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Six-Minute Walk Test Profile in Heart Failure Patients in Brazzaville: A Pilot Study

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Abstract

Background: Heart failure (HF) significantly impairs functional capacity. The six-minute walk test (6MWT) offers a simple, validated assessment tool, yet remains underutilized in sub-Saharan Africa. This study evaluated functional capacity in HF patients in Brazzaville. **Methods:** Cross-sectional study (January-March 2020) at Brazzaville University Hospital. Patients with stable chronic HF and documented echocardiography underwent 6MWT following ATS guidelines. Walking distance, clinical parameters, and factors associated with severe impairment (distance < 300 m) were analyzed. **Results:** Fifty patients (50% women, mean age 50 ± 12 years) were included. Hypertension (74%) predominated among risk factors. Mean left ventricular ejection fraction was 42% ± 15% (52% with reduced LVEF). Hypertensive heart disease (42%) and dilated cardiomyopathy (35%) were leading etiologies. Mean walking distance was 338 ± 91 m (49% of predicted 690 ± 78 m). Severe impairment (<300 m) affected 26% of patients and was independently associated with obesity (OR = 10.9, 95% CI [1.79 - 66.9]), end-of-test symptoms (OR = 13.2, 95% CI [2.87 - 60.6]), and poor medication adherence (OR = 10.2, 95% CI [2.37 - 44.2]). ACE inhibitor/ARB use was protective (OR = 0.18, 95% CI [0.04 - 0.77]). **Conclusion:** Functional capacity is markedly impaired in Brazzaville HF patients, with walking distance averaging half of predicted values. Modifiable factors include obesity, medication adherence, and guideline-directed medical therapy optimization. These findings support systematic 6MWT integration and structured cardiac rehabilitation programs in resource-limited settings.

Keywords

Six-Minute Walk Test, Heart Failure, Functional Capacity, Sub-Saharan

Africa, Brazzaville

1. Introduction

Heart failure (HF) is a complex clinical syndrome defined as the inability of the heart to maintain adequate cardiac output to meet the body's metabolic and functional needs [1]. It represents a major public health concern due to its increasing frequency, high morbidity and mortality, and substantial socioeconomic impact [2] [3].

In industrialized countries, HF prevalence ranges from 0.3% to 2% in the general population and reaches 3% to 13% in individuals over 65 years of age [4]. In sub-Saharan Africa, epidemiological data are mainly hospital-based [5]. In the Republic of Congo, a 2014 hospital-based study reported a frequency of 56.2% [6]. With the ongoing epidemiological transition, hypertension has become the leading cause of HF in this region [7] [8].

HF significantly affects patients' quality of life and exercise capacity [9]. Functional capacity assessment traditionally relies on cardiopulmonary exercise testing, which requires sophisticated equipment and specialized staff. The six-minute walk test (6MWT) represents a simple, reliable, validated, inexpensive, and safe alternative [10]. This submaximal test evaluates exercise tolerance through an activity similar to daily life.

While the 6MWT is widely used in cardiovascular rehabilitation programs in developed countries [11] [12], its use remains limited in resource-constrained settings where subjective functional assessment methods predominate. Furthermore, the 6MWT could serve as a monitoring tool for HF patients.

The objective of this study was to contribute to improving HF management in Brazzaville by evaluating patients' exercise tolerance and identifying potentially modifiable factors associated with severe functional impairment.

2. Methods

2.1. Study Setting and Design

This was a cross-sectional descriptive and analytical study conducted from January 15 to March 15, 2020 (2 months) in the Department of Cardiology and Internal Medicine at Brazzaville University Hospital (CHUB), Republic of Congo. This department has a 60-meter corridor suitable for performing the 6MWT according to American Thoracic Society (ATS) guidelines [13].

2.2. Study Population

Patients with chronic HF followed on an outpatient basis who had been hospitalized at least once in the department were consecutively recruited.

