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**Original Article**

# Prevalence and relationship between RV and LV systolic and diastolic dysfunction in patients with heart failure; an observational cross-sectional study

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## Abstract

**Introduction**: Heart failure is a major cause of morbidity and mortality worldwide, with hypertension as the leading driver in Sub-Saharan Africa. This study assessed the prevalence of RV and LV systolic and diastolic dysfunction and examined their interrelationship in patients with hypertensive heart failure.

**Methods**: This was an observational cross-sectional study conducted at the Federal Medical Centre, Abeokuta, Nigeria. All participants underwent echocardiography following ASE guidelines. Data were analysed with SPSS v26. Continuous variables were expressed as means, categorical variables as frequencies. Pearson correlation and logistic regression were used to assess associations. A p-value <0.05 was considered significant.

**Results**: A total of 120 patients were studied (mean age 56.8 ± 12.4 years; 62.5% male). Most patients (64.2%) presented in NYHA class III–IV. RV systolic dysfunction was present in 45–46% of patients, while RV diastolic dysfunction occurred in 38.3%. LV systolic dysfunction was observed in 65.8%, and LV diastolic dysfunction in 72.5%. RV systolic indices correlated with LV ejection fraction ($r = 0.42$, $p < 0.001$), while RV diastolic parameters correlated with LV diastolic indices ($r = 0.38$, $p < 0.01$). Patients with LV dysfunction were significantly more likely to have RV dysfunction ($p < 0.001$).

**Conclusion**: Biventricular systolic and diastolic dysfunctions are common in hypertensive heart failure and are strongly interrelated. Comprehensive echocardiographic assessment of both ventricles should be standard in this population.

**Keywords**: heart failure, hypertension, left ventricular dysfunction, right ventricular dysfunction, echocardiography, Nigeria

## Introduction

Heart failure (HF) is a global health challenge associated with high morbidity, mortality, and socioeconomic burden (Shakoor et al., 2024). It is defined as a clinical syndrome resulting from structural or functional cardiac abnormalities that impair ventricular filling or ejection, leading to symptoms such as dyspnea, fatigue, and fluid retention (Abbate et al., 2015). The burden of HF is rising worldwide, with over 64 million affected individuals, and the prevalence is particularly high in Sub-Saharan Africa, where hypertension remains the leading cause (Shahim et al., 2023).

Traditionally, research and clinical management of HF have focused on left ventricular (LV) systolic function, particularly ejection fraction, because of its established prognostic value and therapeutic implications (Ma et al., 2020). However, LV diastolic dysfunction also plays a pivotal role in HF pathophysiology, accounting for nearly half of cases (HF with preserved ejection fraction, HFpEF) and being strongly associated with poor outcomes (Ma et al., 2020).

In contrast, the role of the right ventricle (RV) in HF was historically underappreciated, largely due to its complex geometry and the technical challenges of non-invasive assessment (Brittain et al., 2012). Recent studies have highlighted that RV systolic and diastolic dysfunction are powerful independent predictors of prognosis in HF, sometimes exceeding the predictive value of LV dysfunction (Maharaj, 2012). RV dysfunction frequently develops secondary to LV dysfunction via mechanisms such as pulmonary hypertension, ventricular interdependence, or shared myocardial disease (Ojji et al., 2013).

The coexistence of RV and LV dysfunction has important clinical consequences. LV systolic and diastolic impairment may elevate left atrial pressure, increase pulmonary vascular resistance, and subsequently impair RV performance (Obokata et al., 2020). Conversely, RV dysfunction worsens systemic venous congestion, limits exercise capacity, and independently predicts adverse outcomes including mortality and hospitalization (Akintunde, 2017; Dini et al., 2012).

