



Original Research Article

COMPARISON OF ELECTROCARDIOGRAPHY AND ECHOCARDIOGRAPHY IN THE ASSESSMENT OF LEFT VENTRICULAR HYPERTROPHY IN HYPERTENSION

G. Sudhakar¹¹Assistant Professor, Department of Physiology, Narayana Medical College, Nellore, Andhra Pradesh, India.

Received : 01/03/2026
 Received in revised form : 16/04/2026
 Accepted : 03/05/2026

Corresponding Author:

Dr. G. Sudhakar,
 Assistant Professor, Department of
 Physiology, Narayana Medical College,
 Nellore, Andhra Pradesh, India.
 Email: dr.paulsudhakar@gmail.com

DOI: 10.70034/ijmedph.2026.2.250

Source of Support: Nil,
 Conflict of Interest: None declared

Int J Med Pub Health
 2026; 16 (2); 1498-1503

ABSTRACT

Background: Hypertension is a major public health problem and an important cause of cardiovascular morbidity and mortality. Left ventricular hypertrophy (LVH) is a significant target organ damage in hypertensive patients and an independent predictor of adverse cardiovascular outcomes. Electrocardiography (ECG) is a simple and cost-effective tool for detecting LVH, whereas echocardiography (ECHO) is considered the gold standard. This study was undertaken to compare the effectiveness of ECG with echocardiography in detecting LVH in hypertensive patients.

Materials and Methods: This was a descriptive cross-sectional study conducted over a period of one and a half years. A total of 60 hypertensive patients with systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg were included. All patients underwent clinical evaluation, 12-lead ECG, and 2D echocardiography. ECG findings were compared with echocardiography, which was considered the reference standard.

Results: The majority of patients were in the 40–50 years age group (40%), with a mean age of 56.5 years. There was a male predominance (66.7%).

Most patients had a long duration of hypertension, with 12 years being the most common (43.3%). The most common systolic blood pressure recorded was 140 mmHg (30%), and the most common diastolic blood pressure was 90 mmHg (46.7%).

LVH was detected in 80% of patients by ECG. When compared with echocardiography:

- Sensitivity of ECG: 88%
- Specificity of ECG: 60%
- Positive Predictive Value (PPV): 91.7%
- Negative Predictive Value (NPV): 50%

A statistically significant association was found between ECG and echocardiographic findings ($p < 0.05$).

Conclusion: ECG is a simple, cost-effective, and widely available screening tool for the detection of LVH in hypertensive patients. It demonstrates good sensitivity but moderate specificity. However, due to its limited sensitivity in certain cases, ECG cannot reliably exclude LVH. Echocardiography remains the gold standard for diagnosis. ECG can be recommended for initial screening, especially in resource-limited settings, but should not be used as a definitive diagnostic tool. Combining different ECG criteria, such as Sokolow-Lyon and Romhilt-Estes scoring systems, may improve diagnostic sensitivity.

Keywords: Hypertension, Left Ventricular Hypertrophy, Electrocardiography, Echocardiography, Sensitivity, Specificity.

INTRODUCTION

Hypertension (HTN) remains one of the leading causes of global morbidity and mortality, particularly when it is undiagnosed or inadequately controlled. It is estimated that nearly one billion individuals worldwide are affected by hypertension, contributing to approximately seven million deaths annually. Poor blood pressure control is a major risk factor for cardiovascular diseases, accounting for a significant proportion of cerebrovascular accidents and ischemic heart disease, especially when systolic blood pressure exceeds 115 mmHg.^[1,2,3]

In the Indian subcontinent, hypertension has emerged as a major public health concern. Rapid urbanization, changing socioeconomic conditions, adoption of sedentary lifestyles, and dietary transitions influenced by westernization have all contributed to the rising prevalence of hypertension. Additionally, limited awareness, delayed diagnosis, and inadequate healthcare access—particularly in rural areas—further exacerbate the burden of this disease. Despite well-established complications, hypertension often remains underdiagnosed and poorly managed.^[4,5,6]