Inclusion criteria: Stable chronic HF (defined as absence of worsening symptoms or need for hospitalization in the previous 3 months); at least one Doppler

echocardiography performed during the last hospitalization; written informed consent obtained.

Exclusion criteria: Decompensated HF; acute coronary syndrome within the previous month; severe uncontrolled hypertension; neurological or musculoskeletal disorders; isolated right-sided HF; refusal to participate.

2.3. 6MWT Protocol

The test was performed according to the standardized ATS protocol [13]. After 10 minutes of seated rest, baseline parameters (blood pressure, heart rate, oxygen saturation, dyspnea level using modified Borg scale) were recorded. Patients then walked for 6 minutes in a 30-meter corridor marked every 2 meters. Standardized encouragements were provided at regular intervals. SpO_2, heart rate, and symptoms were recorded at 3 minutes, 6 minutes, and 2 minutes after test completion.

The predicted distance was calculated using the Troosters equation [14]:

$$\text{Distance (m)} = 218 + (5.14 \times \text{height in cm}) - (5.32 \times \text{age}) - (1.8 \times \text{weight in kg}) + (51.31 \times \text{sex})$$

(*sex* = 1 *for male*, 0 *for female*)

Medication adherence was assessed using the Girerd questionnaire [15].

2.4. Operational Definitions

- **Preserved LVEF:** ≥50%; **mid-range:** 40% - 49%; **reduced:** <40%
- **Obesity:** BMI ≥ 30 kg/m^2
- **Sedentary lifestyle:** seated or lying position > 7 hours/day (WHO definition)
- **Good adherence:** Girerd score = 0; **moderate:** 1 - 2; **poor:** ≥3
- **Socioeconomic status** was assessed based on monthly income and occupation, according to the classification used in Congolese poverty studies [16]. High socioeconomic status was defined as high-income earners (senior executives, business owners, civil servants, liberal professions); low socioeconomic status as medium and low-income earners (workers, laborers, farmers); and no income as unemployed or without employment.

2.5. Ethical Considerations

Written informed consent was obtained from all participants. Anonymity was maintained in accordance with the principles of the Declaration of Helsinki.

2.6. Statistical Analysis

Data were analyzed using Epi Info version 3.5.1 and Microsoft Excel 2007. Quantitative variables are expressed as mean ± standard deviation with range; qualitative variables as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. Proportions were compared using Fisher's exact test (when expected frequencies < 5) or Chi-square test. Means were compared using Student's t-test.

Factors associated with walking distance < 300 m were identified through univariate logistic regression with calculation of odds ratios (OR) and their 95% confidence intervals (CI). For contingency tables with cell counts < 5, Haldane's cor-

rection (adding 0.5 to all cells) was applied to stabilize estimates. Due to the small sample size (n = 50), multivariate analysis was not performed as it would require ≥10 events per predictor variable to avoid overfitting. Statistical significance was set at two-tailed $p < 0.05$.

Sample size justification

Sample size was determined by convenience sampling during the 2-month study period. Post-hoc power analysis indicated insufficient power ($\beta < 0.80$) for multivariate modeling, limiting our analysis to univariate associations.

3. Results

3.1. Sociodemographic Characteristics

Of 65 eligible patients, 50 were included (6 refusals, 9 exclusions). The sex ratio was 1:1 with 25 women (50%). Mean age was 50 ± 12 years (range: 25 - 69 years). Twenty-two patients (44%) were aged 55 years or older. Most patients (52%) had low socioeconomic status and 52% were single.

3.2. Cardiovascular Risk Factors

Hypertension was the most common risk factor (n = 37; 74%), followed by diabetes mellitus (n = 11; 22%), obesity (n = 7; 14%) and sedentary lifestyle (n = 4; 8%) (Figure 1).

