Scientific Research Publishing

Open Journal of Rheumatology and Autoimmune Diseases, 2026, 16(4), 123-142
https://www.scirp.org/journal/ojra
ISSN Online: 2164-005X
ISSN Print: 2163-9914

Clinical Manifestations and Electrocardiographic and Echocardiographic Abnormalities in Patients with Systemic Lupus Erythematosus in Pointe-Noire, Republic of the Congo

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How to cite this paper: Boumba Makaya, C.R., Lamini N'soundhat, N.E., Loubano-Voumbi, G., Ossendza Goma, T., Nkouala-Kidede, D.C., Angalla, A.R.L. and Bileckot, R. (2026) Clinical Manifestations and Electrocardiographic and Echocardiographic Abnormalities in Patients with Systemic Lupus Erythematosus in Pointe-Noire, Republic of the Congo. *Open Journal of Rheumatology and Autoimmune Diseases*, **16**, 123-142.
https://doi.org/10.4236/ojra.2026.164015

Received: September 14, 2026
Accepted: November 20, 2026
Published: November 23, 2026

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Abstract

Introduction: Systemic lupus erythematosus (SLE) is a chronic autoimmune disease that may be accompanied by various cardiovascular manifestations, sometimes asymptomatic. Data on electrocardiographic and echocardiographic abnormalities in lupus patients remain limited in Central Africa. The objective of this study was to describe the cardiothoracic manifestations as well as the documented electrocardiographic and echocardiographic abnormalities in patients with SLE in Pointe-Noire, Republic of the Congo. Patients and Methods: This was a descriptive and analytical cross-sectional study with retrospective data collection, conducted at Loandjili General Hospital between September 2025 and April 2026. It included 41 patients with SLE meeting the SLICC classification criteria. Clinical characteristics, electrocardiographic findings, and available echocardiographic data were analyzed. Lupus activity was assessed using the SLEDAI score. Factors associated with documented instrumental abnormalities were explored using Firth's penalized logistic regression. Results: The mean age of patients was 33.0 ± 11.2 years, with a female predominance of 90.2%. Cardiothoracic manifestations were reported in 16 patients (39.0%). Electrocardiographic abnormalities were found in 6 patients (14.6%), mainly sinus tachycardia. Echocardiography was performed in 17 patients (41.5%), of whom 9 (52.9%) had abnormalities described in the records as pericardial (n = 7) or myocardial (n = 2) involvement. In total, 11 patients

(26.8%) had at least one documented electrocardiographic and/or echocardiographic abnormality. The SLEDAI score was significantly associated with the presence of instrumental abnormalities in the exploratory model adjusted for age and sex (adjusted OR = 3.92 per point; 95% CI: 1.87 - 81.35; $p < 0.001$). Echocardiography was not performed in 24 patients (58.5%), limiting the assessment of abnormalities in the entire cohort. Conclusion: Electrocardiographic and echocardiographic abnormalities were documented in a notable proportion of patients with SLE in Pointe-Noire, with a statistical association between their presence and lupus activity. However, incomplete performance of echocardiographies, the small number of events, and potential selection and classification biases limit the scope of these results. Prospective multicenter studies based on standardized cardiovascular assessment are needed to better characterize these involvements.

Keywords

Systemic Lupus Erythematosus, Cardiovascular Manifestations, Electrocardiography, Echocardiography, Lupus Activity, Congo

1. Introduction

Systemic lupus erythematosus (SLE) is a chronic autoimmune disease characterized by substantial clinical and immunological heterogeneity and can affect virtually any organ. Its course is marked by periods of activity and remission that may lead to progressive damage accrual and substantial morbidity. Recent international recommendations therefore emphasize the need for regular assessment of disease activity, visceral involvement, and factors likely to influence prognosis [1] [2].

Among the visceral manifestations of SLE, cardiovascular involvement is particularly important because of its diversity and prognostic implications. It may affect the pericardium, myocardium, endocardium and cardiac valves, coronary arteries, and the conduction system [3]-[5]. These complications are compounded by an increased long-term cardiovascular risk resulting from the interplay among conventional risk factors, chronic inflammation, autoimmune mechanisms, and SLE treatments [5] [6].

The clinical expression of these manifestations, however, is variable. Patients may present with chest pain, dyspnea, palpitations, or other cardiothoracic manifestations, whereas some cardiovascular abnormalities may remain paucisymptomatic or subclinical [3] [7]. Clinical assessment should therefore be supplemented, depending on the context, by cardiovascular investigations. Electrocardiography can be used in particular to detect rhythm, conduction, and repolarization abnormalities, while echocardiography is an important noninvasive method for assessing pericardial, myocardial, valvular, and hemodynamic involvement [7] [8]. A recent review also highlights the role of echocardiography in detecting and monitoring cardiovascular involvement in SLE [8].

Contemporary data confirm that cardiovascular morbidity remains substantial in SLE [5] [6] [9]. However, the relationship between disease activity and cardiovascular manifestations is complex and cannot be assessed on the basis of a single marker. Assessment of disease activity should rely on a comprehensive approach incorporating clinical and laboratory manifestations and, when indicated, validated scores such as the SLEDAI [1]. In this context, anti-double-stranded DNA antibodies are an important immunological component of SLE, but their interpretation must remain integrated within the overall clinical picture.

