*CASE REPORT*

# Differences in Sensitivity and Specificity of the Time Up and Go Test and Berg Balance Scale in Assessing the Risk of Falls in Chronic Heart Failure Patients with Systolic Dysfunction

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## ABSTRACT

**Introduction:** Chronic heart failure (HF) patients face increased fall risks due to muscle dysfunction and balance impairment. The Time Up and Go (TUG) and the Berg Balance Scale (BBS) are the tests that have been developed to assess the risk of falls in general population, but research specifically investigating their sensitivity and specificity in chronic HF patients remains scarce.

**Methods**: This study was a cross-sectional study aimed at assessing the sensitivity and specificity of the TUG and BBS for risk of fall, performed using the Receiver Operating Characteristic (ROC) curve, involving patients from the Cardiology Department of Brawijaya University Hospital aged 21 to 60 years who were diagnosed with chronic HF with systolic dysfunction.

R**esults**: Analysis of 32 participants with average age of 56 years showed TUG's area under the curve (AUC) was 0.85 (95% CI 0.5 – 1), with cut-off at 11.22 seconds, with 75.00% sensitivity, and 96.43% specificity. Meanwhile, BBS had an AUC of 0.72 (95% CI 0.4 - 1), with 71.43% sensitivity, and 75.00% specificity respectively with cutoff at 56.

**Conclusion:** TUG demonstrated superior sensitivity and specificity compared to BBS, making it a preferred tool for identifying fall risk in chronic HF with systolic dysfunction.

**Keywords:** Time Up and Go, Berg Balance Scale, heart failure, risk of falls

**ABSTRAK**

**Pendahuluan:** Pasien gagal jantung kronik (HF) menghadapi peningkatan risiko jatuh akibat disfungsi otot dan gangguan keseimbangan. Time Up and Go (TUG) dan Berg Balance Test (BBS) adalah tes yang dikembangkan untuk menilai risiko jatuh pada populasi umum, namun pneelitian yang secar akhusus menyelidiki sensitivitas dan spesifisitasnya pada pasien gagal jantung kronis masih langka.

**Metode:** Penelitian ini merupakan penelitian cross-sectional yang bertujuan untuk menilai sensitivitas dan spesifisitas TUG dan BBS terhadap risiko jatuh, dilakukan dengan menggunakan kurva Receiver Operating Characteristic (ROC), yang melibatkan pasien dari Departemen Kardiologi RS Universitas Brawijaya berusia 21 hingga 60 tahun yang didiagnosis gagal jantung kronis dengan disfungsi sistolik. Hasil: Analisis terhadap 32 partisipan dengan rata-rata usia 56 tahun menunjukkan area under curve (AUC) TUG sebesar 0.85 (95% CI 0.5 – 1), dengan cut-off 11.22 detik, dengan sensitivitas 75.00%, dan spesifisitas 96.43%. Sedangkan BBS memiliki AUC sebesar 0.72 (95% CI 0.4 – 1), sensitivitas 71.43% dan spesifisitas 75.00% dengan cut-off 5.6.

**Kesimpulan:** TUG menunjukkan sensitivitas dan spesifisitas yang lebih unggul dibandingkan BBS, menjadikannya alat pilihan untuk mengidentifikasi risiko jatuh pada gagal jantung kronis dengan disfungsi sistolik.

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## INTRODUCTION

Chronic heart failure (HF), characterized by the heart's inability to meet the body's metabolic demands, presents a significant clinical challenge due to its association with impaired skeletal muscle function and increased risk of falls. Chronic HF patients exhibit alterations in muscle mass, fiber type, metabolism, and mitochondrial function, contributing to functional declines and balance disorders.[1,2] Heart failure patients are categorized as having heart failure with reduced ejection fraction (HFrEF; LVEF <40%), mid-range (HFmrEF; LVEF 40–49%), and preserved ejection fraction (HFpEF; LVEF > 50%).3 Falls are prevalent in this population, affecting up to 43% of individuals, exceeding rates in other chronic conditions Hospitalized HF patients exhibit an even greater risk, with estimates reaching 60% due to acute decompensation and immobilization.[4]

Addressing this critical issue necessitates identifying risk factors and implementing effective assessment tools. Established risk factors in chronic HF include prior falls, mobility limitations, polypharmacy, urinary dysfunction, orthostatic hypotension, and cognitive impairment.[5] Various fall risk assessment scales and tests exist, including the Activities-Specific Balance Confidence (ABC), Berg Balance Scale (BBS), and Time Up and Go (TUG) test.[5,6] The Berg Balance Scale (BBS) offers a comprehensive balance assessment using 14 items but requires substantial time and equipment.7 Conversely, the TUG evaluates functional mobility in daily activities and is quick, simple, and equipment-free.6 While Bennie et al. (2003) demonstrated a strong correlation between the BBS and TUG in general

populations, research specifically investigating their sensitivity and specificity in chronic HF patients is lacking.[8]

This study aimed to address this gap by comparing the BBS and TUG tests in chronic HF patients to determine their effectiveness in identifying fall risk and guiding clinical decision-making.