Despite the growing recognition of biventricular involvement, there remains a paucity of data from Sub-Saharan Africa. Most available studies have concentrated on LV dysfunction, with limited exploration of RV function and its relationship with LV abnormalities in this setting (Akintunde, 2017; Dini et al., 2012; Ojji et al., 2013). Given the predominance of hypertensive heart disease and the distinct epidemiological profile of HF in the region, locally generated data are crucial for guiding patient management. This study was therefore designed to determine the prevalence of RV and LV systolic and diastolic dysfunction among patients with HF, and to explore the relationship between these abnormalities. Understanding this interplay is expected to enhance clinical decision-making and improve prognostic assessment in HF patients in resource-limited environments.

## Methodology

### Study Design and Setting

This was an observational cross-sectional study conducted at the Cardiology Unit of the Department of Internal Medicine, Federal Medical Centre, Abeokuta, Ogun State, Nigeria. The study included adult patients (≥18 years) with a clinical diagnosis of hypertensive heart failure, recruited consecutively from the cardiology outpatient clinics and medical wards. Eligible participants were adults aged 18 years and above with a clinical diagnosis of heart failure established using the Framingham criteria, defined as the presence of at least two major criteria or one major criterion in combination with two minor criteria. Patients were excluded if they had significant valvular heart disease, chronic lung disease, diabetes mellitus, chronic kidney disease with an estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 $m^2$, HIV infection, or any connective tissue disorder.

### Sample Size

The minimum required sample size was calculated using a prevalence of right ventricular systolic

dysfunction in hypertensive HF patients of 44.5% (Ojji et al., 2013), at a 95% confidence interval and 5% margin of error. Adjusting for attrition, 120 HF patients were recruited.

### Clinical and Echocardiographic Evaluation

All participants underwent a detailed clinical history and physical examination, followed by transthoracic echocardiography performed with a Vivid T8 GE Healthcare machine equipped with a 3.5 MHz probe, in accordance with the American Society of Echocardiography (ASE) guidelines.

Left ventricular (LV) systolic function was assessed by calculating the ejection fraction (LVEF), with values below 50% considered indicative of systolic dysfunction. Diastolic function was evaluated using transmitral Doppler to obtain the E/A ratio, deceleration time, and isovolumic relaxation time (IVRT). Additional assessment included tissue Doppler imaging of the septal and lateral mitral annulus to derive e′ velocities and the average E/e′ ratio. Based on these parameters, LV diastolic dysfunction was graded according to ASE recommendations into grades I to III.

Right ventricular (RV) function was also evaluated. Systolic function was determined using the tricuspid annular plane systolic excursion (TAPSE), with values less than 15 mm considered abnormal, and fractional area change (FAC), with values less than 35% defining systolic dysfunction. Diastolic function was assessed by measuring tricuspid inflow velocities (E and A waves), calculating the E/A ratio and deceleration time, and performing tissue Doppler imaging of the tricuspid annulus to obtain e′ velocity and derive the E/e′ ratio. Right ventricular diastolic dysfunction was classified according to ASE criteria as impaired relaxation, pseudonormal filling, or restrictive filling pattern.

### Data Management and Statistical Analysis

Data were entered into SPSS version 26. Continuous variables were summarized as means ± standard deviation and categorical variables as frequencies and percentages. Prevalence of RV and LV systolic and diastolic dysfunction was determined. Associations between RV and LV parameters were assessed using Pearson correlation and logistic regression analyses. A p-value $<0.05$ was considered statistically significant.

## Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of FMC, Abeokuta. Written informed consent was obtained from all participants prior to enrolment. Confidentiality and voluntary participation were assured.

## Results

A total of 120 patients with hypertensive heart failure were studied. The mean age was 56.8 ± 12.4 years, with the majority (39.2%) between 60–69 years. Males accounted for 62.5% of the study population. Most patients were traders (36.1%) or civil servants (30.3%), and the majority were married (80.0%). Almost half (47.5%) had tertiary education, while 9.2% had no formal education. More than half (64.2%) of patients presented in NYHA class III–IV, indicating advanced disease (Table 1).

The mean body weight was 72.7 ± 10.1 kg and the average body mass index was 26.1 ± 3.4 kg/m². The mean waist–hip ratio was 0.93 ± 0.21. The mean systolic and diastolic blood pressures were 125.9 ± 15.7 mmHg and 74.5 ± 14.4 mmHg, respectively, while the average heart rate was 81.1 ± 14.9 beats per minute (Table 2).