African data on the cardiovascular manifestations of SLE remain less extensive than those from other regions. However, a recent study conducted at Yaoundé Central Hospital in Cameroon provides particularly relevant insights for Central Africa. Among 55 patients with SLE, electrocardiographic and echocardiographic abnormalities were observed in 29.1% and 43.6% of patients, respectively, whereas only 18.2% had cardiac symptoms. Pericardial effusion was found in 25.5% of patients, highlighting the possibility of minimally symptomatic or asymptomatic cardiac involvement [10]. Studies conducted in South Africa have also demonstrated the value of cardiovascular imaging in characterizing subclinical involvement in patients with lupus [11].

These observations underscore the importance of characterizing the cardiovascular manifestations of SLE in sub-Saharan African populations. In the Republic of the Congo, particularly in Pointe-Noire, data jointly describing the clinical cardiothoracic manifestations and electrocardiographic and echocardiographic abnormalities associated with SLE remain insufficiently documented**.** The generation of local data could help better define their profile and improve their detection during rheumatologic follow-up.

The present study therefore aimed to describe the clinical, electrocardiographic, and echocardiographic profile of cardiothoracic manifestations in patients with systemic lupus erythematosus followed at Loandjili General Hospital in Pointe-Noire, Republic of the Congo.

2. Materials and Methods

2.1. Type, Period, and Setting of the Study

This was a descriptive and analytical cross-sectional study with retrospective data collection, conducted at Loandjili General Hospital in Pointe-Noire, Republic of the Congo, over the period from September 2025 to April 2026.

2.2. Study Population

The study included patients followed for systemic lupus erythematosus (SLE) during the study period who had usable clinical data and available electrocardiographic and/or echocardiographic findings. After verification and cleaning of the database, 41 patients were retained for analysis. The diagnosis of SLE was based on the Systemic Lupus International Collaborating Clinics (SLICC) criteria. All analyzed patients were positive for anti-double-stranded DNA (anti-dsDNA) an-

tibodies. Because this positivity was constant in the study population, it was considered a cohort characteristic rather than an explanatory variable.

Electrocardiographic and echocardiographic findings were analyzed according to the availability of each examination. Examinations that had not been performed were treated as missing data and were not classified as normal findings. For each investigation, the frequency of abnormalities was calculated using the number of patients who had actually undergone the corresponding examination as the denominator.

2.3. Variables Studied

The variables collected included age, sex, occupation, duration of SLE, SLEDAI score, treatments received, and available cardiovascular risk factors, including arterial hypertension (HTN).

The cardiovascular assessment comprised three components:

- the clinical evaluation of cardiothoracic manifestations, mainly dyspnea, chest pain, and palpitations;
- the electrocardiogram (ECG), enabling, in particular, the identification of sinus tachycardia and low voltage;
- transthoracic echocardiography, assessing the cardiac abnormalities documented in the records, particularly pericardial and myocardial involvement.

2.4. Definition of Cardiovascular Variables

The presence of at least one of chest pain, dyspnea, or palpitations defined a patient as symptomatic. The absence of these manifestations defined the patient as asymptomatic.

The ECG was considered abnormal when at least one electrical abnormality was documented. Electrocardiographic findings, including sinus tachycardia and low QRS voltage, were classified as nonspecific electrical abnormalities and were not considered, in isolation, definitive evidence of cardiac involvement attributable to systemic lupus erythematosus.

Echocardiography was considered abnormal when a cardiac morphological or functional abnormality was reported. Pericardial and myocardial findings were described according to the information available in the medical records. Pericardial effusion was distinguished from clinically diagnosed pericarditis, while echocardiographic findings suggestive of myocardial involvement were distinguished from confirmed myocarditis. In the absence of sufficient documented diagnostic criteria, these findings were not regarded as definitive diagnoses.

A composite variable, termed "instrumental abnormality," was defined by the presence of at least one documented ECG and/or echocardiographic abnormality. This composite outcome reflected abnormalities detected by cardiovascular investigations rather than confirmed cardiovascular disease directly attributable to lupus.

Subclinical cardiovascular involvement was defined as the presence of an ECG and/or echocardiographic abnormality in a patient with none of the specified cardiothoracic manifestations. Given the nonspecific nature of some instrumental

findings, this definition was used descriptively and did not imply confirmed subclinical cardiac disease.

2.5. Assessment of SLE Activity

Disease activity was assessed using the Systemic Lupus Erythematosus Disease Activity Index (SLEDAI) available in the records. The SLEDAI score was analyzed quantitatively to assess its association with the presence of instrumental cardiovascular abnormalities.

2.6. Statistical Analysis

Statistical analyses were performed using R software, version 4.5.3. Qualitative variables were described as counts and percentages. The normality of quantitative variables was assessed using the Shapiro-Wilk test. Normally distributed variables were presented as the mean ± standard deviation, whereas non-normally distributed variables were expressed as the median and interquartile range [Q1 - Q3]. Associations between cardiothoracic manifestations and ECG and/or echocardiographic abnormalities were examined using Fisher's exact test, given the small sample size and some low expected frequencies. Quantitative variables were compared between patients with and without instrumental abnormalities using the Wilcoxon-Mann-Whitney test when their distribution did not permit the use of a parametric test.