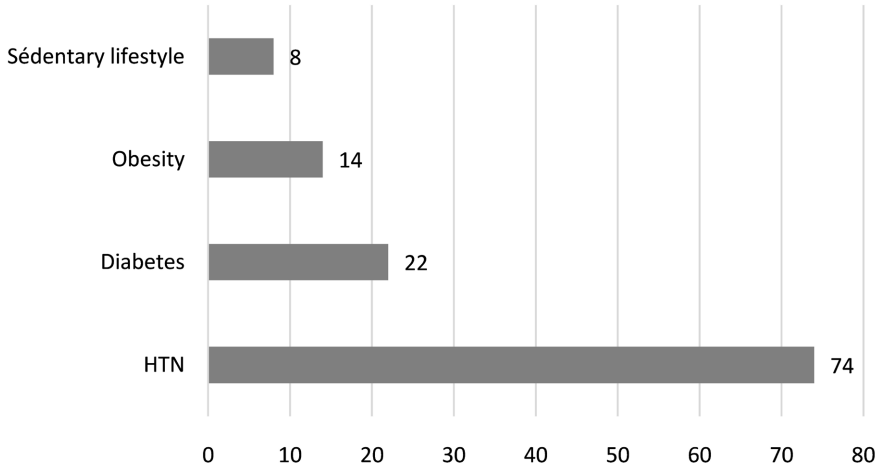

Figure 1. Distribution of cardiovascular risk factors in the study population (n = 50). HTN: hypertension.

3.3. Heart Failure Characteristics

Mean HF duration was 29 ± 42 months (range: 2 - 204 months). Left-sided HF predominated (83%). Mean LVEF was 42% ± 15% (range: 21% - 70%). It was reduced in 26 patients (52%), mid-range in 6 (12%) and preserved in 18 (36%).

Etiologies were dominated by hypertensive heart disease (n = 21; 42%), followed by dilated cardiomyopathy (n = 15; 35%), peripartum cardiomyopathy (n = 5; 10%) and ischemic heart disease (n = 4; 8%) (Table 1).

Table 1. Heart failure etiologies.

Etiology	n	%
Hypertensive heart disease	21	42
Dilated cardiomyopathy	15	35
Peripartum cardiomyopathy	5	10
Ischemic heart disease	4	8
Atrial fibrillation	3	6
Aortic regurgitation	2	4

3.4. Treatment Aspects

All patients received a low-sodium diet. ACE inhibitors/ARBs were prescribed in 46 patients (92%), diuretics in 45 (90%) and beta-blockers in 17 (34%) (**Table 2**). Medication adherence was moderate in 31 patients (62%), good in 6 (12%) and poor in 13 (26%).

Table 2. Pharmacological treatment.

Drug class	n	%
ACE inhibitors/ARBs	46	92
Diuretics	45	90
Beta-blockers	17	34
Calcium channel blockers	12	24
Digitalis	7	14
Aldosterone antagonists	6	12
Vitamin K antagonists	3	6

ACE: angiotensin-converting enzyme; ARB: angiotensin receptor blocker.

3.5. Six-Minute Walk Test Data

Physiological response during 6MWT: Heart rate increased progressively from 78 ± 11 bpm at rest to 90 ± 16 bpm at 3 minutes and 105 ± 30 bpm at 6 minutes (peak), returning to near-baseline (79 ± 15 bpm) two minutes post-test. Oxygen saturation remained stable throughout (98% ± 2% at rest, 96% ± 6% at 6 minutes), with no patient developing significant desaturation (SpO_2 < 90%).

Test interruptions and symptoms: Eight patients (16%) required premature test termination due to: fatigue (n = 5, 62.5%), dyspnea (n = 2, 25%), or chest pain (n = 1, 12.5%). Among those completing the full 6 minutes, 12 patients (24%) reported end-of-test symptoms, predominantly fatigue (n = 8, 67%) and lower limb pain (n = 2, 17%) (**Figure 2**).