According to Table 3, right ventricular (RV) systolic dysfunction was common among patients with HF. Based on fractional area change (FAC), 54 patients (45.0%) had RV systolic dysfunction, while 55 patients (45.8%) were identified using TAPSE. RV diastolic dysfunction was present in 46 patients (38.3%), with the majority classified as grade I (impaired relaxation, 18.3%) or grade II (pseudonormal filling, 18.3%), while 1.7% demonstrated restrictive filling pattern.

**Table 1: Socio characteristics of patients with hypertensive heart failure (n = 120)**

| Variable | Category | Mean ± SD or n (%) |
|---|---|---|
| **Age (years)** | <50 | 18 |
| | 50 – 59 | 44 |
| | 60 – 69 | 47 |
| | ≥70 | 11 |
| | **Mean ± SD** | 56.8 ± 12.4 |
| **Gender** | Female | 64 (53.3) |
| | Male | 75 (62.5) |
| **Occupation** | Civil servant | 36 (30.3) |
| | Trader | 43 (36.1) |
| | Farmer | 12 (10.1) |
| | Professional | 6 (5.0) |
| | Retiree | 19 (16.0) |
| | Artisan | 1 (0.8) |
| | Unemployed | 3 (2.5) |
| **Marital Status** | Single | 4 (3.3) |
| | Married | 96 (80.0) |
| | Widow/widower | 20 (16.7) |
| **Educational Status** | No formal educ | 11 (9.2) |
| | Primary | 13 (10.8) |
| | Secondary | 39 (32.5) |
| | Tertiary | 57 (47.5) |
| **NYHA class** | Class I–II | 43 (35.8) |
| | Class III–IV | 77 (64.2) |

**Table 2: Clinical indices among participants**

| Variable | Mean ± SD or n (%) |
|---|---|
| Weight (kg) | 72.74 ±10.05 |
| Height (m) | 1.65 ± 0.52 |
| BMI (kg/m2) | 26.07 ± 3.40 |
| Hip circumference (cm) | 95.02 ± 6.11 |
| Waist circumference(cm) | 87.46 ± 9.55 |
| W/H ratio | 0.93 ± 0.21 |
| SBP (mmHg) | 125.89 ± 15.69 |
| DBP (mmHg) | 74.50 ± 14.38 |
| Pulse pressure (mmHg) | 18.58 ± 7.49 |
| Heart rate | 81.09 ± 14.88 |

**Table 3 Prevalence of right ventricular systolic and diastolic dysfunction in patients with HF**

| Parameter | Normal n (%) | Abnormal n (%) | Prevalence (%) |
|---|---|---|---|
| **TAPSE (<15 mm)** | 65 (54.2) | 55 (45.8) | 45.8 |
| **FAC (<35%)** | 66 (55.0) | 54 (45.0) | 45.0 |
| **RV Diastolic Dysfunction** | 74 (61.7) | 46 (38.3) | 38.3 |
| **– Grade I (Impaired relaxation)** | — | 22 (18.3) | — |
| **– Grade II (Pseudonormal)** | — | 22 (18.3) | — |
| **– Grade III (Restrictive)** | — | 2 (1.7) | — |

According to table 4, left ventricular (LV) systolic dysfunction, defined as LVEF <50%, was observed in 79 patients (65.8%). LV diastolic dysfunction was detected in 87 patients (72.5%), of whom 41 (34.2%) were grade I, 38 (31.7%) were grade II, and 8 (6.6%) were grade III (Table 2). According to table 5, there was a significant correlation between right and left ventricular dysfunction in patients with heart failure. Right ventricular systolic function, assessed by TAPSE and FAC, showed a positive correlation with left ventricular ejection fraction ($r = 0.42$, $p < 0.001$). Similarly, right ventricular diastolic parameters, including the E/A ratio and E/e′, correlated with left ventricular diastolic indices, particularly mitral E/e′ ($r = 0.38$, $p < 0.01$). Furthermore, patients with left ventricular systolic dysfunction were significantly more likely to also exhibit right ventricular systolic dysfunction ($p < 0.001$). In the same way, the presence of left ventricular diastolic dysfunction was associated with a higher prevalence of right ventricular diastolic dysfunction ($p < 0.01$).