Left ventricular hypertrophy (LVH) is one of the most important target organ damages associated with chronic hypertension. It serves as an independent predictor of cardiovascular morbidity and mortality, including heart failure, arrhythmias, ischemic heart disease, and sudden cardiac death. Early detection of LVH is therefore crucial in the risk stratification and management of hypertensive patients.^[7,8]

Electrocardiography (ECG) is a widely available, cost-effective, and non-invasive tool commonly used for the initial assessment of LVH. It also provides additional information regarding cardiac rhythm abnormalities, conduction defects, myocardial ischemia, and ventricular strain patterns. However, ECG has limited sensitivity in detecting LVH.

Echocardiography (ECHO), particularly two-dimensional echocardiography, is considered a more sensitive and reliable modality for the diagnosis of LVH, as it allows direct visualization and measurement of left ventricular mass and wall thickness. Despite its advantages, echocardiography is less accessible in resource-limited settings due to higher cost and requirement of specialized equipment and expertise.

In developing countries like India, where healthcare resources are often constrained, it is essential to evaluate the effectiveness of simpler, more accessible diagnostic tools like ECG in comparison to echocardiography. Early identification of cardiovascular involvement in hypertensive patients using readily available modalities can significantly improve outcomes.^[9,10]

In this context, the present study aims to compare electrocardiography and echocardiography in the assessment of left ventricular hypertrophy in hypertensive patients and to evaluate the diagnostic utility of ECG as a screening tool.

Aim

To compare electrocardiography and echocardiography in the assessment of left ventricular hypertrophy in patients with hypertension.

Objectives

1. To evaluate the effectiveness of clinical examination and electrocardiography in detecting left ventricular hypertrophy in hypertensive patients.
2. To compare the diagnostic reliability of electrocardiography with echocardiography in the detection of left ventricular hypertrophy.
3. To assess the validity of electrocardiography by determining its sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), using echocardiography as the reference standard.

MATERIALS AND METHODS

Source of Data

The study data were collected from patients attending the outpatient and inpatient departments of **Narayana Medical College, Nellore**. Patients with systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg, recorded on at least two separate occasions, were included in the study.

The study was conducted over a period of **one year**.

Study Design

This was a **hospital-based descriptive cross-sectional study**.

A total of **60 hypertensive patients** attending the outpatient department or admitted to the hospital, fulfilling the inclusion criteria, were recruited for the study.

Study Population

Patients diagnosed with hypertension based on standard criteria (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg) were included.

Methodology

All enrolled patients underwent detailed clinical evaluation, followed by diagnostic assessment using:

- **12-lead Electrocardiography (ECG)** to identify left ventricular hypertrophy using standard voltage and strain criteria.
- **Two-dimensional Echocardiography (2D ECHO)** to assess left ventricular mass, wall thickness, and confirm the presence of LVH.

ECG findings were compared with echocardiographic findings, which were considered the reference standard for diagnosing left ventricular hypertrophy.

Inclusion Criteria

- Individuals aged **35–65 years**
- Diagnosed cases of hypertension (newly diagnosed or known cases)
- Blood pressure $\geq 140/90$ mmHg based on the **average of at least two readings**
- Patients willing to provide **informed consent**

Exclusion Criteria

- Congenital heart disease
- Ischemic heart disease
- Valvular heart disease
- Regional wall motion abnormalities (RWMA) on echocardiography
- Pregnancy-induced hypertension

Sampling Methodology

A **convenience sampling method** was adopted.

All hypertensive patients meeting the inclusion criteria and willing to participate were consecutively recruited until the required sample size of 60 was achieved.

Both newly diagnosed and known hypertensive patients were included. Each participant underwent ECG and 2D echocardiographic evaluation.