## METHOD

### Study Design and Population

This cross-sectional study, conducted at Brawijaya University Hospital between September 29th, 2023, and November 3rd, 2023, explored fall risk in chronic heart failure patients. Cardiology outpatients with chronic heart failure were recruited through consecutive sampling. Balance assessments utilized the Berg Balance Scale (BBS) and Time Up and Go (TUG) test. Demographic data (age, BMI, vital signs), echocardiographic findings, and kidney function test results were collected. Additionally, comorbidities such as hypertension, diabetes, hyperlipidemia, smoking, stroke, atrial fibrillation, valvular heart disease, and coronary heart disease were documented, alongside intervention and medication history (percutaneous coronary intervention, treatment history).

Inclusion criteria required participants to be aged 21-60 years, diagnosed with chronic heart failure with stable systolic dysfunction, and provide written informed consent. Patients were excluded if they had NYHA class IV heart failure; mobility-limiting musculoskeletal disorders (amputation, fracture, joint inflammation, pain>3 on VAS); mobility-limiting neurological disorders (spinal cord injury, head injury, peripheral neuropathy, muscular dystrophy, neuromuscular junction disease, Parkinson's disease, dementia, sensory/vestibular disorders); cognitive impairment; visual impairment; malignant arrhythmia; or chronic kidney disease. Study participation was terminated for any patient exhibiting signs of unstable disease: disease-related complaints, abnormal vital signs (systolic blood pressure >160 mmHg or diastolic blood pressure >100 mmHg, resting pulse >120 beats/minute, SpO2 <95% on room air, or respiratory rate >24 breaths/minute).

### Procedure

Prior to testing, patient safety was ensured by verifying their good physical condition, maintaining a clean and non-slip testing environment, and having research team members present throughout the procedure. Potential risks and side effects, including falls, fatigue, shortness of breath, fainting, and chest pain, were acknowledged and communicated. The Timed Up and Go (TUG) test measured the time taken to rise from a chair, walk 3 meters, turn around, and return to the seated position. Time elapsed from initiating movement until sitting down again was recorded in seconds.[9] The Berg Balance Scale (BBS) evaluated balance function through 14 standardized tasks, including sitting, standing, reaching, turning, gaze stability, single-leg stance, and stepping onto a platform. Each item received a score of 0-4, with a maximum total score of 56.[10]

### Statistical Analysis

Data collected included Assessments for Specific Balance Confidence (ABC), Time Up and Go (TUG) test, and Berg Balance Scale (BBS) scores. Normally distributed numerical data will be presented as mean ± standard deviation, while non-normally distributed data will be shown as median and interquartile range (IQR). The Shapiro-Wilk test will determine normality. Categorical data will be represented by frequencies and percentages.

To compare the sensitivity and specificity of TUG and BBS in identifying fall risk among chronic heart failure patients, Receiver Operating Characteristic (ROC) curve analysis will be employed. This analysis will provide information on sensitivity, specificity, positive likelihood ratio (LR+), negative likelihood ratio (LR−), and Area Under the ROC Curve (AUROC) across different TUG cut-off points, ultimately determining the optimal cut-off value for fall risk prediction. All statistical analyses will be conducted using STATA version 15 (StataCorp., College Station, TX, USA).

## Ethical Clearance

The study was approved by the Research Ethics Committee, ensuring adherence to ethical guidelines. All participants provided written informed consent prior to enrollment, guaranteeing data confidentiality.

## RESULTS

Between October 29, 2023, and November 3, 2023, 172 heart failure patients from the Brawijaya University Hospital Heart Clinic were screened for eligibility. Of these, 97 did not meet inclusion criteria: 45 had preserved ejection fraction (HFpEF), 23 lacked optimal therapy for at least 3 months, and 29 were over 60 years old. This left 75 potentially eligible participants. Further evaluation through history and initial examination identified additional exclusions due to: cognitive impairment (MOCAINA score < 23, n=5), stroke sequelae (n=11), musculoskeletal disorders (n=8), chronic kidney failure (n=14), and vital sign instability (n=3). Two participants were unable to complete all assessments and were excluded during the research process.

