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Review Article

Prevalence and Determinants of Left Ventricular Hypertrophy among Nigerian Adults with Hypertension: A Systematic Review

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Abstract

Left Ventricular Hypertrophy (LVH) is a structural adaptation of the heart linked to increased cardiovascular morbidity and mortality. It occurs in response to chronic pressure or volume overload and varies in pattern across populations. This study aimed to systematically evaluate the prevalence, geometric patterns, and determinants of LVH among Nigerian adults. A systematic review was conducted using PubMed, Google Scholar, African Journals Online (AJOL), and Directory of Open Access Journals (DOAJ) to identify studies published between 2004 and 2025. The research question focused on the prevalence, pattern, and determinants of LVH in Nigerian adults aged ≥18 years. Studies were eligible if they reported LVH prevalence, Left Ventricular (LV) geometry, or associated determinants in hospital-based or community populations, including hypertensive, prehypertensive, and Sickle Cell Anemia (SCA) cohorts. Data extracted included study population, sample size, diagnostic method, and LVH-related outcomes. Seventeen studies were included, with sample sizes ranging from 80 to 450 participants. LVH prevalence ranged from 18% in prehypertensives to 45% in hypertensives and 47% in adults with SCA. Concentric hypertrophy was most common in hypertensives, eccentric hypertrophy in SCA. Key factors associated with LVH included elevated Systolic Blood Pressure (SBP), age, male sex, Body Mass Index (BMI), family history of hypertension, and comorbid conditions such as diabetes. LVH is highly prevalent among Nigerian adults, with geometric patterns reflecting underlying hemodynamic stress. Identification of key factors associated with LVH can guide early detection and targeted interventions to reduce cardiovascular morbidity and mortality.

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Introduction

The left ventricle is the primary pumping chamber of the heart, responsible for delivering oxygenated blood to the systemic circulation. Its structure and function are critical for maintaining adequate cardiac output and ensuring that tissues receive sufficient oxygen and nutrients. Normal Left Ventricular (LV) architecture enables coordinated contraction and relaxation, thereby maintaining optimal stroke volume and cardiac efficiency. Any alteration in LV structure, however, can compromise cardiac performance and predispose individuals to cardiovascular complications, including heart failure, arrhythmias, and sudden cardiac death.[1-2]

Left Ventricular Hypertrophy (LVH) is defined as a pathological increase in LV mass resulting from an adaptive response to chronic hemodynamic stress. In Nigeria, LVH represents a particularly important marker of hypertension-mediated organ damage because of the country's exceptionally high burden of hypertension and historically low rates of awareness, treatment, and blood pressure control. Nigeria accounts for one of the largest populations of adults with hypertension in sub-Saharan Africa, and several studies have shown that hypertensive Nigerians develop target-organ damage, including LVH, at relatively younger ages and sometimes at lower blood pressure thresholds compared with other populations. Emerging evidence suggests that African populations may exhibit greater susceptibility to pressure-overload cardiac remodeling, possibly related to genetic predisposition, heightened salt sensitivity, vascular stiffness, and a high prevalence of comorbid risk factors such as obesity, chronic kidney disease, and anemia. Within Nigeria, substantial regional differences in socioeconomic status, lifestyle patterns, health-seeking behavior, and access to care further influence the development and detection of LVH, contributing to marked heterogeneity in its prevalence and clinical presentation. Because LVH is a strong independent predictor of heart failure, arrhythmias, stroke, and cardiovascular mortality, understanding its burden and determinants in Nigerian populations is essential for risk stratification and targeted cardiovascular prevention strategies. While initially beneficial, prolonged LVH can become maladaptive, resulting in impaired diastolic and systolic function, increased myocardial stiffness, and elevated risk of adverse cardiovascular events.[10,16] Hypertension is the most common cause of LVH in adults.[3-4] Although other conditions that increase pressure or volume load on the heart, such as chronic anemia, valvular heart disease, and sickle cell disease, can also trigger hypertrophy.[13]

