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Exploring the Role of Heart Rate Variability: A Study on Chronic Heart Failure Follow-Up in Two Major Hospitals in Sub-Saharan Africa

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Abstract

Introduction: Heart rate variability (HRV), defined as fluctuations in the time intervals between successive heartbeats, was generated by the sinoatrial node and modulated by the autonomic nervous system (ANS). HRV emerged as a prognostic marker in chronic heart failure (CHF), particularly for mortality risk assessment in Western countries. This study aimed to evaluate the utility of HRV measurement in the follow-up of CHF patients in a sub-Saharan African context. **Methods:** We conducted a cross-sectional, descriptive, and analytical study during six months, in the cardiology departments of the Yaoundé General Hospital (HGY) and the Yaoundé Central Hospital (HCY). Eligible participants were adults with a confirmed diagnosis of CHF based on clinical, echocardiographic and electrocardiographic criteria, who had been on treatment for at least three months and provided informed consent. Exclusion criteria included atrial disease, non-sinus rhythm (atrial fibrillation, atrial flutter), loss to follow-up, and death. Consecutive sampling was applied. HRV recordings were obtained twice at a two-month interval using a Polar H10® heart rate monitor connected via Bluetooth to the Elite HRV application installed on an iPhone 12 Pro Max. SDNN was the standard deviation of all normal-to-normal (NN) intervals, and RMSSD was Root Mean Square of Successive Differences. HF (High Frequency, 0.15 - 0.40 Hz) corresponds to respiratory sinus arrhythmia; R-R intervals were recorded at rest for 5 minutes. Treatment adherence was assessed and its relationship to HRV was explored. Data were entered using CS Pro® 7.0 and analyzed with SPSS® 23. **Results:** Thirty-one patients were included, with a median age of 64 years; women accounted for 54.8% of the sample. The most prevalent cardiovascular risk factors were dyslipidemia (38.7%) and alcohol consumption (34.6%). The leading etiologies of CHF were hypertensive cardiomyopathy and dilated cardiomyopathy, each representing 54.8% of cases. Left ventricular failure was present in 74.2%, and 61.3% had a left ventricular ejection fraction (LVEF) < 40%. The most commonly prescribed medications were ACE inhibitors (80.6%), beta-blockers (77.4%), and loop diuretics (77.4%). Non-adherence to treatment was reported in 45.2% (14/31) of participants. Patients with good adherence demonstrated significantly higher HRV indices at both time points, including SDNN [46.7 (37.3 - 54.4) ms; $p < 0.050$], RMSSD [58.6 (49.5 - 78.9) ms; $p < 0.010$], and HF power [708.2 (417.2 - 1020.0) ms^2; $p = 0.040$]. Factors associated with HRV impairment found a borderline association with BMI: overweight/obese patients tended to have higher odds of HRV impairment (OR = 1.7, 95% CI: 0.4 - 7.4, $p = 0.052$); age ≤ 60 years (OR = 0.8, 95% CI: 0.4 - 8.1, $p < 0.044$) and Beta-blocker (OR = 0.5, 95% CI: 0.1 - 2.5, $p = 0.030$) use was associated with a lower risk of HRV alteration. Treatment with good adherence showed a significant association linked to a lower risk of HRV impairment (OR = 0.2, 95% CI: 0.0 - 1.3). **Conclusion:** This study confirms the potential of HRV as a complementary tool for the follow-up of CHF patients. HRV indices, particularly regarding young age, good weight and combined with treatment adherence assessment, may provide a cost-effective, non-invasive method to improve CHF management in resource-limited settings.