Given the small study sample (N = 41), the limited number of patients with an instrumental abnormality (n = 11), and the presence of data separation or quasi-separation, factors associated with the presence of an ECG and/or echocardiographic abnormality were investigated using Firth's penalized logistic regression. Univariate analyses included age, sex, hypertension, duration of SLE, and SLEDAI score. Parsimonious adjusted models were then constructed to identify independent associations while limiting the risk of overfitting due to the small number of events. Associations were expressed as odds ratios (ORs) or adjusted odds ratios (aORs) with their 95% confidence intervals (95% CIs). The threshold for statistical significance was set at $p < 0.05$.

2.7. Ethical Considerations

The study was conducted in accordance with the ethical principles applicable to research involving health data. The information collected was processed confidentially and anonymized. The protocol was approved by the Institutional Ethics Committee of the National Institute of Biology and Health Surveillance under number INBVS-CE/2026-P008, as indicated in the manuscript.

3. Results

3.1. General Sociodemographic and Clinical Characteristics of the Population

The study included 41 patients, with a mean age of 33.0 ± 11.2 years (range: 16 - 58 years). A marked female predominance was observed, with 37 women (90.2%)

and 4 men (9.8%), corresponding to a male-to-female sex ratio of 0.11. Homemakers (36.6%) and students or school pupils (34.1%) were the most represented socioprofessional categories. The median duration of SLE was 12 months [7 - 24], with a range of 4 to 132 months. The median SLEDAI score was 0 [0 - 4], and 25 patients (61.0%) had a score of zero. Hypertension was found in 13 patients (31.7%) (Table 1).

Table 1. General sociodemographic and clinical characteristics of patients with systemic lupus erythematosus (N = 41).

Characteristics	n	Results
Age (years)		
Mean ± SD	41	33.0 ± 11.2
Extremes	41	16 - 58
Sex		
Feminine	37	90.2%
Masculine	4	9.8%
M/F sex ratio	—	0.11
Profession		
Housewife	15	36.6%
Student/pupil	14	34.1%
Secretary	6	14.6%
Nurse	3	7.3%
Teacher	1	2.4%
Worker	1	2.4%
Saleswoman	1	2.4%
Duration of SLE progression (months)		
Median [Q1 - Q3]	41	12 [7 - 24]
Extremes	41	4 - 132
SLEDAI score		
Median [Q1 - Q3]	41	0 [0 - 4]
SLEDAI = 0	25	61.0%
SLEDAI = 3	5	12.2%
SLEDAI = 4	10	24.4%
SLEDAI = 5	1	2.4%
Cardiovascular risk factors		
HTA	13	31.7%
No factor reported	28	68.3%

SD: standard deviation; Q1 - Q3: first and third quartiles; SLE: systemic lupus erythematosus; SLEDAI: Systemic Lupus Erythematosus Disease Activity Index; hypertension: arterial hypertension.

3.2. Cardiothoracic Manifestations and Electrocardiographic and Echocardiographic Abnormalities

Cardiothoracic manifestations were reported in 16 patients (39.0%), whereas 25 (61.0%) were asymptomatic. Dyspnea was the most frequent manifestation (19.5%), followed by chest pain (14.6%) and palpitations (4.9%). The ECG was abnormal in 6 patients (14.6%), mainly in the form of sinus tachycardia (5 cases; 12.2%), while low voltage was observed in one patient (2.4%). Echocardiography revealed an abnormality in 9 patients (22.0%), including 7 cases of pericarditis (17.1%) and 2 cases of myocarditis (4.9%). Overall, 11 patients (26.8%) had at least one abnormality on ECG and/or echocardiography (Table 2).

Table 2. Cardiothoracic manifestations and electrocardiographic and echocardiographic findings in patients with systemic lupus erythematosus (N = 41).

Parameters	Number (n)	Percentage (%)
Cardiothoracic manifestations		
Absence of manifestations	25	61.0
Presence of at least one manifestation	16	39.0
└Dyspnea	8	19.5
└Chest pain	6	14.6
└Palpitations	2	4.9
Electrocardiogram (N = 41)		
Normal ECG	35	85.4
Abnormal ECG	6	14.6
└Sinus tachycardia	5	12.2
└Low QRS voltage	1	2.4
Performance of echocardiography (N = 41)		
Echocardiography performed	17	41.5
Echocardiography not performed	24	58.5
Echocardiographic findings (n = 17)		
Normal echocardiography	8	47.1
Abnormal echocardiography	9	52.9
└Abnormalities reported as pericarditis	7	41.2
└Abnormalities reported as myocarditis	2	11.8
Combined instrumental assessment (N = 41)		
No documented ECG and/or echocardiographic abnormality	30	73.2
At least one documented ECG and/or echocardiographic abnormality	11	26.8

Note: Percentages for cardiothoracic manifestations, ECG abnormalities, performance of echocardiography, and combined assessment were calculated based on the total number of patients (N = 41). Percentages for echocardiographic findings were calculated only among patients who underwent this examination (n = 17).