Walking performance: Mean distance covered was 338 ± 91 m (range: 120 - 570 m), representing 49% ± 12% of the predicted distance of 690 ± 78 m (range: 520 - 867 m). Distance walked varied considerably, with 13 patients (26%) achieving <300 m, indicating severe exercise intolerance. 24 patients (48%) showed

"poor mobility" (<50% predicted), 12 (24%) "encouraging" (50% - 60%), 8 (16%) "good progress" (60% - 70%), and 6 (12%) "goal near" (70% - 90%). No patient achieved "good mobility" (90% - 100% predicted) (Figure 3).

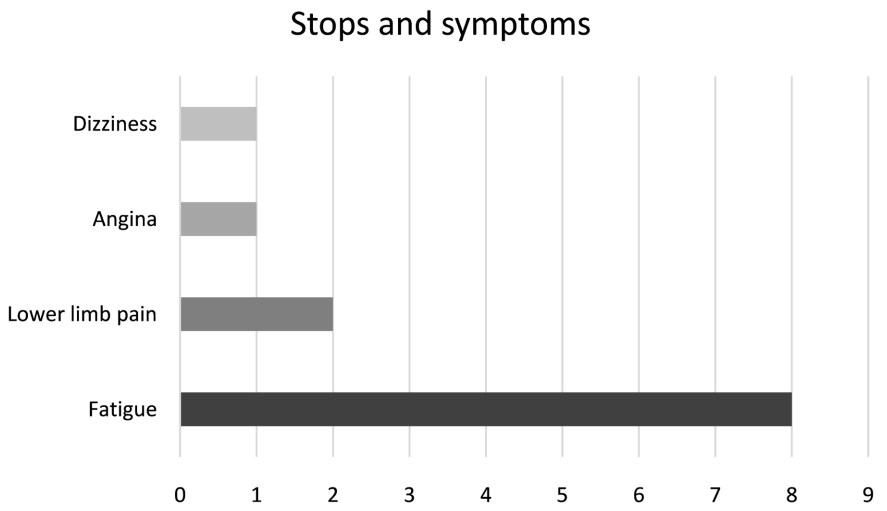

Figure 2. Distribution of symptoms at the end of the six-minute walk test (n = 12 symptomatic patients). Fatigue was the predominant symptom (67%).

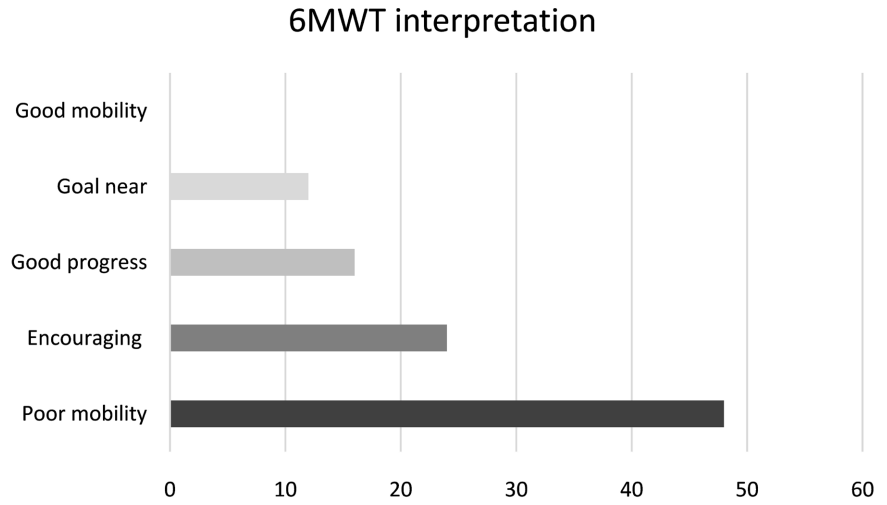

Figure 3. Interpretation of six-minute walk test results (n = 50). No patient achieved "good mobility" (90% - 100% of predicted distance).

3.6. Factors Associated with Walking Distance

Univariate analysis identified several factors significantly associated with a walking distance below 300 m (Table 3).