Keywords

Chronic Heart Failure, Sinus Variability, Adherence, Cameroon

1. Introduction

Heart failure (HF) is defined as the heart's inability to deliver sufficient blood flow to meet the body's needs [1]. As the terminal stage of most heart diseases, HF is extremely common, affecting more than 10% of the population over 70 years of age in Western countries [2]. In France, for example, the prevalence of HF is around 1.5% - 2% of the adult population [3] [4]. HF is the major complication of CVD and a frequent cause of in-hospital death. Its prevalence continues to increase worldwide and in Africa due to the aging population [5]. A Spanish in-hospital study demonstrated a mortality rate of 25.1% and a readmission rate of 30.2% within 30 days, with an average hospital stay of 10.9 days (±8.1) in patients hospitalized for HF [6]. Similarly, Kingue *et al.* [5], in 2005, in Cameroon, found a prevalence of 30% and an overall mortality rate of 9.03% in the internal medicine department of the Yaoundé General Hospital (HGY). These results highlight the significance of HF as a health problem, particularly in our country, Cameroon. Despite therapeutic advances, the prognosis of HF remains concerning, with a mortality rate that can reach 50% within five years [7].

Heart rate variability (HRV), which refers to the variations in the time intervals between successives heart bites,, automatically produced by the sino-atrial node modulated by the autonomic nervous system (ANS) [8], has progressively established itself as a prognostic marker for chronic heart failure (CHF), particularly for assessing the risk of death in Western countries [9]-[12]. This non-invasive marker can be obtained using an electrocardiogram (ECG) or a new device called a heart rate monitor, which detects successive R waves and records each R-R interval expressed in milliseconds (RR series) [13]. In Cameroon, Boombhi *et al.* [14] conducted a study that confirmed the existing link between HRV and the prognostic follow-up of patients with CHF. This study concluded that HRV is reduced in CHF subjects regardless of the etiology compared to healthy subjects. Similarly, the alteration of HRV in CHF increases with the decline in systolic function and the New York Heart Association (NYHA) class [14] [15]. In the authors' context, the use of HRV is still infrequent. To improve current knowledge about the importance of HRV in CHF, particularly in Black individuals, it seemed relevant to conduct a study on HRV in patients with CHF in two reference hospitals in the city of Yaoundé. The objective of this study was to present the value of measuring heart rate variability in the follow-up of patients with chronic heart failure. Specifically, to describe the sociodemographic characteristics of this population, to assess heart rate variability (HRV) parameters, monitor the longitudinal changes in HRV parameters during follow-up and to identify factors associated with improvement in altered HRV parameters over the course of follow-up in patients with chronic heart failure.

2. Methods

Participants and Data Collection

This was a cross-sectional, descriptive, and analytical study conducted from December 1st, 2023, to June 30th, 2024, in the cardiology departments of the Yaoundé General Hospital (HGY) and the Yaoundé Central Hospital (HCY). Included were all patients with a confirmed diagnosis of chronic heart failure (CHF) based on clinical, echocardiographic, and electrocardiographic criteria; under treatment for at least 03 months, all of whom provided their informed consent. The exclusion criteria were as follows: atrial disease, non-sinus rhythm like atrial fibrillation, atrial flutter, loss to follow-up, and death. Sampling was consecutive.

At inclusion, sociodemographic data and medical history were collected, followed by a clinical examination for the collection of anthropometric and hemodynamic parameters.

HRV Assessment

We did an evaluation of the adherence treatment and used it to see its influence on HRV. Treatment adherence was assessed using the Morisky Medication Adherence Scale (MMAS-8), a validated self-reported questionnaire, with scores categorized as high (8), medium (6 - 7), or low (<6) adherence. Patients were consecutively received at each consultation. Previously established HRV data were assessed twice over a time interval of 02 months. The recording of heart rate variability was performed using a Polar H10® heart rate monitor coupled via Bluetooth to an Elite HRV application that had been installed on an IPHONE 12 PRO MAX smartphone. For the resting test, the recording of R-R intervals lasted 5 minutes. The patient was seated and at rest in a quiet room.

Data Management and Analysis

Data were entered using CS Pro® (Census and Survey Processing System) 7.0 software and analyzed using SPSS® (Statistical Package for the Social Sciences) 23. The analysis of RR intervals and the values of the different HRV indices were performed using KUBIOS® software version 3.3.1.

Qualitative variables were described using frequencies and percentages, and continuous variables using the median. The comparison of proportions in the bivariate analysis was performed using the Chi-square test. Factors associated with HRV alteration were investigated using crude and adjusted Odds Ratios (crude OR and adjusted OR); their 95% confidence intervals were calculated. A p-value less than 5% was considered statistically significant.