**Table 4: Prevalence of left ventricular systolic and diastolic dysfunction among patients**

| Parameter | Normal n (%) | Abnormal n (%) | Prevalence (%) |
|---|---|---|---|
| LVEF (<50%) | 41 (34.2) | 79 (65.8) | 65.8 |
| LV Diastolic Dysfunction | 33 (27.5) | 87 (72.5) | 72.5 |
| – Grade I | — | 41 (34.2) | — |
| – Grade II | — | 38 (31.7) | — |
| – Grade III | — | 8 (6.6) | — |

According to Table 5, there was a significant correlation between right and left ventricular dysfunction in patients with heart failure. Right ventricular systolic function, assessed by TAPSE and FAC, showed a positive correlation with left ventricular ejection fraction ($r = 0.42$, $p < 0.001$). Similarly, right ventricular diastolic parameters, including the E/A ratio and E/e′, correlated with left ventricular diastolic indices, particularly mitral E/e′ ($r = 0.38$, $p < 0.01$). Furthermore, patients with left ventricular systolic dysfunction were significantly more likely to also exhibit right ventricular systolic dysfunction ($p < 0.001$). In the same way, the presence of left ventricular diastolic dysfunction was associated with a higher prevalence of right ventricular diastolic dysfunction ($p < 0.01$).

**Table 5: Relationship between right and left ventricular dysfunction in HF patients**

| Relationship | Correlation coefficient (r) | p-value |
|---|---|---|
| LVEF vs TAPSE | 0.42 | <0.001 |
| LVEF vs FAC | 0.40 | <0.001 |
| Mitral E/e′ vs Tricuspid E/e′ | 0.38 | 0.002 |
| LV vs RV diastolic dysfunction | — | 0.008 |

## Discussion

This study provides new insights into the burden and interplay of right and left ventricular dysfunction among Nigerian patients with hypertensive heart failure. The mean age of our patients was 56.8 years, with the majority between 60–69 years, and males accounted for 62.5% of the study population. This demographic profile is consistent with previous African studies where heart failure occurs a decade earlier than in Western populations, largely due to uncontrolled hypertension rather than ischemic heart disease (Bloomfield et al., 2013; Sofowora & Ajayi, 2015). The predominance of advanced NYHA functional class (III–IV in 64.2%) suggests late presentation, which is a recurring theme in Sub-Saharan Africa (Ajayi et al., 2020; Siddikatou et al., 2025). In contrast, Western cohorts often report earlier detection and a higher proportion of patients in NYHA class II (Castro et al., 2019; Mandi et al., 2020). The relatively high BMI and waist–hip ratio in our cohort reflect the emerging role of obesity and central adiposity as modifiers of hypertensive heart failure in African populations (Khafagy & Dash, 2021).

Nearly half of the patients had RV systolic dysfunction, with 45.8% affected using TAPSE and 45.0% using FAC. This prevalence is similar to earlier Nigerian studies, which reported RV dysfunction in 40–50% of patients with hypertensive heart disease (Akintunde, 2017; Ifeoluwa et al., 2019). Our results are also in line with international data, where RV dysfunction is increasingly recognized as a powerful prognostic factor in heart failure (Anastasiou et al., 2023; Shaker et al., 2024).

RV diastolic dysfunction was identified in 38.3% of our patients, most frequently in the early grades. Although less studied, RV diastolic impairment has been shown to predict reduced exercise tolerance and poor prognosis (Kim et al., 2016). The relatively lower prevalence compared to LV diastolic dysfunction suggests that RV filling abnormalities may lag behind LV changes, becoming more pronounced as pulmonary pressures rise.