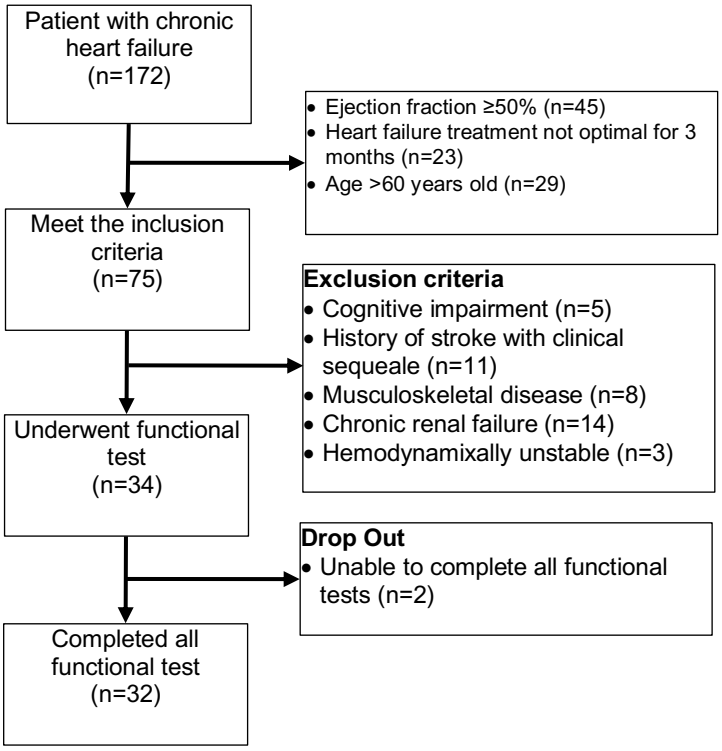


**Figure** 1. **Study flowchart describing the study population**

## Baseline Patient Characteristics

Thirty-two patients with chronic heart failure with stable systolic dysfunction who completed all functional tests were included in this analysis. The majority (71.9%) were male, with a median age of 56 years (interquartile range [IQR]: 49.3-57.8). Echocardiography revealed impaired left ventricular ejection fraction (LVEF) in 40.6% (LVEF <40%), with a median LVEF of 44.0% (IQR: 35.3-48.0%). Enlarged left atrial diameter (LAD: median 39.7 ± 4.9 mm) and left ventricular diameter (median 59.0 mm, IQR: 57.1-65.6) were observed. Activity-specific Balance Confidence Scale scores indicated high fall risk (score <81) in 4 patients (12.5%), with a median score of 95 (IQR: 90.5-98.4). Berg Balance Scale and Time Up and Go test results demonstrated median scores of 56.0 (IQR: 55.0-56.0) and 8.0 seconds (IQR: 6.9-9.1), respectively. Baseline patient characteristics are summarized in Table 1.

**Table 1. Baseline Patient Characteristic (n=32)**

| Parameter | Total (n = 32) | Risk of Fall (n = 4) | No Risk of Fall (n = 28) | P value |
|---|---|---|---|---|
| **Age (years old)** | 56 (49,3 - 57,8) | 55 (52 - 57,5) | 56 (48 - 57.5) | 0,752 |
| **Male (%)** | 23 (71,9) | 2 (50) | 21 (75) | 0,298 |
| **Body Mass Index (kg/m$^2$)** | 26,2 (23,4 - 31,1) | 26,5 (22.2 - 35.2) | 26,3 (24,1 - 30,8) | 0,932 |
| **Comorbidities and risk factors** | | | | |
| **Hypertension** | 15 (46,9) | 3 (75) | 12 (42.9) | 0,228 |
| **Diabetes melitus** | 14 (43,8) | 3 (75) | 11 (39.3) | 0,178 |
| **Hyperlipidemia** | 23 (71,9) | 3 (75) | 20 (71.4) | 0,882 |
| **Active smoker** | 5 (15,6) | 0 (0) | 5 (17.9) | 0,358 |
| **Stroke/TIA** | 4 (12,5) | 0 (0) | 4 (14.3) | 0,419 |
| **Atrial Fibrillation** | 3 (9,4) | 0 (0) | 3 (10.7) | 0,492 |
| **Heart valve disease** | 3 (9,4) | 1 (25) | 2 (7.1) | 0,252 |
| **Coronary artery disease** | 21 (65,6) | 3 (75) | 18 (64.3) | 0,673 |
| **Percutaneous coronary intervention** | 8 (25) | 1 (25) | 7 (25) | 1,000 |
| **Echocardiography** | | | | |
| **LAD (mm)** | 38,6 (37,1 - 42,8) | 38,6 (38,1 - 41,5) | 38,9 (36,6 - 42,8) | 0,776 |

| | | | | |
|---|---|---|---|---|
| **LVIDD (mm)** | 59 (57,1 - 65,6) | 58 (56,6 - 62,5) | 59 (57,6 - 66,2) | 0,512 |
| **LVEF (%)** | 44 (35,3 - 48) | 48 (47 - 48.5) | 42 (34,5 - 47) | 0,037 |
| **Renal function test** | | | | |
| **Creatinin (mg/dL)** | 1.1 (0,9 - 1,4) | 1,1 (0,8 - 1,3) | 1,1 (0,9 - 1,4) | 0,493 |
| **eGFR MDRD (ml/min/1,73 m$^2$)** | 61,3 (50,9 - 77,6) | 66,7 (51,9 - 91) | 61,3 (51,1 – 77,4) | 0,754 |
| **Heart Failure Therapy** | | | | |
| **ACEI/ARB/ARNI** | 32 (100) | 4 (100) | 28 (100) | - |
| **Beta-blocker** | 31 (96,9) | 4 (100) | 27 (96.4) | 0,701 |
| **MRA** | 29 (90,6) | 4 (100) | 25 (89.3) | 0,492 |
| **Loop Diuretic** | 23 (71,9) | 3 (75) | 20 (71.4) | 0,882 |
| **Digoxin** | 12 (40,6) | 2 (50) | 10 (35.7) | 0,683 |
| **Statin** | 26 (81,3) | 3 (75) | 23 (82.1) | 0,732 |
| **Antiplatelet** | 26 (81,3) | 3 (75) | 23 (82.1) | 0,732 |
| **Anticoagulant** | 6 (18,8) | 1 (25) | 5 (17.9) | 0,732 |
| **Nitrate** | 14 (43,8) | 1 (25) | 13 (46.4) | 0,419 |
| **Balance** | | | | |
| **Activity-specific Balance Confident Scale** | 95 (90,5 - 98,4) | 74,7 (63,3 - 80) | 95,9 (92,5 - 99,7) | 0,001 |
| **Time Up and Go (s)** | 8 (6,9 - 9,1) | 12,8 (9,7 - 13.8) | 7,9 (6,9 - 8,7) | 0,026 |
| **Berg Balance Scale** | 56 (55 - 56) | 55 (50,5 - 55,5) | 55 (55 - 56) | 0,918 |