The definition of operational terms:

Chronic heart failure: Inability of the heart to deliver a cardiac output sufficient to meet the body's metabolic needs at normal filling pressures.

Heart rate variability (HRV): Fluctuation in the time intervals between consecutive impulses automatically generated by the sinoatrial node.

SDNN: The standard deviation of all normal-to-normal (NN) intervals measured on an electrocardiogram (ECG) over a given period of time. It reflects the overall heart rate variability (HRV) and represents the combined influence of both sympathetic and parasympathetic branches of the autonomic nervous system. Usually calculated over 24-hour Holter recordings, but can also be assessed over shorter recordings (e.g., 5 minutes).

Higher SDNN = greater HRV → generally indicates good autonomic regulation and cardiovascular health. Lower SDNN = reduced HRV → associated with higher risk of adverse outcomes (e.g., in chronic heart failure, post-myocardial infarction, diabetic autonomic neuropathy). An SDNN value < 100 ms in a 24-hour recording is often considered abnormal and a marker of increased cardiovascular risk.

Impairment of HRV: The impairment of cardiac autonomic control, often associated with an increased risk of cardiovascular events and reduced physiological adaptability. The indicators: SDNN (Standard Deviation of NN intervals) < 50 ms → altered variability/RMSSD (Root Mean Square of Successive Differences)/pNN50 (% of RR intervals differing by more than 50 ms).

RMSSD (Root Mean Square of Successive Differences): Square root of the mean squared differences between successive NN intervals. It reflects short-term HRV and parasympathetic (vagal) activity.

HF (High Frequency, 0.15 - 0.40 Hz): Corresponds to respiratory sinus arrhythmia. It reflects parasympathetic (vagal) activity.

Therapeutic follow-up: All measures implemented to monitor the efficacy and tolerance of a treatment.

Sinus rhythm: Heart rhythm originating from the automatic activity of the sinoatrial node, represented on the ECG by a P wave preceding each QRS complex.

Dilated cardiomyopathy: Disease of the cardiac muscle characterized by enlargement and dilation of one or both ventricles, associated with impaired left ventricular contractility (LVEF < 40%).

Hypertensive heart disease: Group of cardiac complications resulting from elevated blood pressure.

Atrial disease: Group of rhythm abnormalities generally caused by sinoatrial node dysfunction.

Sinoatrial block: Conduction block between the sinoatrial node and the atrial tissue.

Atrial flutter: Disorganized atrial electrical activity resulting in a heart rate usually above 100 bpm, with a regular rhythm.

Atrial fibrillation: Disorganized atrial electrical activity resulting in a heart rate above 100 bpm, which may be irregular or sometimes regular.

Autonomic nervous system: Subdivision of the central nervous system controlling involuntary body functions, consisting of the sympathetic and parasympathetic branches.

Sympathovagal balance: Parameter used to assess autonomic nervous system activity.

Therapeutic adherence (or compliance): The extent to which a patient's behavior corresponds to the treatment plan agreed upon with a healthcare provider.

Ethical Considerations

Research authorization was obtained from the management of the Yaoundé General Hospital and the Yaoundé Central Hospital. Ethical clearance was obtained from the Institutional Ethics Committee of the University of the Mountains (AUTHORIZATION/No: 2024/081/UdM/PR/CEAQ). Patients were included after obtaining free and informed consent. The study was conducted in accordance with the principles applicable to medical research involving human subjects as described in the Declaration of Helsinki.

3. Results

Study population Characteristics

A total of 31 participants were included in the study after excluding 21 individuals due to various reasons: 8 for atrial fibrillation, 3 for atrial flutter, 5 lost to follow-up, and the remainder for other causes.