3.3. Respective Contributions of ECG and Echocardiography According to the Presence of Cardiothoracic Manifestations

Electrocardiographic abnormalities were observed in five of the 16 symptomatic patients (31.3%) compared with one of the 25 asymptomatic patients (4.0%), with a statistically significant difference ($p = 0.026$). Echocardiography was performed in 17 patients (41.5%), including 14 symptomatic and three asymptomatic patients. Among those examined, echocardiographic abnormalities were detected in nine symptomatic patients (64.3%) and none of the asymptomatic patients. However, this difference was not statistically significant ($p = 0.082$). Echocardiography was not performed in 24 patients, including 22 asymptomatic and two symptomatic patients. When both examinations were considered jointly, at least one documented electrocardiographic and/or echocardiographic abnormality was identified in 10 of the 16 symptomatic patients (62.5%) compared with one of the 25 asymptomatic patients (4.0%; $p < 0.001$). Among the 17 patients who underwent echocardiography, concomitant electrocardiographic and echocardiographic abnormalities were documented in four patients. The association between the two types of instrumental abnormalities was not statistically significant (conditional OR = 5.06; 95% CI: 0.35 - 313.62; Fisher's exact test, $p = 0.294$) (Table 3).

Table 3. Association between cardiothoracic manifestations and electrocardiographic and echocardiographic abnormalities in patients with systemic lupus erythematosus (N = 41).

Examination/findings	Asymptomatic (n = 25), n (%)	Symptomatic (n = 16), n (%)	p-value
Electrocardiography (ECG)			0.026
Normal ECG	24 (96.0)	11 (68.8)	
Abnormal ECG	1 (4.0)	5 (31.3)	
Echocardiography			0.082
Not performed	22 (88.0)	2 (12.5)	
Normal echocardiography	3 (12.0)	5 (31.3)	
Abnormal echocardiography	0 (0.0)	9 (56.3)	
ECG and/or echocardiography			<0.001
No documented abnormality	24 (96.0)	6 (37.5)	
At least one documented abnormality	1 (4.0)	10 (62.5)	

Table note: Values are expressed as n (%), with percentages calculated within each clinical group. Fisher's exact test was used for comparisons. The echocardiographic comparison was restricted to the 17 patients who underwent echocardiography (three asymptomatic and 14 symptomatic patients; $p = 0.082$). The ECG and combined ECG/echocardiography comparisons included all 41 patients. The absence of a documented abnormality does not necessarily indicate normal echocardiographic findings, as echocardiography was not performed in 24 patients. ECG = electrocardiography; SLE = systemic lupus erythematosus.

3.4. Association between Electrocardiographic and Echocardiographic Abnormalities

Of the 41 patients included in the study, 17 (41.5%) underwent echocardiography,

while 24 (58.5%) did not undergo this examination. Among the 17 patients evaluated by echocardiography, nine (52.9%) had echocardiographic abnormalities, including seven cases of pericarditis and two cases of myocarditis. Electrocardiographic abnormalities were documented in five of these 17 patients (29.4%), and four patients (23.5%) presented both electrocardiographic and echocardiographic abnormalities.

Among patients with echocardiographic abnormalities, four of nine (44.4%) also had electrocardiographic abnormalities, compared with one of eight patients (12.5%) with normal echocardiographic findings (Table 4).

Table 4. Association between electrocardiographic and echocardiographic abnormalities among patients who underwent echocardiography (n = 17).

ECG findings	Abnormal echocardiography (n = 9)	Normal echocardiography (n = 8)	Total (n = 17)
Abnormal ECG	4 (44.4%)	1 (12.5%)	5 (29.4%)
Normal ECG	5 (55.6%)	7 (87.5%)	12 (70.6%)
Total	9 (100%)	8 (100%)	17 (100%)

Table note: Percentages in the echocardiography columns were calculated within each column; percentages in the total column were calculated among the 17 patients who underwent echocardiography. ECG = electrocardiography. The 24 patients who did not undergo echocardiography were excluded from this analysis.

Fisher's exact test showed no statistically significant association between electrocardiographic and echocardiographic abnormalities (conditional OR = 5.06; 95% CI: 0.35 - 313.62; p = 0.294).

3.5. Factors Associated with Electrocardiographic and/or Echocardiographic Abnormalities: Univariate Analysis

Patients with instrumental abnormalities were significantly younger, with a median age of 24.0 years [22.5 - 28.5], compared with 34.5 years [26.0 - 42.0] among those without abnormalities (p = 0.042). Lupus activity was also strongly associated with instrumental abnormalities. The median SLEDAI score was 4 [4 - 4] in patients with abnormalities, compared with 0 [0 - 0] in those without abnormalities (p < 0.001). The four men in the cohort belonged to the group with ECG and/or echocardiographic abnormalities (p = 0.003). Similarly, hypertension was observed in 8/11 patients (72.7%) with abnormalities, compared with 5/30 (16.7%) among those without abnormalities (p = 0.001). In contrast, the duration of SLE did not differ significantly between the two groups (p = 0.433) (Table 5).

3.6. Factors Associated with Electrocardiographic and/or Echocardiographic Abnormalities: Firth's Penalized Logistic Regression

Firth's penalized logistic regression was used to investigate factors associated with

Table 5. Factors associated with the presence of electrocardiographic and/or echocardiographic abnormalities in patients with SLE.