## BBS and TUG test in Predicting Risk of Falls

The ROC curve analysis aimed to evaluate the Time Up and Go (TUG) and Berg Balance Scale (BBS) tests in predicting high fall risk in chronic heart failure patients based on the Activity-specific Balance Confidence Scale (ABC). The TUG test demonstrated good performance in distinguishing high-risk individuals, with an AUC of 0.8482 (95% CI: 0.5472-1.0000) at a cut-off of 11.22 seconds. This cut-off yielded a sensitivity of 75.00% and a specificity of 96.43%, indicating that heart failure patients exceeding 11.22 seconds on the TUG test are at high fall risk. The BBS test demonstrated moderate performance, with an AUC of 0.7232 (95% CI: 0.4448-1.0000) at a cut-off score of 56. This cut-off yielded a sensitivity of 71.43% and a specificity of 75.00%. Patients with a BBS score below 56 can be considered at high fall risk. Figures 2 present the ROC

curves for TUG and BBS tests, respectively.

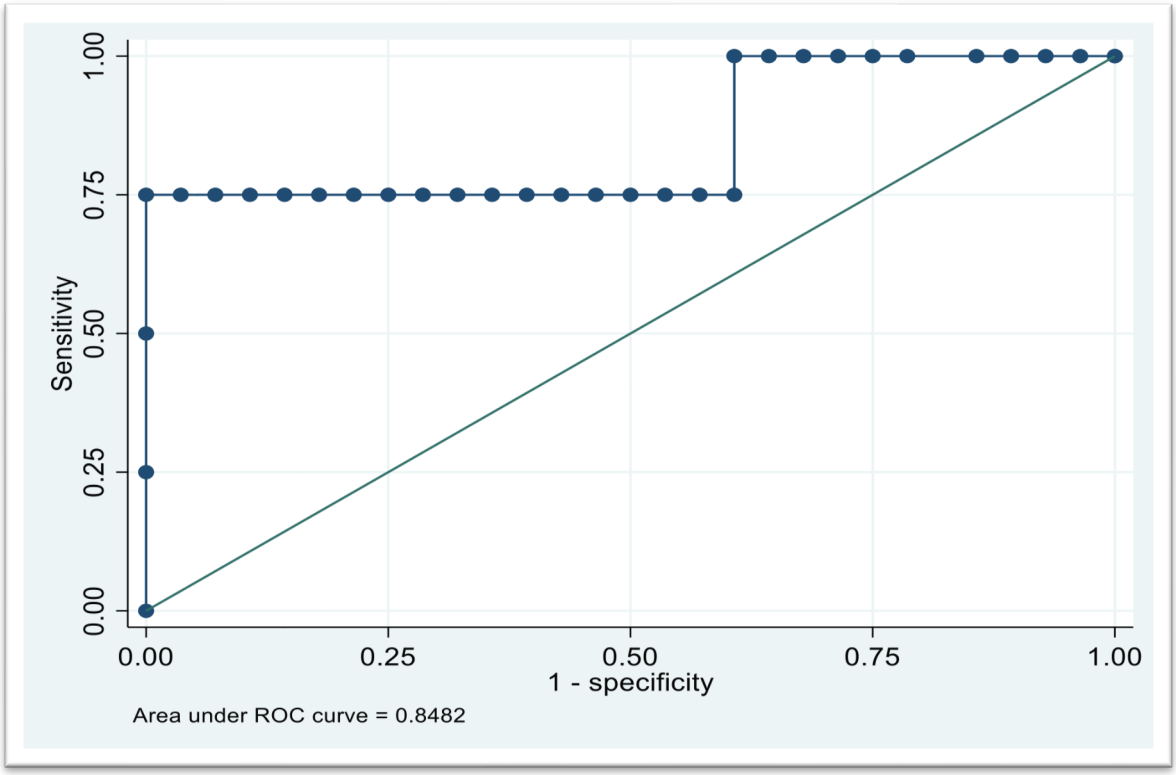


**Figure 2 ROC Curves for Time and Go test in Predicting High Fall Risk**

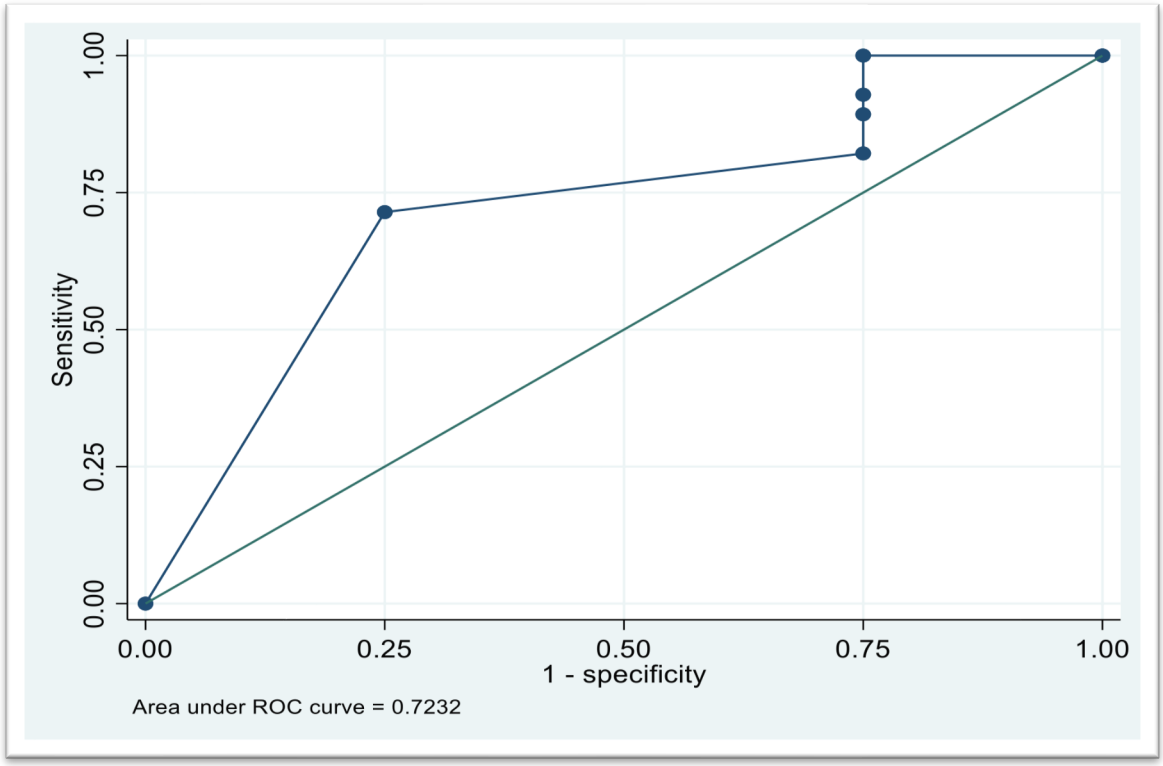


**Figure 3 Berg Balance Scale in Predicting High Fall Risk**

## DISCUSSION

This study included 32 heart failure patients with stable systolic dysfunction,

finding that the Time Up and Go test (TUG) performed well in predicting high fall risk, with a sensitivity of 75.00% and specificity of 96.43% at a cutoff of 11.22 seconds, while the Berg Balance Scale demonstrated moderate performance, with a sensitivity of 71.43% and specificity of 75.00% at a cutoff score of 56. Those participants underwent both tests and the Activity-specific Balance Confidence Scale (ABC). Based on our findings, we aimed to determine the optimal cut-off scores for each test and identify their relative strengths and limitations in predicting fall risk within this population. Median age observed in this study is 56 years (interquartile range [IQR]: 49.3-57.8) among heart failure patients, with some participants younger than 40 years. These findings align with regional epidemiological studies, as acute heart failure onset in Southeast Asia occurs around age 54, compared to age 75 in the United. This earlier onset in Southeast Asian populations is linked to a higher prevalence of hypertension, diabetes mellitus, active smoking, and physical inactivity compared to Western countries States.[11] The study population also demonstrated a male predominance (71.9%), consistent with existing data. Sex differences in heart failure incidence vary by age group. Among middle-aged populations, males exhibit higher rates, while the elderly see a prevalence shift towards females.[12]