The median age of the cohort was 64 years, with a range from 40 to 83 years. The majority of participants were female (54.8%). Among the cardiovascular risk factors assessed, dyslipidemia (38.7%) and alcoholism (34.6%) were the most prevalent. The primary etiologies of heart failure identified were hypertensive cardiopathy and dilated cardiomyopathy, both affecting 54.8% of the cohort. Left ventricular heart failure was observed in 74.2% of participants, with most patients classified in NYHA functional class II (74.2%). Furthermore, 61.3% of participants exhibited a left ventricular ejection fraction (LVEF) below 40%. Regarding pharmacological management, the most frequently prescribed medications included beta-blockers (77.4%), ACE inhibitors (80.6%), and loop diuretics (77.4%). More details are provided in **Table 1**.

Table 1. Characteristics of the study population (N = 31).

Variables	n (%)
Age range, years	
[40 - 50[	1 (3.2)
[50 - 60[	5 (16.2)
[60 - 70[	11 (35.5)
[70 - 80[	8 (25.8)
≥80	6 (19.3)
Sex	
Female	17 (54.8)
Male	14 (45.2)
Cardiovascular risk factors	
Dyslipidemia	12 (38.7)
Smoking	5 (19.2)
Alcoholism	9 (34.6)
Diabetes	6 (19.4)
Past history of myocardial infarction	4 (15.4)
Past history of stroke	7 (22.6)
BMI, Kg/m^2	
<25	23 (70.9)
[25 - 30[	3 (9.7)
≥30	6 (19.4)
Etiologies of HF	
Hypertensive cardiopathy	17 (54.8)
Dilated cardiomyopathy	17 (54.8)
Ischemic cardiopathy	4 (12.9)
Valvopathy	4 (12.9)
Chronic pulmonary heart disease	1 (3.2)
Type of HF	
Left	23 (74.2)

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Right	5 (16.1)
Global	3 (9.7)
NYHA stage	
Stage II	23 (74.2)
Stage III	5 (16.1)
Stage IV	3 (9.7)
LVEF	
<40	19 (61.3)
[40 - 50[	1 (3.2)
>50	11 (35.5)
Treatment received	
ACE inhibitors	25 (80.6)
Angiotensin receptor blockers	6 (19.4)
Beta blockers	24 (77.4)
Loop diuretics	24 (77.4)
Potassium sparing diuretics	18 (58.0)
Calcium channel blockers	14 (45.2)
Thiazide diuretics	4 (15.4)
Antiarrhythmics	8 (25.8)
Anticoagulant	11 (35.4)

HRV according to treatment adherence

Nearly half of the patients with chronic heart failure enrolled in the study, 45.2% (14/31), were non-adherent to the treatment protocols prescribed by their physicians. It is noteworthy that almost the same proportion, 48.4% (15/31), remained non-adherent to the prescribed protocols despite receiving counseling.

Table 2 compares HRV parameters between patients with good and poor treatment adherence at two time points. At the first measurement, statistically significant differences ($p < 0.05$) were observed between the good and poor adherence groups for SDNN, with the good adherence group showing a median (IQR) of 46.7 [37.8 - 53.1] ms compared to 37.7 [26.9 - 47.1] ms in the poor adherence group. RMSSD, primarily reflecting parasympathetic activity, was also significantly higher ($p < 0.001$) in the good adherence group [57.3 (48.9 - 76.5) ms] compared to the poor adherence group [44.9 (29.5 - 59.1) ms].

Similarly, at the second measurement, SDNN remained significantly higher ($p < 0.050$) in the good adherence group [46.7 (37.3 - 54.4) ms] compared to the poor adherence group [37.7 (24.0 - 46.6) ms]. RMSSD also remained significantly elevated ($p < 0.010$) in the good adherence group [58.6 (49.5 - 78.9) ms] compared

Table 2. Description of heart rate variability according to treatment adherence during the first and the second measurement.

