of functional tests provides valuable, and measurable assessment of functional capacity across diverse cohorts. Their strong correlation with the 6MWT supports their integration into clinical practice, enhancing patient evaluations, rehabilitation strategies, and preventive interventions for cardiovascular and respiratory health.

KEYWORDS: 2MST, 2MWT, 3MWT, 10STST, 60STST, and cardiorespiratory parameters.

INTRODUCTION

Cardiovascular disease (CVD) continues to be a major cause of sickness and mortality worldwide; it is imperative that risk be identified and prevented through routine cardiovascular fitness evaluations. Smoking,

excessive alcohol use, a sedentary lifestyle, and poor diet are the main behavioural risk factors for heart disease and stroke. CVDs are the leading cause of death globally, taking an estimated 17.9 million lives each year. Economic hardships, a protracted transition to adulthood, and rapid technological advancements all seem to be causing adults' health issues by making them more stressed and sedentary and decreasing their participation in work and family responsibilities, which act as powerful social restraints on taking risks.[1]

Young adults (ages 18–24) are the most likely age group to meet physical activity guidelines (30%), followed by those aged 25–44 (24%) and 45–54 (18%). However, adults also show higher rates of fast-food consumption, smoking, drug use, binge drinking, and STDs. With aging populations worldwide, there has been growing emphasis on evaluating and preserving functional fitness to support healthy aging and prevent the decline of physical independence Technological changes, economic pressures, and delayed adulthood contribute to increased stress, sedentary habits, and reduced participation in stabilizing social roles, worsening young adult health trends[2].

Exercise training is a key strategy in CVD prevention and management, improving outcomes and reducing mortality. Personalized prescriptions, guided by cardiopulmonary exercise testing, enhance effectiveness by assessing cardiorespiratory fitness and ventilatory thresholds[3].

Functional capacity—the ability to perform daily activities without fatigue—is often measured through aerobic capacity using tests. This capability is crucial for maintaining autonomy and a high quality of life, especially among older adults. [2]. A variety of physical performance tests—such as the 6-Minute Walk Test (6MWT), 2-Minute Step Test (2MST), 2-Minute Walk Test (2MWT), 3-Minute Walk Test (3MWT), and Sit-to-Stand Tests (STS)—are widely used to assess submaximal functional aerobic capacity and lower-extremity strength[4,5,6].

The effect of exercise capacity on patients' quality of life may therefore be more accurately reflected by evaluating and enhancing functional capacity using patient-centered submaximal outcome measures. Furthermore, it is well recognized that enhancing functional exercise ability and lowering symptoms might raise the degree of independence needed to complete ADLs.[7]

While these tests are commonly employed in both clinical and research settings, there remains a need to better understand their impact on cardiorespiratory parameters, particularly in healthy individuals. Additionally, differences in physical fitness, test procedures, and subjective judgments of exertion make it difficult to compare results across varied populations.[8,9,10,11]. This review aims to explore and evaluate the current evidence regarding the validity, responsiveness, and practicality of these field-based functional tests, with a particular focus on their correlation with cardiovascular responses. Highlighting these relationships may guide future assessments and interventions aimed at improving overall functional health and endurance in healthy adults.

METHOD

A narrative review was performed utilizing literature obtained from the PubMed, Google Scholar, and Scopus databases. The relevant searched keywords include 2MST, 2MWT, 3MWT, 10STST, 60STST, and cardiorespiratory parameters.