Maintaining balance requires good postural control, which integrates information from the visual, vestibular, and somatosensory systems. Muscle strength in the trunk and legs, along with coordination skills, contribute to postural control and the ability to maintain body position.[18] However, balance disorders increase fall risk and impede daily activities. Chronic heart failure often reduces cardiac output, leading to decreased physiological function and impaired adaptation to stressors, a condition known as frailty. In one study, approximately 44.5% of chronic heart failure patients exhibited frailty.[19] This accelerated muscle loss is characterized by preserved or increased adipose tissue, altered muscle fiber structure, and reduced capillary density, ultimately leading to mitochondrial dysfunction, decreased exercise capacity, and physical weakness. Increased systemic inflammation is thought to contribute to these changes.[20]

Chronic heart failure is associated with a high prevalence of reduced muscle mass and strength, known as sarcopenia. A meta-analysis by Zhang et al. (2021) reported a prevalence of 55% (95% CI: 43-66%) in hospitalized heart failure patients and 26% (95% CI: 16-37%) in outpatients.[21] Sarcopenia significantly increases the risk of falls, with a 3.3-fold higher incidence over two years compared to non-sarcopenic individuals.[22] Additionally, neuromuscular changes beyond muscle mass loss might contribute to decreased strength in heart failure.[23] These impairments in muscle strength and fear of falling can profoundly impact balance, daily activities, and quality of life. Therefore, fall risk assessment is crucial in heart failure patients. The Activity-specific Balance Confidence Scale (ABC) with a cut-off score of 81 is commonly used to identify individuals at high fall risk in the general population.[24,35,36] This questionnaire assesses psychological barriers related to falls and their resulting activity limitations. These limitations can lead to further loss of strength, mobility, and independence, perpetuating the risk of falls. In this study, the mean ABC score was 95 (IQR: 90.5-98.4), with 12.5% of patients classified as high fall risk.