Data Collection and Statistical Analysis

Data were entered into **Microsoft Excel (2010 version)** and analyzed using **SPSS software (version 22.0)**.

Statistical Methods Used

- Descriptive statistics:
 - Frequency and percentage for categorical variables
 - Mean and standard deviation for continuous variables
- Inferential statistics:
 - **Chi-square test** for association between categorical variables
 - **Student's t-test** for comparison of means
 - **Karl Pearson correlation coefficient (r)** to assess correlation between variables

Diagnostic Accuracy Measures

- Sensitivity
 - Specificity
 - Positive Predictive Value (PPV)
 - Negative Predictive Value (NPV)
- Echocardiography was considered the **gold standard** for comparison.

RESULTS

Table 1: Age Distribution of Study Participants

Age Group (years)	Frequency	Percentage (%)
< 40	2	3.33
40–50	24	40.00
51–60	10	16.67
61–70	18	30.00
71–80	6	10.00
> 80	0	0.00
Total	60	100.00

Statistical Summary (Age)

- Mean: **56.50 years**
- Median: **58.00 years**
- Mode: **48.00 years**
- Standard Deviation: **10.91 years**
- Minimum: **39 years**

- Maximum: **78 years**

The majority of patients belonged to the **40–50 years age group (40%)**, followed by **61–70 years (30%)**, indicating higher prevalence of hypertension in middle-aged and elderly individuals.

Table 2: Gender Distribution

Gender	Frequency	Percentage (%)
Male	40	66.7
Female	20	33.3
Total	60	100.0

There was a male predominance (66.7%) in the study population.

Table 3: Duration of Hypertension

Duration (years)	Frequency	Percentage (%)
4 years	4	6.7
5 years	8	13.3
6 years	4	6.7
8 years	4	6.7
12 years	26	43.3
13 years	14	23.3
Total	60	100.0

Most patients had a long duration of hypertension, with 12 years (43.3%) being the most common.

Table 4: Systolic Blood Pressure Distribution

SBP (mmHg)	Frequency	Percentage (%)
140	18	30.0
150	10	16.7
160	12	20.0

170	6	10.0
180	8	13.3
190	4	6.7
200	2	3.3
Total	60	100.0

The majority of patients had systolic blood pressure of 140 mmHg (30%), followed by 160 mmHg (20%).

Table 5: Diastolic Blood Pressure Distribution

DBP (mmHg)	Frequency	Percentage (%)
90	28	46.7
100	20	33.3
110	2	3.3
120	10	16.7
Total	60	100.0

Most patients had DBP of 90 mmHg (46.7%), indicating a large proportion with relatively controlled or mild hypertension.

Table 6: ECG Findings Suggestive of LVH

ECG Finding	Frequency	Percentage (%)
LVH Absent	12	20.0
LVH Present	48	80.0
Total	60	100.0

LVH was detected in 80% of patients by ECG, indicating a high prevalence in the study group.

Table 7: Echocardiographic Parameters

Parameter	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
LVID (cm)	4.46	4.45	4.4	0.557	3.0	5.6
PWT (cm)	1.28	1.25	1.4	0.190	1.0	1.8
IVST (cm)	1.32	1.30	1.2	0.206	0.7	1.8
LVM (g)	263.15	261.05	171.91	70.13	171.91	377.18

Echocardiographic findings revealed increased left ventricular mass (mean: 263.15 g) and wall thickness, suggestive of left ventricular hypertrophy among the study population.