Several factors determine the development and progression of LVH. Elevated systolic and diastolic blood pressures are primary drivers, as chronic afterload increases myocardial wall stress.[4,7] Age and sex also play a role, with older adults and males generally exhibiting higher prevalence and severity of LVH.[5,14] Obesity and increased Body Mass Index (BMI) impose additional cardiac workload, predisposing individuals to hypertrophy even in the absence of overt hypertension.[1-2] Genetic predisposition, family history of hypertension, and comorbid conditions such as diabetes, renal impairment, and chronic anemia further modify the risk and pattern of LVH.[12,15] In patients with Sickle Cell Anemia (SCA), chronic hemolytic anemia induces volume overload, leading predominantly to eccentric remodeling.[13]

The aim of this systematic review is to determine the prevalence of LVH across different populations and identify key demographic, clinical, and hemodynamic determinants that influence the development of LVH. It also provides insights to guide early detection, risk stratification, and intervention strategies aimed at reducing cardiovascular morbidity as a result of LVH.

Methods

Study Design

The study was conducted as a systematic review designed to synthesize existing evidence on the prevalence and determinants of LVH among hypertensive adults in Nigeria. The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological transparency, comprehensive reporting, and reproducibility. The methodological framework included a structured search strategy, study area, research question, predefined eligibility criteria, rigorous study selection processes, and systematic data extraction and synthesis.

Study Area

The study focused exclusively on Nigeria, a West African country with a large and ethnically diverse population distributed across six geopolitical zones. The included studies were conducted in different regions of the country, encompassing both urban and rural settings and various levels of health care delivery. This geographic diversity allows the review to reflect national patterns of LVH across multiple Nigerian populations.

Research Question

This systematic review was guided by the following research question: What is the prevalence of LVH, and what factors are associated with it among hypertensive adults in Nigeria? This question was developed using the Population, Exposure, Outcome (PEO) framework, in which the population consisted of Nigerian adults diagnosed with hypertension, the exposure was systemic hypertension, and the outcomes were the prevalence of LVH and the determinants associated with its development.

Search Strategy

A comprehensive and systematic search of the literature was undertaken across five databases: PubMed, Scopus, African Journals Online (AJOL), Directory of Open Access Journals (DOAJ), and Google Scholar. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords to ensure broad retrieval of relevant studies. The core search terms included "Left Ventricular Hypertrophy," "LVH," "Hypertension," "High Blood Pressure," "Nigeria," "Prevalence," "Determinants," and "Risk Factors," which were combined using Boolean operators AND and OR. For example, the PubMed search string included: ("Left Ventricular Hypertrophy"[MeSH] OR "Left Ventricular Hypertrophy" OR LVH) AND ("Hypertension"[MeSH] OR Hypertension OR "High Blood Pressure") AND Nigeria AND (Prevalence OR Determinants OR "Risk Factors").

Eligibility Criteria

Studies were eligible for inclusion if they were observational in design, specifically cross-sectional, cohort, or case-control studies conducted among hypertensive adults in Nigeria. To be included, studies had to report the prevalence of LVH and its determinants, with LVH diagnosis based on echocardiographic or electrocardiographic criteria. Only full-text articles published in English were included. Eligibility assessment was conducted by the author and further assessed by a reviewer using predefined inclusion and exclusion criteria. Studies were excluded if they were conducted outside Nigeria, involved participants younger than 18 years, lacked extractable data on LVH prevalence or determinants, or had unclear diagnostic methods for LVH. Studies presenting duplicated datasets were also excluded.

Study Selection

All search results were imported into Zotero reference management software, where duplicate records were removed. The study selection process involved two screening stages. First, the titles and abstracts of all retrieved articles were screened to identify potentially eligible studies. Full texts of selected articles were then retrieved and assessed against the eligibility criteria. The selection process followed PRISMA recommendations, and a PRISMA flowchart was generated to document the number of studies identified, screened, excluded, and included.