Beyond sarcopenia, other mechanisms contribute to reduced muscle strength in heart failure patients, including altered neuromuscular activity and qualitative changes within muscle fibers independent of size.[23] These factors, along with fear of falling, significantly impact

balance, daily activities, and quality of life in patient with heart failure. Hence, fall risk assessment is crucial in this population.

The Activity-specific Balance Confidence Scale (ABC), often used with a cut-off of 81, identifies individuals at increased risk of falls within the general population by addressing psychological barriers affecting activity limitations.[24] In this study, the mean ABC score was 95 (IQR: 90.5-98.4), with 12.5% classified as high fall risk. Patients required an average of 8.0 seconds (IQR: 6.9-9.1) to complete the Time Up and Go (TUG) test, though some took longer. Notably, the TUG test differentiated high-risk heart failure patients (as per ABC) with a threshold of 11.22 seconds, indicating superior specificity over sensitivity in identifying high fall risk, marking the first evaluation of TUG's diagnostic efficacy within this population.

Comparative studies on the Time Up and Go (TUG) test across diverse populations have shown varying diagnostic accuracies for fall risk assessment. For instance, in general population, Barry et al. (2014) reported a TUG cut-off of 13.5 seconds with higher specificity (73%) than sensitivity (32%) for identifying fall risk.[25] Conversely, in other disease cohorts, specific thresholds demonstrated commendable diagnostic accuracy. For instance, Hafsteinsdóttir et al. (2014) identified 14-second threshold with high reliability (ICC > 0.95) among stroke patients, while Liwsrisakun et al. (2020) reported a sensitivity of 95.8% and specificity of 90.4% with a threshold of 12 seconds among COPD patients.26,27 Furthermore, Talley et al. (2008) revealed a negative correlation (r = -0.39) between TUG and the Activity-specific Balance Confidence Scale (ABC), suggesting that prolonged TUG times correlated with higher perceived fall risk based on the ABC score.[28] Our study contributes to this body of evidence by demonstrating the utility of TUG in assessing fall risk in chronic heart failure patients, highlighting a specific cut-off of 11.22 seconds. However, the divergent performance across populations underscores the need for further investigation to establish optimal thresholds and tailor the TUG to distinct disease contexts.

The diagnostic performance of the Time Up and Go (TUG) test for fall risk in heart failure patients remains unexplored despite its excellent reliability. Prior studies suggest associations between longer TUG times and various factors such as poorer quality of life, older age, disease severity, history of falls, and impaired functional performance in heart failure patients.[29] TUG evaluates functional mobility, fall risk, and treatment outcomes across various conditions,[18] integrating balance and gait evaluation with minimal equipment and ease of use.[29] Unlike other balance tests, TUG lacks a ceiling effect, enhancing its utility for data analysis and conclusion drawing.[30]

Our study found that the Berg Balance Scale (BBS) identified high fall risk patients with a cut-off score of 56 (IQR: 55-56), the maximum possible score, exhibiting higher specificity than sensitivity, thus better suited for ruling-in high fall risk. The BBS assesses balance across three domains (sitting, standing, and postural changes), providing a comprehensive picture of risk, although setting a single sut-off score is challenging due to the "fall risk gradient" across the scale.[18] Studies report diverse cut-offs (33-54) and sensitivities (25-88%), reflecting potential limitations.[31] A meta-analysis by Park and Lee (2016) found moderate predictive ability (AUC 0.7-0.9) for fall risk, but with heterogeneous sensitivity and specificity across subgroups.[32] Consistency was only observed in specific age groups, neuromuscular diagnoses, and cut-off ranges (e.g., 45-49 for individuals <65 years old). Additionally, a positive

correlation ($r = 0.806$, $p < 0.01$) between BBS and the ABC was reported by Lajoie et al. (2004), suggests that higher self-confidence associates with lower fall risk.[33]

Our study identified a BBS cut-off of 56 for high fall risk, likely influenced by ceiling effect, as 21/31 participants obtained the maximum score, skewing data distribution (scores: 56-21, 55-5, 54-2, 53-1, 50-2, 46-1). Similar limitations of BBS have been noted, including floor effects in acute stroke settings and ceiling effects after 3 months,[32] potentially due to factors such as limited sample size, restricted patient characteristics (independent ambulation without assistive devices), and potentially less challenging assessment items.[31,34]. To mitigate this, future studies should strive for larger and more diverse samples and consider additional fall risk assessments alongside the BSS for a comprehensive evaluation.