Table 1: Summary of studies conducted on functional capacity test

S no.	Authors	Objective	Study design	Material and methods	Outcomes measures	Results	Limitations
1.	Machado A et al., Braz J Phys Ther (2024)[7]	To assess the functional capacity of individuals with COPD through sit-to-stand tests and examine its relationship with disease severity and associated clinical factors	Cross-sectional study with matched controls	Functional capacity in 302 COPD patients and 304 matched controls was assessed via 5-STS and 1-min STS; associations with GOLD stage, symptoms, strength, and quality of life were analysed.	• 5-STS (time in seconds) • 1-minSTS (repetitions) • GOLD stage • Muscle strength • Quality of life (QoL)	• 23% showed reduced performance in 5-STS, 33% in 1-minSTS • COPD patients scored lower than controls (5-STS: 8.4 s vs 7.4 s; 1-minSTS: 27 vs 35 reps) • Impairments noted across all GOLD stages • Weak associations with symptoms, muscle strength, and quality of life	• Cross-sectional design cannot establish causality • Functional impairment may be underestimated without longitudinal assessment • Results may not generalize beyond COPD population
2.	Poncumhak et al., Annals of Geriatric Medicine and Research (2023)[4]	To examine the ability of the 2-minute step test (2MST) to predict functional fitness in older adults with hypertension	Cross-sectional observational study	Ninety-one hypertensive older adults completed fitness tests including the 2MST, 6MWT, Five Times Sit-to-Stand, grip and leg strength, and TUG. Associations and cutoff points were statistically evaluated.	• 2MST (number of steps) • 6MWT (distance) • Grip & leg strength • FTSST & TUG (duration)	• Average age: 70.3 years; average hypertension duration: 8.9 years • Low fitness is indicated by a 2MST of less than or equal to 60 steps (specificity: 70.6%, sensitivity: 87.5%, and AUC: 0.91). • Strong positive correlations with 6MWT (r=0.747), grip (r=0.567), and leg strength (r=0.472) •The negative relationships with TUG (r=-0.632) and FTSST (r=-0.491)	• Conducted in a specific population (older adults with hypertension) • No long-term follow-up • Results may not generalize to younger populations or those with other conditions
3.	Patchareeya Amput et al., Journal of the Medical Association of	To examine the relationship between functional capacity and mobility in older adults with hypertension.	Cross-sectional	Functional tests: 2MST, TUG, STS10, STS60 in hypertensive older adults	Steps (2MST), time (TUG & STS10), repetitions (STS60)	Demonstrated association with mobility; cardiorespiratory factors were not evaluated	The group was restricted to elderly people with hypertension, and cardiorespiratory

	Thailand (2021)[8]						indicators were excluded.
4.	Nogueira et al., Journal of Manipulative and Physiological Therapeutics (2021)[9]	To evaluate the intrarater and interrater reliability of the 2-minute step test (2MST) and its effectiveness in distinguishing active from sedentary lean adults	Observational reliability study	Two hundred lean adults were grouped by age (18–24, 25–44) and activity level (active, sedentary). Participants completed the 2MST twice, one week apart, evaluated by two raters. The Baecke Questionnaire was used to quantify physical activity. Accuracy was assessed using ROC analysis, while reliability was assessed using ICC.	• 2MST score (step count) • Baecke Questionnaire score • Intrarater and interrater ICC • ROC (AUC, sensitivity, specificity)	• Interrater and intrarater reliability were excellent (ICC ≥ 0.83) • Weak yet significant positive correlation with BQ score ($r = 0.344$, $p < .001$) • Limited accuracy in distinguishing activity levels (AUC = 0.671, Sensitivity = 61%, Specificity = 67%)	• Focused only on lean individuals aged 18–44 • 2MST has limited utility for distinguishing active vs. sedentary individuals • Findings not generalizable to older adults or those with health conditions
5.	Ibikunle et al., Journal of Clinical and Experimental Cardiology (2020)[12]	To assess the validity and responsiveness of the 3-Minute Walk Test (3-MWT) in measuring functional capacity among patients with hypertension.	Correlational study	One hundred fifty patients with mild to moderate hypertension completed four trials each of the 3-MWT and 6-MWT on separate days over four weeks. Tests were conducted on a 30-meter flat corridor. VO_2 max was estimated, and cardiovascular plus anthropometric measurements were collected.	• Distance walked (3-MWT & 6-MWT) • VO_2 max • Reliability (ICC) • Responsiveness (Effect size)	• Strong correlation between 3-MWT distance and VO_2 max from 6-MWT ($r = 0.937$, $p = 0.001$) • Excellent reliability: 3-Minute Walk Test (3-MWT) ICC = 0.998; 6-Minute Walk Test (6-MWT) ICC = 0.997 • The 3-MWT and 6-MWT effect sizes were 0.16 and 0.27, respectively. • Functional capacity predicted by age, height, and weight	• Conducted in one location; results may not generalize to broader populations • Only hypertensive patients included • VO_2 max not directly measured, only estimated
6.	Hülya Nilgün Gürses et al., Medicine (2018)[10]	To assess the effectiveness of sit-to-stand (STS) tests as substitutes for the	Comparative study	Administered timed STS tests and 6MWT	Time to complete STS10; Distance (6MWT)	Concluded that timed STS tests can be quick and valid alternatives to 6MWT	Concluded that timed STS tests can be quick and valid