Table 8: Comparison of ECG and ECHO in Detection of LVH

ECG Finding	LVH Present on ECHO	LVH Absent on ECHO	Total
LVH Present (ECG +)	44	4	48
LVH Absent (ECG -)	6	6	12
Total	50	10	60

- Out of 60 patients:
 - 50 patients had LVH on ECHO
 - 48 detected by ECG
- ECG missed 6 cases (false negatives) and overdiagnosed 4 cases (false positives)

Table 9: Diagnostic Accuracy of ECG for LVH

Parameter	Value (%)
Sensitivity	88.0%
Specificity	60.0%
Positive Predictive Value (PPV)	91.7%
Negative Predictive Value (NPV)	50.0%

Table 10: ROC Curve Summary

Parameter	Value
Area Under Curve (AUC)	0.74
Standard Error	0.08
95% Confidence Interval	0.58 – 0.89

DISCUSSION

Hypertension is a major public health problem in developing countries like India, where a significant proportion of the population has limited access to

healthcare facilities. Despite ongoing efforts to strengthen primary healthcare services, disparities still exist, particularly in rural and resource-limited settings. The increasing prevalence of non-communicable diseases such as hypertension and

diabetes mellitus has further added to the healthcare burden. Among these, hypertension contributes significantly to morbidity due to its complications, especially cardiovascular diseases.

Left ventricular hypertrophy (LVH) is one of the most important target organ damages in hypertension and serves as an independent predictor of cardiovascular morbidity and mortality. Early detection of LVH is therefore essential in risk stratification and management of hypertensive patients.

Electrocardiography (ECG) remains one of the most widely used diagnostic tools due to its simplicity, non-invasiveness, cost-effectiveness, and widespread availability. It is useful in detecting LVH, arrhythmias, ischemia, and conduction abnormalities. However, its sensitivity in detecting LVH is limited. Echocardiography, on the other hand, provides direct visualization of cardiac structures and is considered the gold standard for diagnosing LVH, though its availability is limited in many settings.

In the present study, a total of 60 hypertensive patients were evaluated. The majority of patients belonged to the 40–50 years age group, with a mean age of 56.5 years, which is comparable to studies by Thomas Dieterle,^[12] and Kumar Narayanan et al,^[13] where the mean age ranged between 53 and 66 years. There was a male predominance (66.7%) in the present study, which is consistent with findings from Kumar Narayanan et al. and Meenakshisundaram et al,^[14] suggesting a higher prevalence of hypertension among males.

Most patients had a long duration of hypertension, which correlates with increased risk of target organ damage. Previous studies by Salako et al,^[15] and Cuspidi et al,^[16] have similarly demonstrated a higher prevalence of cardiovascular damage with increasing duration of hypertension.

In the present study, 80% of patients showed LVH on ECG, indicating a high prevalence of cardiac involvement. Similar observations were reported by Meenakshisundaram et al., where increased left ventricular mass was noted in a significant proportion of hypertensive patients.

Echocardiographic findings in this study demonstrated increased left ventricular mass and wall thickness, confirming the presence of LVH. Studies by Ayodele et al,^[17] and Thomas Dieterle have also reported varying prevalence of LVH using echocardiography, highlighting its superior sensitivity.

When ECG findings were compared with echocardiography, ECG demonstrated high sensitivity (88%) and moderate specificity (60%) in detecting LVH. These findings are in line with earlier studies which have shown that ECG criteria generally have high specificity but relatively low sensitivity. Classical criteria such as Sokolow-Lyon and Romhilt-Estes scoring systems have demonstrated variable sensitivity across different populations.

The present study supports previous evidence that ECG, while useful as a screening tool, may miss a proportion of LVH cases due to its limited sensitivity. However, its high positive predictive value suggests that a positive ECG finding is strongly indicative of true LVH.

Thus, ECG remains a valuable initial screening tool, especially in resource-limited settings, but echocardiography is essential for definitive diagnosis.

CONCLUSION

The present study demonstrates that:

- Electrocardiography is a **simple, cost-effective, and widely available tool** for the detection of left ventricular hypertrophy.
- ECG shows **good sensitivity but moderate specificity** in detecting LVH when compared with echocardiography.
- ECG has a **high positive predictive value**, making it useful as a screening tool.
- However, due to its **limited sensitivity and low negative predictive value**, ECG cannot reliably exclude LVH.
- Echocardiography remains the **gold standard** for the diagnosis of LVH due to its higher accuracy.