This study's limitations include a small sample size (n=31) potentially limiting the generalizability of the derived fall risk cut-off of 56 on the Berg Balance Scale (BBS). Additionally, all participants ambulated independently without assistive devices, suggesting a relatively high baseline balance function and potentially biasing results towards better performance. Future studies should utilize larger, more diverse samples encompassing the broader spectrum of chronic heart failure patients to achieve more representative findings.

## CONCLUSION

The study identified specific cut-off scores for the Time Up and Go (TUG) and Berg Balance Scale (BBS) to assess fall risk in chronic heart failure patients. TUG is more suitable tool for identifying fall risk in the heart failure with systolic dysfunction population compared to BBS due to its higher sensitivity and specificity. BBS might be better suited for identifying individuals already at high risk.

## REFERENCES


1. Bloom MW, Greenberg B, Jaarsma T, et al. Heart failure with reduced ejection fraction. Nat Rev Dis Prim [Internet]. 2017;3:1–20. Available from: http://dx.doi.org/10.1038/nrdp.2017.58
2. Lee K, Davis MA, Marcotte JE, et al. Falls in community-dwelling older adults with heart failure: A retrospective cohort study. Hear Lung [Internet]. 2020;49:238–50. Available from: https://linkinghub.elsevier.com/retrieve/pii/S014795631930559X
3. Groenewegen A, Rutten FH, Mosterd A, et al. Epidemiology of heart failure. Eur J Heart Fail [Internet]. 2020;22:1342–56. Available from: https://onlinelibrary.wiley.com/doi/10.1002/ejhf.1858
4. McCoy J, Bates M, Eggett C, et al. Pathophysiology of exercise intolerance in chronic diseases: the role of diminished cardiac performance in mitochondrial and heart failure patients. Open Hear [Internet]. 2017;4:e000632. Available from: https://openheart.bmj.com/lookup/doi/10.1136/openhrt-2017-000632
5. Lee K, Pressler SJ, Titler M. Falls in Patients With Heart Failure. J Cardiovasc Nurs [Internet]. 2016;31:555–61. Available from: https://journals.lww.com/00005082-201611000-00012
6. Benavent-Caballer V. The Effectiveness of Exercise Interventions and The Factors Associated with The Physical

Performance in Older Adult. University CEU Cardenal Herrera; 2016.
7. Muir-Hunter SW, Graham L, Montero Odasso M. Reliability of the Berg Balance Scale as a Clinical Measure of Balance in Community-Dwelling Older Adults with Mild to Moderate Alzheimer Disease: A Pilot Study. Physiother Canada [Internet]. 2015;67:255–62. Available from: https://utpjournals.press/doi/10.3138/ptc.2014-32
8. Bennie S, Bruner K, Dizon A, et al. Measurements of Balance: Comparison of the Timed "Up and Go" Test and Functional Reach Test with the Berg Balance Scale. J Phys Ther Sci [Internet]. 2003;15:93–7. Available from: http://www.jstage.jst.go.jp/article/jpts/15/2/15_2_93/_article
9. Chan PP, Si Tou JI, Tse MM, et al. Reliability and Validity of the Timed Up and Go Test With a Motor Task in People With Chronic Stroke. Arch Phys Med Rehabil [Internet]. 2017;98:2213–20. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0003999317302216
10. Hohtari-Kivimäki U, Salminen M, Vahlberg T, et al. Short Berg Balance Scale, BBS-9, as a predictor of fall risk among the aged: a prospective 12-month follow-up study. Aging Clin Exp Res [Internet]. 2013;25:645–50. Available from: http://link.springer.com/10.1007/s40520-013-0159-x
11. Lam CSP. Heart failure in Southeast Asia: facts and numbers. ESC Hear Fail [Internet]. 2015;2:46–9. Available from: https://onlinelibrary.wiley.com/doi/10.1002/ehf2.12036
12. Cediel G, Codina P, Spitaleri G, et al. Gender-Related Differences in Heart Failure Biomarkers. Front Cardiovasc Med [Internet]. 2021;7. Available from: https://www.frontiersin.org/articles/10.3389/fcvm.2020.617705/full
13. Carbone S, Lavie CJ, Elagizi A, et al. The Impact of Obesity in Heart Failure. Heart Fail Clin [Internet]. 2020;16:71–80. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1551713619300923
14. Bornstein AB, Rao SS, Marwaha K. Left Ventricular Hypertrophy. StatPearls [Internet] [Internet]. 2023; Available from: https://www.ncbi.nlm.nih.gov/books/NBK557534/
15. Gopinathannair R, Chen LY, Chung MK, et al. Managing Atrial Fibrillation in Patients With Heart Failure and Reduced Ejection Fraction: A Scientific Statement From the American Heart Association. Circ Arrhythmia Electrophysiol [Internet]. 2021;14. Available from: https://www.ahajournals.org/doi/10.1161/HAE.0000000000000078
16. Hajouli S, Ludhwani D. Heart Failure And Ejection Fraction. StatPearls [Internet]. 2021 [cited 2022 Feb 11]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK553115/
17. van Poelgeest EP, Handoko ML, Muller M, et al. Diuretics, SGLT2 inhibitors and falls in older heart failure patients: to prescribe or to deprescribe? A clinical review. Eur Geriatr Med [Internet]. 2023;14:659–74. Available from: https://link.springer.com/10.1007/s41999-023-00752-7
18. Agyemang AA. Social (Pragmatic) Communication Disorder. In: Encyclopedia of Clinical Neuropsychology [Internet]. Cham: Springer International Publishing; 2018. p. 3204–6. Available from: http://link.springer.com/10.1007/978-3-319-57111-9_9172
19. Denfeld QE, Winters-Stone K, Mudd JO, et al. The prevalence of frailty in