		6-Minute Walk Test (6MWT) in healthy young adults.					alternatives to 6MWT
7.	Naoko Yanagawa et al., Journal of physiological Anthropology (2016)[11]	To investigate the relationship between sit-to-stand (STS) and maximal walking (MW) performance in older women through both cross-sectional and longitudinal analyses.	Cross-sectional and longitudinal analysis	One hundred fifty-four non-disabled women aged 60–79 completed 10-repetition STS and 5-meter MW tests before and after a 3-month bodyweight exercise program. Power indices for both tasks (STS-PI, MW-PI) were calculated.	• STS time and MW time • STS-PI and MW-PI (calculated power indexes)	• Before and after the intervention, there was a high association between STS-PI and MW-PI ($r = 0.545–0.567$, $p < 0.0001$). • Time scores association ($r = 0.271–0.309$) i.e. is a weaker association • After training, all metrics showed a considerable improvement. • A moderate correlation ($r = 0.366$, $p < 0.0001$) was found between changes in the STS-PI and MW-PI.	• Only older ladies without disabilities • Functional improvement specific to the trained people • For a number of categories, the power index formula may not be accurate.
8.	Haas F., et. al, Open Journal of Therapy and Rehabilitation (2017)[13]	To validate the 2-minute step test (2MST) as an alternative to the 6-minute walk test (6MWT) for evaluating functional improvement, especially in settings with limited space.	Observational, cross-sectional study	The 2MST and 6MWT were finished by 148 individuals, including inpatients, outpatients, and healthy controls. Measurements were made of BP, HR, SpO_2 and RPE Sensitivity and reproducibility were assessed.	Heart rate, oxygen saturation, blood pressure, perceived exertion, number of steps (2MST), 6MWT distance	Similar physiological responses, reproducibility with an 8% learning effect, sensitivity to identifying functional changes across groups, and a strong correlation between 2-minute step test and 6-minute walk test ($r = 0.925$, $p < 0.0001$) were all noted.	Restricted to patients who are able to move up and down comfortably; absence of long-term monitoring; There is no documented inter-rater reliability.
9.	Segura-Ortí et al., Physical therapy and Rehabilitation Journal (2011)[6]	To assess the relative reliability of STS-10, STS-60, 6MWT, one-leg heel-rise, and handgrip strength tests in haemodialysis patients, and to determine the	Prospective, nonexperimental investigation	Thirty-nine haemodialysis patients from two Spanish clinics completed two sessions of STS-10, STS-60, 6MWT, one-leg heel-rise, and handgrip tests 1–2 weeks apart. ICC and	• STS-10 (time in seconds) • STS-60 (repetitions) • 6MWT (distance) • One-leg heel-rise (reps)	• Excellent reliability (ICC ≥ 0.88) for all tests • MDC (90% CI): STS-10: 8.4sec STS-60:4 reps 6MWT: 66.3 m Handgrip: 3.4 kg Heel-rise: 3.7 (right),5.2	• Small sample size • Limited to patients with haemodialysis • It might not apply to healthy people or other chronic illnesses.

		minimal detectable change (MDC) scores for each test.		MDC (90% CI) were calculated.	• Handgrip strength (kg)	(left) Reliable tools for tracking functional changes in dialysis patients	
10.	Pedrosa R & Holanda G, Brazilian Journal of Physical Therapy (2009)[14]	To examine the association between aerobic endurance and functional mobility in older women with hypertension.	Cross-sectional observational and analytical study	A sample of 32 community-dwelling hypertensive older women completed three physical function tests: the 6MWT to measure distance walked in six minutes, the 2MST to count steps marched in place for two minutes, and the TUG, a timed test involving standing, walking three meters, turning, and returning.	Distance walked (6MWT), number of steps (2MST), time to complete TUG	Moderate positive correlation observed between 6MWT and 2MST ($r = 0.36$, $p = 0.04$); moderate negative correlations found between 6MWT and TUG ($r = -0.59$, $p < 0.001$) and between 2MST and TUG ($r = -0.66$, $p < 0.001$), indicating a strong link between endurance and mobility.	• Small sample size • Only included women • No cardiorespiratory parameters assessed (e.g., HR, BP)

RESULTS

Studies[4,6,7,8,9,10,11,12,13.14]confirm the reliability, validity, and practicality of functional performance tests like the 2-Minute Walk Test (2MWT), 2-Minute Step Test (2MST), Sit-to-Stand (STS) tests, and 3-Minute Walk Test (3MWT) across diverse populations. STS tests, especially the 5-STS and 1-minSTS, effectively identify functional limitations in COPD patients and correlate with walking performance and energy expenditure in both young adults and the elderly[7]. In haemodialysis patients, STS-10 and STS-60 showed high test-retest reliability and sensitivity to progress[6].