Data Extraction

The data extraction was conducted independently by two reviewers using a standardized data extraction form. From each study, detailed information was extracted on author name, year of publication, study location within Nigeria, study design, sampling technique, sample size, participant characteristics, diagnostic criteria for hypertension, and the echocardiographic or electrocardiographic methods used to define LVH. Additional data extracted included the prevalence of LVH, indices of LV mass or geometry, and all assessed determinants or risk factors, such as age, sex, BMI, duration of hypertension, systolic and diastolic blood pressure, and comorbidities. Where multivariable models were reported, adjusted odds ratios, relative risks, regression coefficients, and their corresponding confidence intervals were recorded. All final extracted data were compiled into structured tables for synthesis and subsequent analysis.

Quality Assessment

The methodological quality assessment of the included studies was independently assessed by two reviewers using the Newcastle–Ottawa Scale (NOS) for observational studies. The NOS evaluates studies across three key domains: selection of study groups, comparability of groups, and assessment of outcomes/exposures. Each study was awarded a maximum of nine stars based on these criteria. Studies were categorized as high quality (7–9), moderate quality (4–6), or low quality (≤3). Any discrepancies in quality ratings between reviewers were resolved through discussion and consensus. The results of the quality assessment were considered during data interpretation to strengthen the reliability of the findings.

Data Analysis

The data were analyzed using a narrative synthesis approach due of methodological heterogeneity across the included studies, arising from differences in diagnostic methods for LVH, variations in LV mass indexing, study designs, sample characteristics, and study settings. Findings were synthesized narratively, and where possible,

results were stratified by diagnostic method. Both echocardiographic and electrocardiographic criteria for LVH were included because echocardiography remains the gold standard for assessing LV mass and geometry, while Electrocardiography (ECG) is widely used in resource-limited settings in Nigeria due to its accessibility and low cost. Excluding ECG-based studies would have resulted in the loss of important community-based data and reduced the representativeness of the national evidence. ECG and echocardiography differ in diagnostic performance, with ECG showing lower sensitivity but higher specificity for LVH than echocardiography.

Extracted data were systematically organized into evidence tables and evaluated to identify patterns in the prevalence of LVH and the determinants reported across studies. Prevalence estimates from each study were recorded as reported, and because the included studies varied in sample size, diagnostic methods, and cut-off values, no statistical pooling or meta-analysis was conducted. Instead, prevalence rates were compared descriptively across subgroups, including sex, geographical zone, hypertension status, and diagnostic modality. For studies reporting LV geometric patterns, the proportions of concentric hypertrophy, eccentric hypertrophy, and concentric remodeling were summarized narratively to highlight regional variations and methodological differences.

Determinants of LVH were analyzed by extracting all statistically significant and non-significant variables, including sociodemographic factors, anthropometric indices, blood pressure parameters, and comorbid conditions. For studies that conducted multivariable regression, the adjusted models were examined to identify independent predictors, and the covariates included in the analyses were noted. The strength and direction of associations were described using the original effect measures reported, such as odds ratios, relative risks, regression coefficients, or p-values. Where sufficient similarity existed across studies, patterns were grouped to provide broader thematic interpretations, such as the influence of obesity, duration of hypertension, sex differences, or blood pressure severity on LVH prevalence. The findings were integrated to identify consistent trends and potential variations arising from different diagnostic methods, population characteristics, or study settings. A flow chart of the search strategy and study selection is shown in Figure 1.