HRV parameters	First measurement				Second measurement			
	Overall (n = 31)	Good adherence (n = 17)	Poor adherence (n = 14)	p value	Overall (n = 31)	Good adherence (n = 16)	Poor adherence (n = 15)	p value
SDNN, ms				0.043				<0.050
Median [IQR]	41.3 [35.0 - 49.0]	46.7 [37.8 - 53.1]	37.7 [26.9 - 47.1]		44.0 [35.0 - 51.9]	46.7 [37.3 - 54.4]	37.7 [24.0 - 46.6]	
Min - Max	12.4 - 170.0	15.6 - 170.0	12.4 - 76.5		12.0 - 169.0	15.6 - 170.0	12.4 - 65.4	
RMSSD, ms				<0.001				<0.010
Median [IQR]	54.0 [41.9 - 62.0]	57.3 [48.9 - 76.5]	44.9 [29.5 - 59.1]		55.0 [40.9 - 70.0]	58.6 [49.5 - 78.9]	43.8 [25.0 - 56.0]	
Min - Max	14.0 - 155.0	14.0 - 155.0	14.4 - 99.9		14.4 - 145.0	14.0 - 155.0	14.4 - 71.7	
LF, ms²				0.036				0.070
Median [IQR]	429.4 [221.0 - 570.0]	416.2 [251.8 - 542.3]	434.0 [212.4 - 607.0]		503.0 [325.2 - 650.0]	386.5 [231.3 - 524.5]	506.0 [212.9 - 637.0]	
Min - Max	38.9 - 1351.0	75.0 - 1308.0	38.9 - 1351.0		40.5 - 1203.0	38.9 - 1308.0	39.0 - 1351.0	
HF, ms²				0.952				0.040
Median [IQR]	639.0 [347.0 - 901.0]	705.5 [609.0 - 916.0]	578.0 [146.0 - 844.0]		708.2 [417.2 - 1020.0]	705.5 [597.0 - 910.0]	578.0 [167.0 - 829.0]	
Min - Max	30.0 - 1883.0	30.0 - 1883.0	42.0 - 1521.0		42.6 - 1783.0	30.0 - 1883.0	42.0 - 1521.0	
LF/HF, ms²				0.393				0.103
Median [IQR]	0.6 [0.4 - 1.6]	0.6 [0.4 - 1.0]	0.9 [0.4 - 2.0]		0.7 [0.7 - 1.4]	0.6 [0.4 - 0.8]	0.9 [0.4 - 2.1]	
Min - Max	0.1 - 5.1	0.1 - 2.5	0.2 - 5.1		0.2 - 3.0	0.1 - 2.5	0.2 - 5.1	

to the poor adherence group [43.8 (25.0 - 56.0) ms]. Additionally, high frequency (HF) power, another marker of parasympathetic activity, was significantly higher ($p = 0.040$) in the good adherence group [708.2 (417.2 - 1020.0) ms²] at the second measurement compared to the poor adherence group [578.0 (167.0 - 829.0) ms²].

Factors associated with HRV alteration

Table 3 presents the factors associated with HRV alteration between the first and second measurements. Univariate logistic regression analysis revealed a statistically significant association between age group and HRV alteration ($p < 0.044$). Specifically, patients aged ≤ 60 years had a significantly lower odds ratio (OR = 0.8, 95% CI: 0.4 - 8.1) of experiencing HRV alteration compared to those older than 60 years. Additionally, it was associated with a lower risk of HRV alteration ($p = 0.030$), with patients receiving beta-blockers having a lower odds ratio (OR = 0.5, 95% CI: 0.1 - 2.5) of HRV alteration. A borderline significant association was observed for BMI, with overweight/obese patients showing a trend towards a higher odds ratio (OR = 1.7, 95% CI: 0.4 - 7.4, $p = 0.052$) of HRV alteration. Treatment adherence also showed a significant association ($p = 0.040$), with

Table 3. Factors associated with HRV alteration between the first and the second measurement.