Factors	No documented ECG/echo abnormality (n = 30)	With documented ECG and/or echo abnormalities (n = 11)	p-value
Age (years), median [Q1 - Q3]	34.5 [26.0 - 42.0]	24.0 [22.5 - 28.5]	0.042
SLE duration (months), median [Q1 - Q3]	12 [7 - 45]	12 [7.5 - 18]	0.433
SLEDAI, median [Q1 - Q3]	0 [0 - 0]	4 [4 - 4]	<0.001
Male sex, n (%)	0 (0.0)	4 (36.4)	0.003
Hypertension, n (%)	5 (16.7)	8 (72.7)	0.001
Treatment regimen, n (%)			—
Corticosteroids + antimalarials	28 (93.3)	11 (100.0)	—
Antimalarials alone	1 (3.3)	0 (0.0)	—
Corticosteroids + antimalarials + immunosuppressants	1 (3.3)	0 (0.0)	—

Table note: Percentages were calculated within each cardiovascular outcome group. ECG = electrocardiography; echo = echocardiography; SLEDAI = Systemic Lupus Erythematosus Disease Activity Index. No statistical comparison was performed across treatment categories because two categories included only one patient each. The absence of documented ECG and/or echocardiographic abnormalities should not be interpreted as evidence of normal cardiac findings, as echocardiography was not performed in all patients.

documented electrocardiographic and/or echocardiographic abnormalities among the 41 patients, of whom 11 presented at least one instrumental abnormality.

In the unadjusted analyses, age was inversely associated with instrumental abnormalities (OR = 0.93; 95% CI: 0.85 - 0.99; p = 0.034), whereas hypertension (OR = 11.26; 95% CI: 2.59 - 60.39; p = 0.001) and male sex (OR = 36.60; 95% CI: 3.35 - 5063.90; p = 0.002) were positively associated. Disease duration was not significantly associated with instrumental abnormalities (OR = 0.98 per month; 95% CI: 0.92 - 1.00; p = 0.120).

SLEDAI score was also associated with instrumental abnormalities in the unadjusted Firth model (OR = 17.06 per point; 95% CI: 2.31 - 356.28; p < 0.001).

After adjustment for age and sex, the association between SLEDAI and instrumental abnormalities remained statistically significant (adjusted OR = 3.92 per point; 95% CI: 1.87 - 81.35; p < 0.001). In this model, neither age (adjusted OR = 0.95; 95% CI: 0.81 - 1.04; p = 0.284) nor male sex (adjusted OR = 1.31; 95% CI: 0.04 - 217.64; p = 0.878) was significantly associated with the outcome.

In the previously specified model adjusting SLEDAI for hypertension, SLEDAI remained significantly associated with instrumental abnormalities (adjusted OR = 5.02 per point; 95% CI: 1.97 - 3278.00; p < 0.001), whereas hypertension was no longer statistically significant (adjusted OR = 6.56; 95% CI: 0.60 - 145.70; p =

0.121).

An exploratory analysis treating SLEDAI as a categorical variable was performed to examine the assumption of a linear association. However, the uneven distribution of SLEDAI scores and the small number of patients in certain categories, particularly the single patient with a score of 5, prevented a reliable assessment of linearity. Accordingly, the odds ratios expressed per one-point increase in SLEDAI should be interpreted cautiously.

In an exploratory sensitivity analysis excluding isolated pericarditis findings from the composite cardiovascular outcome, six patients retained instrumental abnormalities. After adjustment for age and sex, the association with SLEDAI persisted (adjusted OR = 2.63 per point; 95% CI: 1.35 - 20.95; p = 0.002). Nevertheless, the small number of events and the wide confidence intervals indicate substantial uncertainty in the magnitude of this association.

Overall, these findings should be considered exploratory, given the limited sample size, sparse outcome events, and potential overlap between cardiovascular manifestations contributing to SLEDAI and those included in the composite cardiovascular outcome (Table 6).

Table 6. Firth's penalized logistic regression of factors associated with electrocardiographic and/or echocardiographic abnormalities.

Factor	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Main analysis: ECG and/or echocardiographic abnormalities (11/41)				
Age, per year	0.93 (0.85 - 0.99)	0.034	0.95 (0.81 - 1.04)	0.284
Male sex	36.60 (3.35 - 5063.90)	0.002	1.31 (0.04 - 217.64)	0.878
Hypertension	11.26 (2.59 - 60.39)	0.001	6.56 (0.60 - 145.70)	0.121
SLEDAI, per point	17.06 (2.31 - 356.28)	<0.001	3.92 (1.87 - 81.35)	<0.001
Duration of SLE, per month	0.98 (0.92 - 1.00)	0.120	—	—
Sensitivity analysis: Excluding isolated pericarditis (6/41)				
SLEDAI, per point	—	—	2.63 (1.35 - 20.95)	0.002

Notes: OR: odds ratio; CI: confidence interval; SLEDAI: Systemic Lupus Erythematosus Disease Activity Index; ECG: electrocardiography. Crude estimates were obtained from separate univariable Firth penalized logistic regression models. Adjusted estimates for age, male sex, and SLEDAI were obtained from a model including these three variables. The adjusted hypertension estimate was obtained from a separate model including hypertension and SLEDAI.