Table 3. Factors associated with walking distance < 300 m at 6MWT.

Factor	<300 m n (%)	≥300 m n (%)	OR [95% CI]	p
Age ≥55 years	11 (84.6)	11 (29.7)	13.0 [2.58 - 65.4]	<0.001

Continued

Obesity	5 (38.5)	2 (5.4)	10.9 [1.79 - 66.9]	0.009
Sedentary lifestyle	3 (23.1)	1 (2.7)	10.8 [0.97 - 67.8]	0.055
End-of-test symptoms	8 (61.5)	4 (10.8)	13.2 [2.87 - 60.6]	0.001
Poor adherence	8 (61.5)	5 (13.5)	10.24 [2.37 - 44.2]	0.002
ACE-I/ARB use (protective)	7 (53.8)	32 (86.5)	0.18 [0.04 - 0.77]	0.023

4. Discussion

This first systematic evaluation of functional capacity in Brazzaville HF patients reveals three key findings. First, walking distance averaged less than half of predicted values (49%), indicating profound exercise intolerance that exceeds impairment typically reported in developed countries [17] [18]. Second, severe functional limitation (distance < 300 m) affected one-quarter of patients, a proportion associated with elevated mortality risk in Western cohorts [19]. Third, impairment was strongly associated with modifiable factors—obesity, medication non-adherence, and suboptimal neurohormonal blockade—suggesting opportunities for targeted interventions.

4.1. Population Characteristics

The relatively young age of our cohort (50 ± 12 years) confirms that HF in sub-Saharan Africa occurs at a markedly earlier age than in Western countries, where mean age usually exceeds 60 years [20]. Similar observations have been reported in Congo by Ikama *et al.* [8] and by Bertrand *et al.* [5], reflecting the predominance of hypertension and cardiomyopathies as underlying etiologies. The high frequency of hypertensive heart disease (42%) aligns with the evolving epidemiological transition described by Ellenga Mbolla *et al.* [7]. Peripartum cardiomyopathy (10%), another typical African feature, remains a significant contributor [21].

4.2. Comparison with the Literature

The mean 6MWT distance in our cohort (338 ± 91 m) is nearly identical to values reported in Burkina Faso by Naibé *et al.* [22] and Mandi *et al.* [23], confirming consistently severe functional limitation in African HF populations lacking cardiac rehabilitation programs. In contrast, distances reported in countries with structured rehabilitation services are substantially higher—for example, 491 ± 91 m after rehabilitation in Brazil [17] and approximately 350 m in European outpatient HF cohorts [18]. Cahalin *et al.* in the United States reported a mean distance of 310 ± 100 m [24]. The markedly reduced performance in our setting illustrates the consequences of limited access to supervised exercise training, despite strong recommendations from international guidelines [25] [26].

The proportion of patients walking less than 300 m (26%) is clinically relevant. Distances below this threshold are consistently associated with higher mortality and morbidity in HF cohorts [19] [27]. These findings emphasize the prognostic

severity of HF in our population.

4.3. Mechanisms of Functional Impairment

The mechanisms underlying reduced walking distance in this study are consistent with established pathophysiology. Obesity and sedentary behavior negatively affect exercise performance by promoting peripheral muscle deconditioning, reduced oxidative capacity, and early onset of fatigue—mechanisms well described in chronic HF [28] [29]. Furthermore, poor medication adherence, observed in most patients, likely contributed to suboptimal hemodynamic control, fluid retention, and exertional dyspnea, echoing findings from Nesbitt *et al.* [30] and Jourdain *et al.* [31], similar pattern have been reported in other African series where medication adherence remains a major challenge, as demonstrated by the THESUS-HF study by Damasceno *et al.* [32]. The beneficial association with ACE inhibitors/ARB use supports their known effects on ventricular remodeling and afterload reduction [26] [33]. Medical treatment in our series was comparable to that reported in the literature [33] [34]. These observations are in line with the results of Forman *et al.* [35] and Ingle *et al.* [36]. Finally, the strong relationship between end-of-test symptoms and reduced distance reflects fundamental HF mechanisms, including impaired cardiac output and skeletal muscle abnormalities [37] [38].