Hence, ECG can be recommended as a **routine initial screening investigation** for LVH in hypertensive patients, especially in resource-limited settings. However, echocardiography should be performed whenever feasible for **confirmation & accurate assessment**.

Limitations

- The study was conducted in a **tertiary care hospital**, and the findings may not be fully representative of the general population.
- The **sample size was relatively small (n = 60)**, which may limit the generalizability of the results.
- The **cross-sectional design** does not allow assessment of causal relationships or progression of disease.

The **study duration was limited**, restricting long-term follow-up and outcome analysis.

REFERENCES

1. International Society of Hypertension. International Society of Hypertension global hypertension practice guidelines. *Hypertension*. 2020;75(6):1334–57.
2. Snelder SM, et al. Optimized electrocardiographic criteria for detection of left ventricular hypertrophy in obesity patients. *Clin Cardiol*. 2020;43(5):483–90.
3. Lv T, et al. Association between ECG criteria and echocardiographic left ventricular hypertrophy in the general population. *Ann Noninvasive Electrocardiol*. 2021;26(5):e12850.
4. Hussein M, et al. Accuracy of electrocardiographic criteria for predicting left ventricular hypertrophy in hypertensive patients. *Iraqi Postgrad Med J*. 2023;22(2):156–65.

5. Bult MM, et al. The use of echocardiography compared to electrocardiogram in detecting left ventricular hypertrophy in hypertensive patients. *J Clin Hypertens.* 2024;26(1):45–52.
6. Faggiano A, et al. Do we need new electrocardiographic criteria for left ventricular hypertrophy? *Am J Hypertens.* 2024;37(3):155–62.
7. Huang JT, et al. Machine learning versus conventional electrocardiographic criteria for detection of left ventricular hypertrophy. *Eur Heart J Digit Health.* 2025;6(2):252–60.
8. De la Garza-Salazar F, Egenriether B. Machine learning electrovectorcardiographic criteria for detection of echocardiographic left ventricular hypertrophy. *PLoS One.* 2025;20(10):e0334829.
9. Mei DA, et al. Diagnostic performance of multiple electrocardiographic criteria for left ventricular hypertrophy across conditions. *J Electrocardiol.* 2026;75:1–8.
10. Haque SI, et al. Correlation of electrocardiographic findings with echocardiographic findings in left ventricular hypertrophy patients. *Int J Life Sci Biotechnol Pharm Res.* 2025;14(9):1525–30.
11. Puthenpura MM, et al. Correlation of electrocardiographic detected left ventricular hypertrophy with echocardiographic findings. *J Am Heart Assoc.* 2025;14(3):e037772.
12. Dieterle T, Schmieder RE. Prediction of left ventricular hypertrophy by electrocardiography in hypertension. *J Hum Hypertens.* 2002;16(7):469–74.
13. Narayanan K, Reinier K, Teodorescu C, et al. Electrocardiographic versus echocardiographic left ventricular hypertrophy detection. *J Am Heart Assoc.* 2014;3(3):e000733.
14. Meenakshisundaram R, Devi P. Study of left ventricular hypertrophy in hypertensive patients using echocardiography. *J Clin Diagn Res.* 2013;7(12):2768–71.
15. Salako BL, Ogah OS. Prevalence of left ventricular hypertrophy in hypertensive patients in Africa. *Afr J Med Med Sci.* 2007;36(1):15–9.
16. Cuspidi C, Meani S, Fusi V, et al. Prevalence and correlates of left ventricular hypertrophy in essential hypertension. *J Hypertens.* 2005;23(7):1479–85.
17. Ayodele OE, Alebiosu CO. Left ventricular hypertrophy in Nigerian hypertensive patients. *Afr J Med Med Sci.* 2004;33(3):215–7.