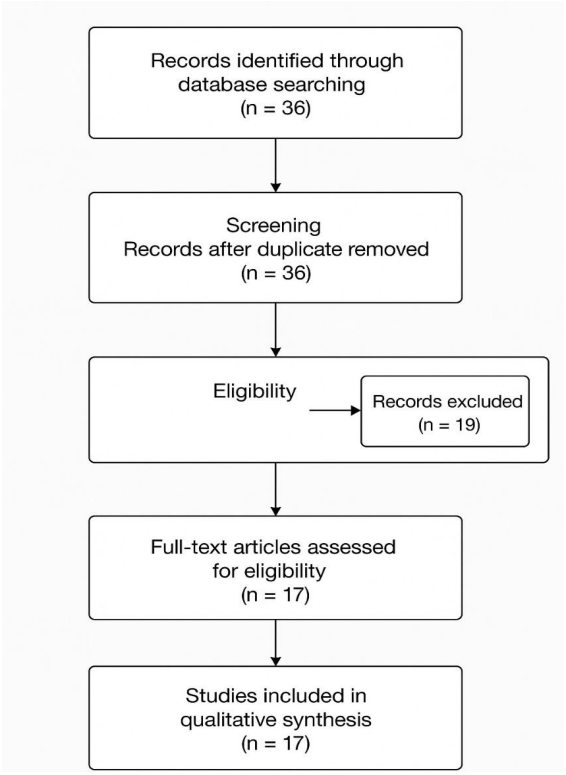

Figure 1. Flow diagram of the literature search.

Results

Study Characteristics

Seventeen studies published between 2004 and 2025, with sample sizes ranging from 80 to 450 participants aged 18–80 years, were included. Most studies investigated hospital-based hypertensive populations, while a few focused on community-based adults, prehypertensives[11,14], type 2 diabetic females[1], or adults with SCA.[13] Diagnostic modalities varied, with echocardiography used in 13 studies[1-8,11-12,15], Doppler echocardiography in two studies[10,16], and ECG in two studies.[9,14]

Table 1 summarizes study characteristics, populations, diagnostic modalities, LVH prevalence, LV geometry patterns, and key determinants.

Prevalence of LVH

Across studies, LVH prevalence varied by population type, diagnostic method, and LV mass index. Among hospital-based hypertensive adults, prevalence ranged 28–45%.[1-5,7] Community-based adults or prehypertensives had a lower prevalence of 18–22.5%.[11,14] In SCA adults, prevalence was 47%, with eccentric hypertrophy predominating.[13] Notably, studies using height$^{2.7}$ indexed LV mass detected LVH in over 80% of participants.[15] Subgroup analyses revealed higher prevalence in older adults, males, and patients with comorbidities such as diabetes.[1,5] Figure 2 illustrates the prevalence of LVH by population type.

Table 1. Summarizes study characteristics, populations, diagnostic modalities, LVH prevalence, LV geometry patterns, and key determinants.

Study	Year	Sample	Population	Diagnostic method	LVH Prevalence	LV Geometry	Key Determinants
Nworah et al.	2013	120	Hypertensive and Normotensive T2DM females	Echocardiography	45%(HTN), 20%(NT)	Concentric	HTN, BMI, diabetes duration
Galtimari et al.	2025	256	Newly diagnosed hypertensives	Echocardiography	36%	Concentric 40%, eccentric 31%, remodeling 29%	Age, SBP, BMI
Salako et al.	2009	200	Treated hypertensives	Echocardiography	33%	Concentric	Poor BP control, BMI
Talle et al.	2023	182	Untreated hypertensives	Echocardiography	41%	Concentric 45%, eccentric 28%, remodeling 27%	SBP, BMI
Akintunde et al.	2013	150	Hypertensives and obese adults	Echocardiography	38%(M), 34%(F)	Concentric	Sex, BMI, BP
Dele-Ojo et al.	2021	152	Newly diagnosed hypertensives	Echocardiography	42%	Concentric	BP dipping pattern, SBP, BMI
Dele-ojo	2021	110	White-coat HTN	Echocardiography	28%	Concentric	BMI, Age
Ogunyemi et al.	2012	120	Hypertensives with exercise	Echocardiography + ECG	30%	Not reported	Exercise response, BP
Nkado et al.	2004	102	Adult hypertensives	ECG vs Echo	35%	Not reported	BP, Age
Abubakar et al.	2023	180	Newly diagnosed hypertensives	Doppler Echo	59%(diastolic dysfunction)	Impaired relaxation Age, BP,BMI	Age, sex, BP (SBP/DBP), and BMI
Hadiza et al.	2016	80	Prehypertensives	Echocardiography	18%	Remodelling 12%, eccentric 6%	Age, BP, Sex
Abiodun et al.	2024	200	Hypertensives+ family history	Echocardiography	39%	Concentric	Family history, Age, BP
Oni et al.	2022	84	Sickle cell anemia	ECG + Echo	47%	Eccentric	SCA phenotype