LV systolic dysfunction on the other hand was highly prevalent in our patients (65.8%), which is expected given that long-standing hypertension commonly progresses to dilated and dysfunctional ventricles. Similar findings have been documented in regional studies, where hypertensive heart disease remains an important cause of reduced EF (Oh & Cho, 2020).

However, LV diastolic dysfunction was even more common in our cohort, present in 72.5% of patients, and this was not confined to those with preserved EF. This agrees with international observations that diastolic abnormalities occur across the spectrum of EF and contribute significantly to symptoms and outcomes (Maharaj, 2012; Obokata et al., 2020). The distribution of grades, with predominance of impaired relaxation and pseudonormal filling, suggests that diastolic impairment progresses alongside systolic dysfunction in hypertensive heart failure.

One of the most important findings of this study is the significant correlation between RV and LV dysfunction. RV systolic indices (TAPSE and FAC) correlated positively with LV ejection fraction, while RV diastolic parameters correlated with LV filling indices, particularly mitral E/e′. This relationship highlights the concept of ventricular interdependence, whereby deterioration in LV function leads to increased pulmonary venous pressures, elevated RV afterload, and subsequent RV systolic and diastolic impairment (Ryan & Archer, 2014; Salazar et al., 2022).

Our finding that patients with LV dysfunction were significantly more likely to also have RV dysfunction supports prior evidence that RV abnormalities rarely occur in isolation in hypertensive HF but instead reflect downstream consequences of LV disease (Oketona et al., 2017). Compared with Western cohorts where RV dysfunction may be influenced by ischemic injury or primary pulmonary hypertension, our results suggest that in this setting, the dominant mechanism is post-capillary pulmonary hypertension secondary to LV dysfunction (Agrawal et al., 2020; Bernardo et al., 2020).

## Strengths and Limitations

A key strength of this study is the comprehensive echocardiographic evaluation of both ventricles, which provides a holistic understanding of hypertensive HF. To our knowledge, few Nigerian studies have simultaneously assessed both systolic and diastolic function in both ventricles. However, limitations include its single-center design, cross-sectional nature, and modest sample size, which limit generalizability and prognostic inference. Echocardiographic parameters such as TAPSE and E/e′ are also load-dependent, though they remain widely accepted and reproducible clinical measures.

## Conclusion

This study demonstrates that RV and LV dysfunction frequently coexist in hypertensive HF and are strongly interrelated. Both systolic and diastolic dysfunction are common in this population, and their significant correlations highlight the need for comprehensive biventricular evaluation in routine practice. Future longitudinal studies should determine the prognostic implications of combined RV and LV dysfunction and assess whether therapeutic strategies aimed at reducing LV filling pressures can improve RV performance and outcomes in hypertensive HF.

### Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## References

Abbate, A., Arena, R., Abouzaki, N., Van Tassell, B., Canada, J., Shah, K., Biondi-Zoccai, G., & Voelkel, N. (2015). Heart failure with preserved ejection fraction: Refocusing on diastole. International Journal of Cardiology, 179, 430–440.

Agrawal, V., Lahm, T., Hansmann, G., & Hemnes, A. R. (2020). Molecular mechanisms of right ventricular dysfunction in pulmonary arterial hypertension: Focus on the coronary vasculature,

sex hormones, and glucose/lipid metabolism. Cardiovascular Diagnosis and Therapy, 10(5), 1522–1540. https://doi.org/10.21037/cdt-20-404

Ajayi, A. A., Sofowora, G. G., & Ladipo, G. O. (2020). Explaining heart failure hyper-mortality in Sub Saharan Africa: Global genomic and environmental contribution review. Journal of the National Medical Association, 112(2), 141–157. https://doi.org/10.1016/j.jnma.2020.02.003

Akintunde, A. A. (2017). Right ventricular function in patients with heart failure in a cardiac clinic in Southwest Nigeria. Nigerian Medical Journal, 58(1), 7–12. https://doi.org/10.4103/0300-1652.218411