4.4. Clinical Implications

These findings have important clinical implications. First, systematic implementation of the 6MWT may improve routine assessment of functional status in HF clinics, especially in resource-limited settings where cardiopulmonary exercise testing is unavailable. Second, the identification of modifiable factors such as obesity, sedentary lifestyle, and medication non-adherence provides actionable targets for intervention. Structured therapeutic education, promotion of physical activity, and optimized neurohormonal blockade may help improve exercise capacity, reduce hospitalizations, and enhance quality of life—benefits repeatedly demonstrated in HF rehabilitation literature [25]. Third, the magnitude of functional impairment observed underscores the urgent need to establish accessible cardiac rehabilitation programs in Congo, as recommended by international societies [26].

4.5. Study Limitations

This study presents several methodological and interpretative limitations that should be acknowledged. The small sample size (n = 50) substantially reduces statistical power and explains the wide confidence intervals observed for several associations, particularly for factors with low frequencies such as sedentary lifestyle or poor adherence. Moreover, the WHO-based threshold used to define sedentary lifestyle may underestimate the true prevalence of physical inactivity in this population. Because several contingency tables contained very small cell counts, mul-

tivariate analysis was not feasible. Given the small sample size, findings should be interpreted with caution and considered hypothesis-generating rather than confirmatory.

Some methodological aspects of the 6MWT may have influenced performance. The absence of a practice test, despite being recommended by the ATS [13], probably underestimated walking distance. In addition, the prediction equation used (Troosters) was derived from European cohorts, and its applicability to Central African populations remains uncertain.

Finally, the monocentric design in a tertiary hospital setting restricts generalizability to other regions or levels of care within the Republic of Congo or sub-Saharan Africa.

Additionally, the low beta-blocker prescription rate (34%) in our cohort, despite being a cornerstone of guideline-directed medical therapy [26], represents a significant therapeutic gap and a potential target for optimization of HF management in our setting. This underutilization may partly explain the observed functional impairment and warrants focused educational interventions for prescribers.

5. Conclusions

This first systematic assessment of functional capacity in chronic HF patients in Brazzaville reveals marked exercise intolerance, with 6MWT distance averaging only 49% of predicted values—substantially lower than typically observed in developed countries with established cardiac rehabilitation programs. One-quarter of patients demonstrated severe functional impairment (distance < 300 m), a threshold associated with elevated mortality risk in prognostic studies.

Univariate analysis identified several potentially modifiable factors associated with reduced walking distance, including obesity, poor medication adherence, and underutilization of ACE inhibitors/ARBs. However, given the small sample size (n = 50), absence of multivariate analysis to control for confounding, and wide confidence intervals for several estimates, these findings should be interpreted with caution and considered hypothesis-generating rather than confirmatory. Validation in larger, adequately powered cohorts is essential before definitive conclusions can be drawn.

Despite these limitations, our findings highlight important opportunities to improve HF management in resource-limited settings. Pragmatic interventions warrant investigation, including: (1) Structured therapeutic patient education programs emphasizing medication adherence; (2) Systematic integration of the 6MWT as a low-cost monitoring tool in routine clinical practice; (3) Weight management and physical activity counseling; and (4) Optimization of guideline-directed medical therapy, particularly neurohormonal blockade. Most critically, our results underscore the urgent need for feasibility studies and pilot implementation of adapted cardiac rehabilitation programs in sub-Saharan Africa, where such programs remain virtually non-existent despite strong evidence of benefit. Future research

should employ longitudinal designs, larger sample sizes enabling multivariate analysis, and randomized controlled trials to test whether addressing identified factors translates into meaningful improvements in functional capacity, quality of life, and clinical outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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