Variables	HRV alteration		OR (95% CI)	p value
	Yes (n = 18)	No (n = 13)		
Age groups, yrs				
≤60	4 (30.8)	8 (44.4)	0.8 (0.4 - 8.1)	<0.044
>60	9 (69.2)	10 (55.6)		
Sex				
Female	5 (38.5)	11 (61.1)	2.5 (0.6 - 10.9)	0.213
Male	8 (61.5)	7 (38.9)		
Etiologies				
Hypertensive Cardiopathy	7 (53.8)	11 (61.1)	0.7 (0.2 - 3.1)	0.686
Valvulopathies	3 (23.1)	1 (5.6)	5.1 (0.5 - 55.9)	0.151
Dilated Cardiomyopathy	5 (38.5)	12 (66.7)	0.3 (0.1 - 1.4)	0.119
Ischemic Cardiopathy	3 (23.1)	1 (5.6)	5.1 (0.5 - 55.9)	0.151
Chronic Pulmonary Heart Disease	1 (5.6)	0 (0)	NA	0.999
Cardiovascular risk factors				
Smoking	2 (15.4)	3 (16.7)	0.9 (0.1 - 6.4)	0.924
Alcoholism	4 (30.8)	5 (27.8)	1.2 (0.2 - 5.5)	0.856
Diabetes	2 (15.4)	4 (22.2)	0.6 (0.1 - 4.1)	0.634
Dyslipidemia	4 (30.8)	5 (27.8)	1.2 (0.2 - 5.5)	0.856
Myocardial Infarction	3 (23.1)	1 (5.6)	5.1 (0.5 - 55.9)	0.151
Stroke	4 (30.8)	3 (16.7)	2.2 (0.4 - 12.3)	0.354
NYHA stage				
Stage II	7 (53.8)	8 (44.4)	1.5 (0.3 - 6.1)	0.605
Stage III	4 (30.8)	2 (19.4)	3.6 (0.5 - 23.4)	0.172
Stage IV	1 (7.7)	2 (11.1)	0.7 (0.1 - 8.2)	0.751
LVEF				
<40	8 (61.6)	10 (55.6)	1.3 (0.3 - 5.5)	0.739
[40 - 50[	1 (7.7)	0 (0)		
≥50	4 (30.8)	8 (44.4)	0.6 (0.1 - 2.5)	0.440
BMI, Kg/m²				
Overweight/Obese	6 (46.2)	6 (33.3)	1.7 (0.4 - 7.4)	0.052
Normal	7 (53.8)	12 (66.7)		
Treatment received				

Continued

ACE Inhibitor	11 (84.6)	14 (77.8)	1.6 (0.2 - 10.2)	0.634
ARB	1 (7.7)	4 (22.2)	0.3 (0.0 - 3.0)	0.278
Beta Blocker	9 (69.2)	15 (83.3)	0.5 (0.1 - 2.5)	0.030
Loop Diuretic	10 (76.9)	15 (83.3)	0.7 (0.1 - 4.0)	0.656
Thiazide Diuretic	2 (15.4)	2 (11.1)	1.5 (0.2 - 12.0)	0.726
Potassium-Sparing Diuretic	7 (53.8)	11 (61.1)	0.7 (0.2 - 3.1)	0.686
Antiarrhythmic	5 (38.5)	3 (16.7)	3.1 (0.6 - 16.6)	0.171
Anticoagulants	4 (30.8)	7 (38.9)	0.7 (0.2 - 3.2)	0.641
Calcium Channel Blocker	5 (38.5)	7 (38.9)	1.0 (0.2 - 4.3)	0.981
Treatment adherence				
Good	2 (15.4)	8 (44.4)	0.2 (0.0 - 1.3)	0.040
Moderate	3 (23.1)	3 (16.7)	1.5 (0.3 - 9.0)	0.656
Poor	8 (61.5)	7 (38.9)	2.5 (0.6 - 10.9)	0.213

good adherence associated with a lower odds ratio (OR = 0.2, 95% CI: 0.0 - 1.3) of HRV alteration. Sex, various etiologies of heart failure, other cardiovascular risk factors, NYHA stage, LVEF, and other medications did not show statistically significant associations with HRV alteration in this univariate analysis.

4. Discussion

This study explored the prognostic role of heart rate variability (HRV) in the follow-up of patients with chronic heart failure (CHF) in two referral hospitals in Yaoundé, Cameroon. The results confirm the clinical interest of HRV as a non-invasive marker of autonomic nervous system function and its potential utility in monitoring treatment adherence and cardiovascular risk in African populations.