Anastasiou, V., Papazoglou, A. S., Moysidis, D. V., Daios, S., Tsalikakis, D., Giannakoulas, G., Karamitsos, T., Delgado, V., Ziakas, A., & Kamperidis, V. (2023). The prognostic value of right ventricular longitudinal strain in heart failure: A systematic review and meta-analysis. Heart Failure Reviews, 28(6), 1383–1394. https://doi.org/10.1007/s10741-023-10329-y

Bernardo, R. J., Haddad, F., Couture, E. J., Hansmann, G., de Jesus Perez, V. A., Denault, A. Y., de Man, F. S., & Amsallem, M. (2020). Mechanics of right ventricular dysfunction in pulmonary arterial hypertension and heart failure with preserved ejection fraction. Cardiovascular Diagnosis and Therapy, 10(5), 1580–1603. https://doi.org/10.21037/cdt-20-479

Bloomfield, G. S., Barasa, F. A., Doll, J. A., & Velazquez, E. J. (2013). Heart failure in sub-Saharan Africa. Current Cardiology Reviews, 9(2), 157–173. https://doi.org/10.2174/1573403x11309020008

Brittain, E. L., Hemnes, A. R., Keebler, M., Lawson, M., Byrd, B. F., 3rd, & Disalvo, T. (2012). Right ventricular plasticity and functional imaging. Pulmonary Circulation, 2(3), 309–326. https://doi.org/10.4103/2045-8932.101407

Castro, R. R. T., Joyce, E., Lakdawala, N. K., Stewart, G., Nohria, A., Givertz, M. M., Desai, A., Lewis, E. F., & Stevenson, L. W. (2019). Patients report more severe daily limitations than recognized by their physicians. Clinical Cardiology, 42(12), 1181–1188. https://doi.org/10.1002/clc.23269

Dini, F. L., Demmer, R. T., Simioniuc, A., Morrone, D., Donati, F., Guarini, G., Orsini, E., Caravelli, P., Marzilli, M., & Colombo, P. C. (2012). Right ventricular dysfunction is associated with chronic kidney disease and predicts survival in patients with chronic systolic heart failure. European Journal of Heart Failure, 14(3), 287–294. https://doi.org/10.1093/eurjhf/hfr176

Ifeoluwa, A. A., Adewole, A. A., Abiodun, A. M., & Akinyemi, A. (2019). Right ventricular systolic function in Nigerians with heart failure secondary to hypertensive heart disease. African Health Sciences, 19(2), 2130–2139. https://doi.org/10.4314/ahs.v19i2.37

Khafagy, R., & Dash, S. (2021). Obesity and cardiovascular disease: The emerging role of inflammation. Frontiers in Cardiovascular Medicine, 8, Article 768119. https://doi.org/10.3389/fcvm.2021.768119

Kim, J., Di Franco, A., Seoane, T., Srinivasan, A., Kampaktsis, P. N., Geevarghese, A., Goldburg, S. R., Khan, S. A., Szulc, M., Ratcliffe, M. B., Levine, R. A., Morgan, A. E., Maddula, P., Rozenstrauch, M., Shah, T., Devereux, R. B., & Weinsaft, J. W. (2016). Right ventricular dysfunction impairs effort tolerance independent of left ventricular function among patients undergoing exercise stress myocardial perfusion imaging. Circulation: Cardiovascular Imaging, 9(11), Article e005115. https://doi.org/10.1161/CIRCIMAGING.116.005115

Ma, C., Luo, H., Fan, L., Liu, X., & Gao, C. (2020). Heart failure with preserved ejection fraction: An update on pathophysiology, diagnosis, treatment, and prognosis. Brazillian Journal of Medical and Biological Research, 53(7), Article e9646. https://doi.org/10.1590/1414-431X20209646

Maharaj, R. (2012). Diastolic dysfunction and heart failure with a preserved ejection fraction: Relevance in critical illness and anaesthesia. Journal of the Saudi Heart Association, 24(2), 99–121. https://doi.org/10.1016/j.jsha.2012.01.004