Mbadiawe et al.	2024	324	Community low-income adults	ECG	22.5%	Not reported	SBP, Male sex
Ojji et al.	2018	450	Untreated black hypertensives	Echo, LVM indexed BSA/ hight^2.7	80%	Concentric 33-40%	Indexing method, age
Ogah et al.	2012	Review	Nigerians	Literature sysnthesis	Variable	Concentric	Poor awareness, Low BP Control
Adamu et al.	2010	150	Newly diagnosed hypertensives	Doppler Echo	62%	Impaired relaxation	LVH, BP

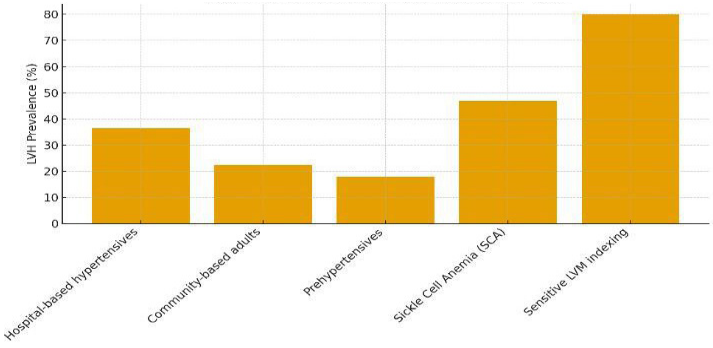

Figure 2. Prevalence of LVH by population type.

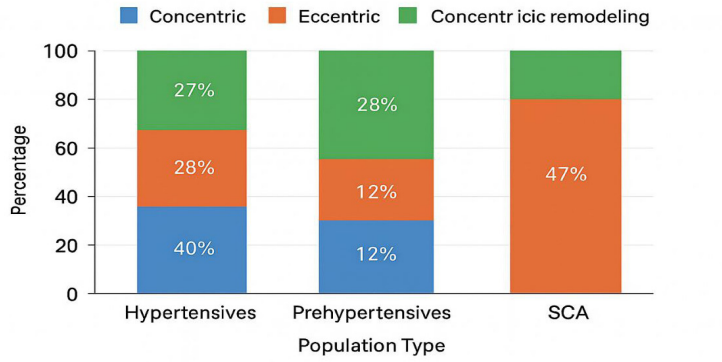

Figure 3. Shows a stacked bar chart of LV geometry by population, highlighting differences between hypertensive, prehypertensive, and SCA cohorts.

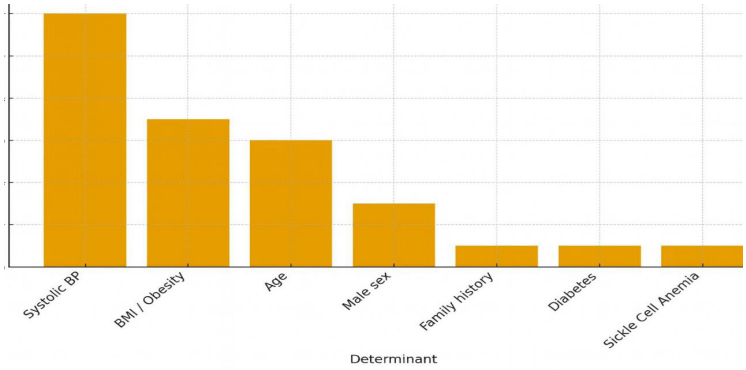

Figure 4. The main determinants of Left Ventricular Hypertrophy (LVH).

Left Ventricular Geometry Patterns

Patterns of LV geometry varied according to population characteristics. Concentric hypertrophy predominated among hypertensive populations, with prevalence ranging from 33% to 45%,[2-4] while eccentric hypertrophy was most frequent in SCA patients (6–47%).[13] Concentric remodeling was commonly observed in prehypertensive adults, ranging from 12% to 29%.[11] These findings reflect the hemodynamic load: pressure-overload states favor concentric hypertrophy, whereas volume-overload conditions favor eccentric remodeling or hypertrophy. Figure 3 shows the distribution of LV geometry across population types.