HRV and Treatment Adherence

Our study found that patients with good therapeutic adherence had significantly higher HRV indices—including SDNN, RMSSD, and HF power—at both measurement points. These findings are consistent with the physiological understanding that HRV reflects the balance between sympathetic and parasympathetic activity, and that effective heart failure treatment tends to restore this balance [16].

Several international studies have shown that increased HRV, particularly RMSSD and HF components, correlates with improved clinical status and lower mortality risk in CHF patients [17] [18]. Our findings reinforce this evidence in a sub-Saharan African context and support earlier local data from Boombhi *et al.* in Cameroon [14], who found significantly lower HRV indices in CHF patients compared to controls.

In resource-limited settings like Cameroon, where follow-up and patient retention remain a challenge, HRV could serve as an objective surrogate for treatment adherence. Its integration in outpatient follow-up strategies—using affordable tools like mobile heart rate monitors—could revolutionize chronic disease monitoring.

Determinants of HRV Alteration

Young age was significantly associated with the protection of HRV in our cohort, echoing well-documented findings in both healthy and diseased populations in opposition of advanced age [19] [20]. Autonomic dysfunction is known to progress with aging, contributing to reduced vagal tone and increased sympathetic dominance.

Unlike some studies [21], we did not find a significant association between HRV indices and either NYHA functional class or LVEF. This may reflect the relative homogeneity of our study population. Indeed, most patients had moderately reduced systolic function (LVEF < 40% in 58% of participants, ≥50% in 38%), and were predominantly in NYHA class II (49%) or class III (25%), with very few in class IV (9%). This limited variability in disease severity likely reduced the power to detect correlations between HRV and these clinical parameters. Additionally, Boombhi *et al.* in Cameroon previously showed that HRV decreases proportionally with worsening NYHA class and declining LVEF, suggesting that a larger and more diverse sample might better capture these associations [14].

Interestingly, beta-blocker use was found to be a protective factor against HRV degradation. This aligns with data from major heart failure trials like the CIBIS-II and MERIT-HF, which demonstrated not only improved survival but also favorable modulation of autonomic function with beta-blockade [22] [23]. Our study corroborates these findings in a local population, highlighting the importance of sustained pharmacological adherence, especially to evidence-based drugs such as beta-blockers.

The borderline association observed between BMI and HRV alteration suggests that excess body weight may contribute to autonomic imbalance, a hypothesis supported by international research linking obesity to decreased parasympathetic activity [24] [25]. However, the modest sample size of our study may have limited the power to detect statistically significant associations.

Clinical and Public Health Implications

The integration of HRV assessment into CHF management in low-resource settings is both feasible and potentially transformative. The use of digital tools like the Polar H10® monitor, coupled with mobile applications, allowed our team to perform accurate and reproducible HRV measurements at low cost. This approach aligns with global initiatives promoting digital health in sub-Saharan Africa [26].

In Cameroon, where CHF prevalence remains high and access to biomarkers like NT-proBNP is limited, HRV could serve as a practical and scalable tool for early risk stratification and patient engagement. Such strategies are critical in a region where cardiovascular disease is projected to become the leading cause of mortality by 2030 [27].

Study Limitations

This study has limitations. The small sample size may have reduced the statistical power to detect associations between HRV and certain clinical variables. The follow-up period of two months limits insights into long-term prognostic outcomes. Moreover, treatment adherence was assessed through self-reporting, which is subject to bias. Finally, the absence of a healthy control group hinders direct comparison of HRV values with those of non-CHF individuals.

5. Conclusion

This study confirms that HRV, particularly time-domain indices such as SDNN and RMSSD, can serve as valuable non-invasive indicators of treatment adherence and autonomic function in CHF patients. Age and beta-blocker therapy were independently associated with HRV preservation, while good treatment adherence was consistently linked to better autonomic outcomes. In the Cameroonian context, the use of HRV could complement conventional follow-up and provide a cost-effective solution to improve CHF management. Larger, multicentric, and longitudinal studies are now warranted to validate these findings and inform national guidelines.

Conflicts of Interest

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

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