The 2MST stands out as a low-resource, space-efficient alternative to the 6MWT, showing high sensitivity and specificity in hypertensive[4,8,14] and post-COVID-19 patients[17]. It closely mirrors the 6MWT in physiological responses and correlates strongly with mobility and strength measures[4,14,17]. The 1-minSTS is particularly useful in detecting exertional desaturation in post-COVID recovery[7].

Short walk tests like the 2MWT and 3MWT are practical alternatives to the 6MWT, especially for patients with fatigue, comorbidities, or limited space. While the 3MWT closely matches the 6MWT-derived VO_2 max and predicts poor outcomes in individuals with heart failure and COPD, the 2MWT correlates well with age and height[12]. These shorter tests[4,6,7,8,9,10,11,12,13,14] offer efficient, accurate, and scalable options for clinical use.

DISCUSSION

Cardiovascular disease (CVD) remains a major global health burden, necessitating regular assessment of cardiovascular fitness to mitigate risk and promote early intervention[4].Traditionally, the 6-minute walk test (6MWT) has served as a gold standard for evaluating functional capacity. However, logistical limitations—such as the need for a 30-meter track and the physical demand it places on frail individuals[15]—highlight the need for shorter, more accessible alternatives like the 2-minute step test (2MST), 2-minute walk test (2MWT), 3-minute walk test (3MWT), and various sit-to-stand (STS) protocols.

The present review of studies highlights the validity, reliability, and clinical utility of these shorter tests in both healthy and diseased populations. The 2MST, for example, consistently demonstrated high correlation with 6MWT in multiple studies ($r > 0.90$), while also offering good sensitivity and specificity for identifying impaired functional performance, especially in older adults with hypertension[4]. The 3MWT has shown similarly robust results, with near-equivalent VO_2max predictions and excellent test-retest reliability (ICC = 0.998)[16]. Both the 2MWT and 3MWT serve as efficient surrogates to the 6MWT, particularly where space or endurance is a limiting factor, such as in emergency departments or early-stage rehabilitation settings [12,14].

The sit-to-stand tests (STS), including 5-STS, 10-STS, 1-minSTS, and STS-60, offer a simple and practical means of assessing lower-limb strength, functional mobility, and endurance[6,7,8].

These tests are especially suitable for frail populations or those with COPD, as highlighted in studies showing that up to 33% of individuals with COPD demonstrated impaired performance on STS tests despite varied GOLD classification. STS tests also showed meaningful correlations with mobility outcomes (e.g., TUG) and exercise tolerance measures (e.g., 6MWT), reinforcing their value as accessible markers of physical function[7, 17,.]

Anthropometric variables such as age, weight, and height significantly influenced performance across all tests. Several studies reported negative correlations between age and distance or step count in the 2MWT and 2MST, while height and leg strength positively influenced outcomes. Interestingly, oxygen saturation and perceived exertion (Borg scale) varied notably across tests, with the 1-minSTS in post-COVID patients showing a significant drop in SpO_2 (≥4%) and increased dyspnoea in those with longer hospital stays[17]. The

physiological significance of these tests in identifying mild deficits in cardiopulmonary function is highlighted by these results.

While each test offers its strengths, their effects on cardiovascular parameters—including heart rate, systolic/diastolic blood pressure, and exertion—differ, suggesting that test selection should be tailored to the individual's physical status, setting, and clinical goals. For instance, the 2MST elicited responses equivalent to the 6MWT in terms of heart rate and perceived exertion, while STS tests were more suitable for detecting muscular endurance deficits in the elderly.

In summary, the integration of 2MST, 2MWT, 3MWT, and STS tests into clinical and community health settings offers a flexible, valid, and practical approach to evaluating cardiovascular and functional health. These tests enable a more personalized assessment of physical capacity, especially in scenarios where standard testing like the 6MWT is impractical. Further research should aim to develop normative data stratified by age, sex, and anthropometry, and establish standardized guidelines for test selection in both healthy and diseased populations.

CONCLUSIONS

Collectively, the reviewed studies affirm the clinical value of alternative functional capacity tests—such as 2MST, 3MWT, 2MWT, and various STS protocols—as viable, efficient, and sensitive tools across different populations including those with COPD, hypertension, post-COVID-19, and elderly cohorts. These tests demonstrate significant correlations with the gold standard 6MWT, with correlation coefficients frequently exceeding 0.90, indicating strong agreement.

In clinical practice, these shorter and simpler alternatives not only enhance accessibility and patient compliance but also maintain strong diagnostic and prognostic relevance. Their implementation can enrich patient assessment frameworks, support early detection of decline, and inform rehabilitation strategies tailored to cardiovascular, respiratory, and musculoskeletal conditions.

Declaration by Authors

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