Mandi, D. G., Bamouni, J., Yaméogo, R. A., Naïbé, D. T., Kaboré, E., Kambiré, Y., Kologo, K. J., Millogo, G. R. C., & Zabsonré, P. (2020). Spectrum of heart failure in sub-Saharan Africa: Data from a tertiary hospital-based registry in the eastern center of Burkina Faso. The Pan African Medical Journal, 36, Article 30. https://doi.org/10.11604/pamj.2020.36.30.19321

Obokata, M., Reddy, Y. N. V., & Borlaug, B. A. (2020). Diastolic dysfunction and heart failure with preserved ejection fraction: Understanding mechanisms by using noninvasive methods. JACC: Cardiovascular Imaging, 13(1 Pt 2), 245–257. https://doi.org/10.1016/j.jcmg.2018.12.034

Oh, G. C., & Cho, H. J. (2020). Blood pressure and heart failure. Clinical Hypertension, 26(1), Article 1. https://doi.org/10.1186/s40885-019-0132-x

Ojji, D. B., Opie, L. H., Lecour, S., Lacerda, L., & Sliwa, K. (2013). Right ventricular systolic dysfunction is common in hypertensive heart failure: A cross sectional study in Nigerian patients. PLOS ONE, 8(4), Article e60796. https://doi.org/10.1371/journal.pone.0060796

Oketona, O., Balogun, M., Akintomide, A., Ajayi, O., Adebayo, R., Mene-Afejuku, T., Oketona, O., & Bamikole, O. (2017). Right ventricular systolic function in hypertensive heart failure. Vascular Health and Risk Management, 13, 353–360. https://doi.org/10.2147/VHRM.S142429

Ryan, J. J., & Archer, S. L. (2014). The right ventricle in pulmonary arterial hypertension: Disorders of metabolism, angiogenesis and adrenergic signaling in right ventricular failure. Circulation Research, 115(1), 176–188. https://doi.org/10.1161/CIRCRESAHA.113.301129

Salazar, I., Lancaster, A., Kauffman, M., Weller, A., Simpson, C., Kolb, T., Damico, R., Mathai, S., Kass, D., Tedford, R., Hassoun, P., & Hsu, S. (2022). Abstract 10899: Excessive right ventricular afterload in pulmonary arterial hypertension: Effects on diastolic function and the left ventricle. Circulation, 146(Suppl_1), Article A10899. https://doi.org/10.1161/circ.146.suppl_1.10899

Shahim, B., Kapelios, C. J., Savarese, G., & Lund, L. H. (2023). Global public health burden of heart failure: An updated review. Cardiac Failure Review, 9, Article e11. https://doi.org/10.15420/cfr.2023.05

Shaker, M. M., Taha, H. S., Kandil, H. I., & El-Moteleb, A. A. (2024). Prognostic significance of right ventricular dysfunction in patients presenting with acute left-sided heart failure. The Egyptian Heart Journal, 76(1), Article 2. https://doi.org/10.1186/s43044-023-00431-7

Shakoor, A., Van Maarschalkerwaart, W., Schaap, J., De Boer, R., Van Mieghem, N., Boersma, E., Van Heerebeek, L., Brugts, J., & Van Der Boon, R. (2024). Socio-economic inequalities and heart failure morbidity and mortality: A systematic review and data synthesis. ESC Heart Failure, 12(1), 927–941. https://doi.org/10.1002/ehf2.14986

Siddikatou, D., Mandeng Ma Linwa, E., Ndobo, V., Nkoke, C., Mouliom, S., Ndom, M. S., Abas, A., & Kamdem, F. (2025). Heart failure outcomes in Sub-Saharan Africa: A scoping review of recent studies conducted after the 2022 AHA/ACC/HFSA guideline release. BMC Cardiovascular Disorders, 25(1), Article 302. https://doi.org/10.1186/s12872-025-04756-y

Sofowora, G. G., & Ajayi, A. L. (2015). Congestive heart failure in Nigerians: A review. In A. A. Ajayi (Ed.), Management of heart failure (pp. 319–328). Springer. https://doi.org/10.10007/978-1-4471-6657-3_17