Factors Associated with LVH

Several factors were consistently associated with LVH. Systolic Blood Pressure (SBP) was the factor most consistently associated with concentric hypertrophy.[4,7,14] Obesity, measured as BMI, was significantly associated with concentric hypertrophy in multiple studies.[1-2,5-6] Age was another important determinant, with older adults showing a higher prevalence and greater risk in multivariable models.[2,12,15] Male sex was associated with slightly higher prevalence and more concentric hypertrophy in some studies,[5-6,14] while family history of hypertension increased LVH risk.[12] Comorbidities also contributed: diabetes was associated with a higher prevalence of LVH risk,[1] whereas SCA was also independently associated with eccentric hypertrophy.[13] Figure 4 depicts the main determinants with reported effect sizes.

Functional Cardiac Changes

Functional impairment was frequently reported, particularly diastolic dysfunction. Even among newly diagnosed hypertensives, 59–62% demonstrated impaired relaxation,[10,16] suggesting that functional changes may precede structural hypertrophy.

Discussion

Overview of Key Findings

This review identified a consistently high burden of LVH across diverse Nigerian populations, with the highest prevalence observed among hypertensive adults and substantial structural abnormalities also noted among community-dwelling individuals. The predominance of concentric hypertrophy among hypertensives and eccentric patterns among SCA patients reflects the distinct hemodynamic stresses characterizing each population and prehypertensive groups. Collectively, the studies demonstrate that myocardial remodeling begins early, progresses silently, and is strongly influenced by factors such as blood pressure, age, BMI, anemia, and genetic susceptibility.

Interpretation of LVH Prevalence Across Populations

Hypertensive adults consistently exhibited high LVH prevalence, ranging from 28% to 45%, suggesting prolonged and often poorly controlled blood pressure exposure in Nigerian clinical settings.[1-4] Evidence of significant LVH in newly diagnosed hypertensives further indicates that structural remodeling frequently precedes formal clinical diagnosis, reflecting the extended subclinical phase of hypertension in the population.[16] The 22.5% prevalence of LVH reported among community-dwelling adults indicates widespread unrecognized cardiovascular stress beyond hospital settings.[14] This level of subclinical disease may reflect undiagnosed hypertension, obesity, chronic psychosocial stress, or emerging metabolic transitions associated with urbanization in Nigeria. The presence of LVH in 18% of prehypertensive adults highlights a particularly important finding: myocardial structural changes may begin at blood pressure levels still considered "normal-high" within current diagnostic frameworks.[11] Such early remodeling suggests that African populations may be more susceptible to hypertensive target-organ damage at lower pressures than other ethnic groups. SCA populations displayed a distinct remodeling pattern, with eccentric hypertrophy dominating due to chronic anemia and high-output circulation.[13] This volume-overload physiology drives chamber dilation and increased myocardial mass, representing a different mechanistic pathway compared with pressure-driven changes seen in hypertensives. These variations in prevalence and patterns reflect unique physiological burdens and underline the need for population-specific clinical strategies.

LV Geometry Patterns and Their Pathophysiological Implications

The predominance of concentric hypertrophy and concentric remodeling in hypertensive adults reflects long-standing pressure overload and increased systemic vascular resistance.[2-4]. Such concentric patterns are clinically significant because they predispose patients to diastolic dysfunction and Heart Failure with preserved Ejection Fraction (HFpEF), now increasingly observed in African medical facilities. The frequency of concentric remodeling in prehypertensives also suggests that maladaptive myocardial changes often emerge before overt hypertrophy, emphasizing the

continuum of blood pressure-related myocardial injury. In contrast, the strong predominance of eccentric hypertrophy in SCA patients aligns with the chronic high-output state characteristic of hemolytic anemia, where increased preload leads to chamber dilation rather than wall thickening.[13] Over time, this structural adaptation may lead to systolic dysfunction or high-output cardiac failure, underscoring the need for early and routine cardiac evaluation in individuals with SCA.