4. Discussion

In our study of 41 patients with systemic lupus erythematosus (SLE), cardiothoracic manifestations were observed in 39.0% of patients, while 14.6% had electrocardiographic abnormalities. Echocardiography, performed in 17 patients (41.5% of the cohort), revealed abnormalities in nine of them, *i.e.*, 52.9% of the patients examined. In total, 11 patients (26.8%) had at least one documented electrocardiographic and/or echocardiographic abnormality. However, this proportion does not constitute an exhaustive estimate of the prevalence of cardiovascular involvement, since echocardiography had not been performed in more than half of the

patients. These results are consistent with the context of increased cardiovascular morbidity in SLE, as highlighted by the multicenter work of Bolla *et al.* [12] and by the meta-analysis by Bello *et al.* [13]. The latter notably reported a relative risk of cardiovascular events of 2.24 in lupus patients compared with subjects without SLE. However, the cardiovascular events studied in this meta-analysis differed from the instrumental abnormalities retained in our work.

Our population was young, with a mean age of 33.0 ± 11.2 years, and showed a strong female predominance (90.2%). This profile is consistent with that usually described in SLE. In the international study by Bolla *et al.*, involving 3,401 patients from 24 countries, women represented 89.7% of the population, with a median age of 43 years [12]. The female predominance of our cohort was therefore comparable to that of this large international population, although our patients were overall younger. McMahon *et al.* recall that the cardiovascular complications of SLE result from the interaction between systemic inflammation, immunological mechanisms, and traditional cardiovascular risk factors [14]. Furthermore, Katayama *et al.*, in an overview of systematic reviews, identified several factors associated with cardiovascular disease in SLE, including disease activity, disease duration, renal involvement, and certain therapeutic exposures [15]. These observations emphasize that the young age of patients should not lead to underestimation of the need for appropriate cardiovascular evaluation.

Cardiothoracic manifestations concerned 16 patients (39.0%), mainly in the form of dyspnea, chest pain, and palpitations. Documented instrumental abnormalities were significantly more frequent in symptomatic patients than in asymptomatic patients, 62.5% and 4.0% respectively ($p < 0.001$). This difference highlights the value of history-taking and clinical examination in guiding cardiovascular investigations. However, the performance of echocardiographies was strongly linked to the presence of symptoms: 14 of the 16 symptomatic patients had undergone this examination, compared with only three of the 25 asymptomatic patients. This selection may have contributed to the high frequency of abnormalities observed in the symptomatic group and to their low detection in the asymptomatic group. It is therefore not possible to conclude, from these data, that subclinical cardiovascular abnormalities were rare in our population.

Electrocardiographic abnormalities were found in six patients (14.6%), mainly in the form of sinus tachycardia, while low voltage was observed in one patient. These abnormalities are nonspecific and may be influenced by several factors, including inflammatory status, hemodynamic disturbances, or associated comorbidities. Wu *et al.*, in a study of 317 patients with SLE, reported an association between lupus activity assessed by SLEDAI-2K and certain electrocardiographic abnormalities, notably ST-segment and T-wave changes [16]. As the abnormalities observed in our study were mainly sinus tachycardias, our results cannot be directly equated with those of Wu *et al.* They nevertheless confirm the value of ECG as a simple and accessible examination allowing certain electrical abnormalities to be documented during the follow-up of lupus patients.

Echocardiography revealed abnormalities in nine of the 17 patients examined (52.9%). Seven observations were recorded as pericarditis and two as myocarditis. These designations must be interpreted with caution, because the retrospective information available did not allow systematic confirmation of the diagnostic criteria for these conditions. In particular, the presence of a pericardial effusion is not sufficient, in itself, to establish the clinical diagnosis of pericarditis, while an echocardiographic abnormality suggestive of myocardial involvement does not necessarily confirm myocarditis.

Aguilar-Molina *et al.*, in a retrospective study conducted within a tertiary referral center, highlighted the value of echocardiography in characterizing cardiac abnormalities in patients with SLE [17]. Advanced echocardiographic techniques also make it possible to identify functional changes that may not be detected by conventional parameters. In a meta-analysis of nine studies, Di Minno *et al.* reported impaired myocardial deformation parameters in lupus patients compared with controls, involving both the left and right ventricles [18]. Kadoglou *et al.*, in a study including 102 patients with SLE and 51 controls, also observed alterations in advanced myocardial deformation parameters and in certain cardiac biomarkers in lupus patients without known cardiac involvement [19].

These observations suggest that conventional echocardiography may not identify all early myocardial abnormalities. Akiash *et al.* studied the value of three-dimensional echocardiography with myocardial deformation analysis in the assessment of ventricular function in SLE [20]. More recently, Gürsoy *et al.* showed, in 43 lupus patients compared with 40 controls, alterations in myocardial deformation, particularly in the endocardial layers of the left ventricle, with an association between certain parameters and disease activity [21]. These results are not, however, directly comparable to ours, because our study did not include systematic measurement of myocardial strain. They nevertheless highlight the potential value of more in-depth echocardiographic investigations in future prospective studies.

Analysis of the relationship between electrocardiographic and echocardiographic abnormalities showed that four patients had concomitant abnormalities on both examinations, while five patients had an abnormal echocardiography despite a normal ECG. The association between electrocardiographic and echocardiographic abnormalities was not statistically significant (conditional OR = 5.06; 95% CI: 0.35 - 313.62; p = 0.294). The width of the confidence interval reflects substantial imprecision related to the small number of patients examined. These observations suggest that the two examinations may provide complementary information, without demonstrating a systematic association between their abnormalities. Piscione *et al.* emphasize the value of a multimodal imaging approach, combining echocardiography, cardiac magnetic resonance imaging, and other techniques according to clinical indications, in order to better characterize the different forms of cardiovascular involvement in SLE [22]. Thus, a normal ECG does not necessarily exclude an echocardiographic abnormality, but the nature

and origin of the latter must be established by appropriate clinical and diagnostic evaluation.