heart failure: A systematic review and meta-analysis. Int J Cardiol [Internet]. 2017;236:283–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0167527316329771
20. Pandey A, Kitzman D, Reeves G. Frailty Is Intertwined With Heart Failure. JACC Hear Fail [Internet]. 2019;7:1001–11. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2213177919307966
21. Zhang Y, Zhang J, Ni W, et al. Sarcopenia in heart failure: a systematic review and meta-analysis. ESC Hear Fail [Internet]. 2021;8:1007–17. Available from: https://onlinelibrary.wiley.com/doi/10.1002/ehf2.13255
22. Landi F, Liperoti R, Russo A, et al. Sarcopenia as a risk factor for falls in elderly individuals: Results from the ilSIRENTE study. Clin Nutr [Internet]. 2012;31:652–8. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0261561412000362
23. Umehara T, Kaneguchi A, Yamasaki T, et al. Reduced upper and lower limb muscle strengths without reduced skeletal muscle in elderly patients with heart failure. J Rural Med [Internet]. 2023;18:2022–9. Available from: https://www.jstage.jst.go.jp/article/jrm/18/1/18_2022-029/_article
24. Moore DS. The Activities-specific Balance Confidence ( ABC ) Scale. Res Q Exerc Sport. 2011;50:545–54.
25. Barry E, Galvin R, Keogh C, et al. Is the Timed Up and Go test a useful predictor of risk of falls in community dwelling older adults: a systematic review and meta- analysis. BMC Geriatr [Internet]. 2014;14:14. Available from: https://bmcgeriatr.biomedcentral.com/articles/10.1186/1471-2318-14-14
26. Hafsteinsdóttir TB, Rensink M, Schuurmans M. Clinimetric Properties of the Timed Up and Go Test for Patients With Stroke: A Systematic Review. Top Stroke Rehabil [Internet]. 2014;21:197–210. Available from: http://www.tandfonline.com/doi/full/10.1310/tsr2103-197
27. Liwsrisakun C, Pothirat C, Chaiwong W, et al. Diagnostic ability of the Timed Up & Go test for balance impairment prediction in chronic obstructive pulmonary disease. J Thorac Dis [Internet]. 2020;12:2406–14. Available from: http://jtd.amegroups.com/article/view/38169/html
28. Choung R, Talley N. Epidemiology and Clinical Presentation of Stress-Related Peptic Damage and Chronic Peptic Ulcer. Curr Mol Med. 2008;8:253–7.
29. Hwang R, Morris NR, Mandrusiak A, et al. Timed Up and Go Test: A Reliable and Valid Test in Patients With Chronic Heart Failure. J Card Fail [Internet]. 2016;22:646–50. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1071916415011240
30. Herman T, Giladi N, Hausdorff JM. Properties of the 'Timed Up and Go' Test: More than Meets the Eye. Gerontology [Internet]. 2011;57:203–10. Available from: https://www.karger.com/Article/FullText/314963
31. Lima CA, Ricci NA, Nogueira EC, et al. The Berg Balance Scale as a clinical screening tool to predict fall risk in older adults: a systematic review. Physiotherapy [Internet]. 2018;104:383–94. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0031940618300324
32. Park S-H, Lee Y-S. The Diagnostic Accuracy of the Berg Balance Scale in Predicting Falls. West J Nurs Res [Internet]. 2017;39:1502–25. Available from:

http://journals.sagepub.com/doi/10.1177/0193945916670894

33. Lajoie Y, Gallagher S. Predicting falls within the elderly community: comparison of postural sway, reaction time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. Arch Gerontol Geriatr [Internet]. 2004;38:11–26. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0167494303000827
34. Chen H, Smith SS. Item Distribution in the Berg Balance Scale: A Problem for Use With Community-Living Older Adults. J Geriatr Phys Ther [Internet]. 2019;42:275–80. Available from: https://journals.lww.com/10.1519/JPT.0000000000000208
35. Wang, YC, Sindhu B, Lehman L, Li X, Yen SC, Kapellusch J [Internet]. 2018. Rasch Analysis of the Activities-Specific Balance Confidence Scale in Older Adults Seeking Outpatient Rehabilitation Services. Journal of Orthopaedic & Sports Physical Therapy, 48(7), 574-583. Doi:10.2519/jospt.2018.8023.
36. Mak MK, Pang MY. Balance confidence and functional mobility are independently associated with falls in people with Parkinson's disease. J Neurol. 2009 May;256(5):742-9. doi: 10.1007/s00415-009-5007-8. Epub 2009 Feb 25. PMID: 19240961.