Factors Associated with LVH and LV Geometry

Across studies, SBP emerged as the most robust determinant of increased LV mass and abnormal geometry, with higher SBP consistently associated with concentric hypertrophy and impaired myocardial relaxation.[4,7] BMI played a significant role across several cohorts, particularly in community-based and prehypertensive populations, where excess adiposity increased cardiac workload.[1,5] Age was a strong and consistent determinant, with older individuals exhibiting more pronounced hypertrophy and diastolic dysfunction due to cumulative arterial stiffness and prolonged exposure to cardiovascular risk factors.[12,15] Male sex was also associated with greater LV mass and concentric remodeling, reflecting sex-specific myocardial responses to hemodynamic load.[14] Family history of hypertension increased the likelihood of LVH, suggesting a genetic component that amplifies susceptibility to hypertensive target-organ damage.[12] In SCA populations, hemoglobin concentration was a major determinant of eccentric remodeling, underscoring the influence of anemia-induced volume overload.[13]

Clinical and Public Health Implications

The findings have significant clinical implications. The high prevalence of LVH among hypertensive adults highlights the need for more aggressive blood pressure control, particularly using antihypertensive classes known to facilitate LVH regression. The detection of LVH in hypertensive and community adults underscores the importance of expanding screening strategies to include individuals with borderline blood pressure, obesity, or metabolic risk factors. Echocardiographic evaluation may be necessary at earlier stages to identify high-risk individuals before progression to heart failure. For SCA populations, routine cardiac assessment should be integrated into standard care, given the strong association between chronic anemia and eccentric hypertrophy. Strategies aimed at maintaining stable hemoglobin levels and reducing hemolysis may reduce long-term cardiac remodeling. At the population level, the findings highlight the urgent need for improved hypertension awareness, accessible diagnostic services, and cardiovascular monitoring infrastructure across Nigeria.

Strengths and Limitations of the Evidence

The included studies offer comprehensive insights across multiple Nigerian regions and populations, with most using echocardiography as the preferred modality to assess LV geometry. However, limitations include small sample sizes in several studies, potential regional biases, and limited adjustment for confounding variables such as renal function or lipid profiles. The predominance of cross-sectional designs restricts causal inference, and the lack of longitudinal follow-up limits understanding of disease progression or regression following treatment.

Conclusion

This review shows that LVH remains common across Nigerian adult populations, especially among hypertensive adults and individuals with additional cardiometabolic risks. Concentric hypertrophy and concentric remodeling are the most frequent patterns, reflecting long-standing pressure overload and suboptimal cardiovascular risk control. Several demographic and clinical factors, such as age, BMI, blood pressure levels, and renal function, consistently influence these structural changes. Overall, the findings highlight the need for earlier detection, better hypertension management, and improved access to echocardiography to reduce the long-term cardiovascular burden in the region.

List of Abbreviations

AJOL	African Journals Online
BMI	Body Mass Index
DOAJ	Directory of Open Access Journals
ECG	Electrocardiography
HFpEF	Heart Failure with Preserved Ejection Fraction
LV	Left Ventricular
LVH	Left Ventricular Hypertrophy
MeSH	Medical Subject Headings
NOS	Newcastle–Ottawa Scale
PEO	Population Exposure Outcome
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SBP	Systolic Blood Pressure
SCA	Sickle Cell Anemia

Ethical Clearance

Not applicable.

Publication Approval

Author consent to the publication of this manuscript.

Author Contributions

Conceptualization, study design, literature search, data extraction, data interpretation, and manuscript preparation were performed by the author. Review and validation of the extracted data and critical review of the manuscript was performed by the external supervisor.

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Conflict of Interest

None.

Availability of Data and Materials

Not applicable.

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Copyright/Permissions for Figures

Not applicable.

Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, generative AI/AI-assisted technology was used solely to assist with language refinement, grammar, clarity. The author independently conducted the literature search, data extraction, interpretation of the findings.

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