Hypertension was found in 13 patients (31.7%). This frequency was close to that reported by Bolla *et al.*, who observed hypertension in 35.6% of patients in their international cohort [12]. In our study, hypertension was significantly associated with the presence of instrumental abnormalities in the univariate analysis by Firth's penalized logistic regression (OR = 11.26; 95% CI: 2.59 - 60.39; p = 0.001). This observation is consistent with the importance of traditional cardiovascular risk factors in SLE. Koletsos *et al.* notably showed that the accumulation of microvascular target-organ damage in lupus patients was associated with an increased cardiovascular risk [23]. Zinglersen *et al.*, in a longitudinal cohort, also reported an association between the progression of coronary calcifications and certain risk factors, notably smoking and SLE duration [24].

However, in our study, the association between hypertension and instrumental abnormalities was no longer statistically significant after adjustment for SLEDAI (adjusted OR = 6.56; 95% CI: 0.60 - 145.70; p = 0.121). This result does not make it possible to exclude a role of hypertension, owing to the imprecision of the estimate and the small number of events. Above all, it highlights the difficulty of separately assessing the contributions of lupus activity and conventional cardiovascular risk factors in a small cohort.

One of the main findings of our study concerned the association between lupus activity and documented electrocardiographic and/or echocardiographic abnormalities. The median SLEDAI score was 4 [4 - 4] in patients with an instrumental abnormality, compared with 0 [0 - 0] in those with no documented abnormality (p < 0.001). In the Firth penalized logistic regression model adjusted for age and sex, SLEDAI remained significantly associated with instrumental abnormalities (adjusted OR = 3.92 per point; 95% CI: 1.87 - 81.35; p < 0.001). In a separate model adjusted for hypertension, this association persisted (adjusted OR = 5.02; 95% CI: 1.97 - 3278.00; p < 0.001).

This association is consistent with the hypothesis of a relationship between the inflammatory activity of SLE and certain cardiovascular manifestations. Katayama *et al.* identified high disease activity among the factors associated with cardiovascular risk in the studies synthesized in their review [15]. Wu *et al.* also reported an association between lupus activity and certain electrocardiographic abnormalities [16], while Kadoglou *et al.* observed differences in cardiac biomarkers according to the level of SLE activity [19]. Gürsoy *et al.*, for their part, reported a relationship between SLEDAI-2K and certain myocardial deformation parameters [21]. However, these studies did not address an outcome identical to ours. Comparisons must therefore be interpreted as elements of pathophysiological convergence and not as direct validation of our statistical estimates.

Interpretation of the association between SLEDAI and instrumental abnormalities also requires consideration of a possible overlap between certain cardiovascular manifestations and the components of the activity score. Observations of

pericarditis could notably contribute both to the assessment of lupus activity and to the definition of the cardiovascular outcome, introducing a risk of circularity. A sensitivity analysis excluding observations of isolated pericarditis was therefore performed. Six patients retained an instrumental abnormality according to this redefined criterion. The association with SLEDAI persisted after adjustment for age and sex (adjusted OR = 2.63; 95% CI: 1.35 - 20.95; p = 0.002). This persistence does not, however, completely eliminate biases related to variable overlap, small sample size, and unbalanced distribution of scores. SLEDAI therefore cannot be considered a definitively established independent cardiovascular predictor on the basis of this study.

Age was inversely associated with instrumental abnormalities in the crude analysis (OR = 0.93 per year; 95% CI: 0.85 - 0.99; p = 0.034). Male sex also showed a statistically significant association in the crude analysis (OR = 36.60; 95% CI: 3.35 - 5063.90; p = 0.002). However, after simultaneous adjustment for age, sex, and SLEDAI, neither age (p = 0.284) nor male sex (p = 0.878) retained a statistically significant association. Interpretation of the result concerning sex was particularly limited by the presence of only four men in the cohort, all belonging to the group with an instrumental abnormality. Similarly, SLE duration was not significantly associated with abnormalities (OR = 0.98 per month; p = 0.120). The results of Zinglersen *et al.*, showing an association between SLE duration and the progression of coronary calcifications, illustrate the importance of distinguishing cross-sectional instrumental abnormalities from evolving cardiovascular involvement studied longitudinally [24].

The majority of patients in our study (39/41; 95.1%) received corticosteroid therapy combined with antimalarial treatment, and the 11 patients with instrumental abnormalities belonged to this group. This distribution does not, however, allow us to conclude that there is an association between this treatment and cardiovascular abnormalities, since almost the entire cohort received the same therapeutic combination. Data on cumulative doses, duration of exposure, and treatment chronology were not sufficiently detailed to allow reliable analysis. The review by Katayama *et al.* emphasizes that certain therapeutic exposures, notably to glucocorticoids, are among the factors associated with cardiovascular risk in the literature [15]. However, these observations do not allow the abnormalities in our cohort to be attributed to the treatments received. Therapeutic factors must therefore be considered as potential sources of confounding that were not fully controlled.

The question of subclinical cardiovascular manifestations also deserves discussion. In our series, only one of the 25 patients without cardiothoracic manifestations had a documented instrumental abnormality. This low apparent frequency should not be interpreted as a low true prevalence of subclinical involvement, because 22 of these 25 patients had not undergone echocardiography. Furthermore, our study did not include systematic investigation of subclinical atherosclerosis. Mageau *et al.*, in a longitudinal study of 63 lupus patients, showed that the presence of carotid plaques was associated with the subsequent occurrence of cardio-

vascular events, even in patients considered to be at apparent low cardiovascular risk [25]. This study, however, concerned carotid atherosclerosis and not the electrocardiographic or echocardiographic abnormalities studied in our work. It nevertheless highlights the diversity of silent cardiovascular involvement that may occur during SLE.

Interpretation of the pericardial and myocardial observations constitutes another important point. Inflammatory involvement of the pericardium may be part of the systemic activity of SLE, but its diagnosis must be based on a confrontation of clinical, electrocardiographic, and imaging data. A recent review devoted to lupus pericarditis emphasizes the importance of this diagnostic approach, particularly to distinguish active pericardial inflammation from other pericardial abnormalities [26]. Similarly, a recent systematic review on the management of inflammatory cardiopulmonary manifestations of SLE highlights the diversity of these involvements and the need for appropriate diagnostic characterization [27]. In our study, the absence of detailed data allowing systematic confirmation of pericarditis and myocarditis therefore limits the etiological interpretation of the observed abnormalities.

Our study has several methodological limitations. First, its retrospective and single-center nature, associated with the small sample size of 41 patients, limits the precision of the estimates and their generalizability. Second, only 11 patients had a documented instrumental abnormality, which restricts the stability of the multivariate models. The use of Firth's penalized logistic regression was suited to the problem of separation or quasi-separation encountered in certain analyses. Heinze and Schemper showed the value of this approach for obtaining finite estimates in the presence of separated data [28]. Heinze also highlighted the difficulties encountered by conventional logistic regression methods when sample sizes are small or data are highly unbalanced [29]. However, this method eliminates neither the uncertainty related to the small number of events nor the risk of overfitting. The particularly wide confidence intervals observed in our models therefore require exploratory interpretation.

Third, the incomplete availability of echocardiography constitutes a major limitation. This examination had been performed in only 17 patients, mainly symptomatic ones. This selection may have led to an overestimation of the frequency of abnormalities among the patients examined and to an under-detection of abnormalities in the overall cohort. The overall proportion of 26.8% of documented instrumental abnormalities therefore cannot be equated with the true prevalence of cardiovascular involvement in SLE. Fourth, the available data did not allow independent verification of all diagnostic criteria for pericardial and myocardial involvement, nor did they allow certain attribution of nonspecific electrocardiographic abnormalities to SLE.

Finally, the SLEDAI score had been collected retrospectively, without the possibility of verifying all of its components. The possible overlap between certain cardiovascular manifestations and the components of the activity score, as well

as the absence of exhaustive adjustment for renal involvement, other cardiovascular risk factors, and therapeutic exposures, could influence the observed associations. The cross-sectional nature of the study did not allow a temporal or causal relationship to be established between lupus activity and cardiovascular abnormalities.

Despite these limitations, our study provides hospital-based data on cardiothoracic manifestations and documented electrocardiographic and echocardiographic abnormalities in patients with SLE in Pointe-Noire. It highlights the value of a cardiovascular evaluation adapted to the clinical presentation and risk factors, as well as the need to improve access to cardiac investigations. A recent review devoted to multimodal cardiovascular imaging in SLE recalls that the choice of examinations must take into account the clinical suspicion, the abnormalities initially identified, and the diagnostic question raised [30]. Prospective multicenter studies, based on standardized protocols and on more systematic performance of cardiovascular examinations, are needed to clarify the frequency of abnormalities, their clinical significance, and their relationships with lupus activity in Central African populations.

5. Conclusions

This study, conducted in 41 patients with systemic lupus erythematosus at Loandjili General Hospital in Pointe-Noire, demonstrates the presence of documented electrocardiographic and echocardiographic abnormalities in 26.8% of patients. Electrocardiographic abnormalities concerned 14.6% of the cohort, while echocardiographic abnormalities were observed in 52.9% of the 17 patients who underwent this examination.

Lupus activity, assessed by the SLEDAI score, was significantly associated with the presence of instrumental cardiovascular abnormalities, including after adjustment for certain clinical factors. However, the small number of events, the imprecision of the estimates, and the possible overlap between certain components of the SLEDAI and cardiovascular manifestations require a cautious interpretation of this association.

The incomplete performance of echocardiography, limited to 41.5% of patients, does not allow accurate estimation of the true frequency of cardiovascular involvement in the entire study population, particularly in asymptomatic patients. Furthermore, the instrumental abnormalities identified cannot all be considered as cardiac manifestations directly attributable to lupus.

These results highlight the value of a cardiovascular evaluation adapted to the clinical presentation and risk factors of patients with SLE, combining electrocardiography and echocardiography when the latter is indicated and available. Prospective multicenter studies, based on larger sample sizes and standardized cardiovascular investigation protocols, are needed to better characterize these abnormalities and clarify their relationship with lupus activity in Central African populations.

Conflicts of Interest

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

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