

Association of Electrocardiogram Findings with Gender and Advancing Age among a Healthy Elderly Rural Population: A Cross-sectional Study

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ABSTRACT

Introduction: Electrocardiogram (ECG) is a cost-effective, non invasive screening tool widely used for detecting Cardiovascular Diseases (CVD). Despite its usefulness, there is limited research on ECG abnormalities in asymptomatic elderly rural populations, particularly concerning advancing age and gender.

Aim: To study the ECG findings and their association with advancing age and gender among a healthy elderly rural population.

Materials and Methods: This cross-sectional study was conducted at Jawaharlal Nehru Medical College in Belagavi district, Karnataka, India over a period of six months from May to November 2017, catering to a low socioeconomic rural population. A total of 200 elderly asymptomatic individuals aged 60 years and above were included after obtaining a brief medical history, performing a systemic examination, and conducting routine blood tests to rule out co-morbidities. A 12-lead ECG was recorded for the study participants. The ECG findings were then interpreted to assess the prevalence of ECG abnormalities

and their association with age and gender. Statistical analysis was performed using the Chi-square test, with a p-value of <0.05 considered statistically significant.

Results: The average age of the subjects was 66 years. Among the total participants, 74 (37%) were male and 126 (63%) were female. The largest proportion of participants was in the 60-64 years age group, whereas the ≥75 year category had the lowest representation. Out of the 200 elderly participants in this study, 78 (39%) showed atleast one abnormal finding on their 12-lead ECG. The most commonly detected issue was Left Ventricular Hypertrophy (LVH). The data clearly showed that ECG abnormalities were more common as age increased. While a greater proportion of men (43.2%) had abnormal ECGs compared to women (36.5%), this difference was not statistically significant.

Conclusion: The findings of this study indicate a notable link between increasing age and the occurrence of ECG abnormalities in elderly subjects in rural areas who are otherwise healthy, emphasising age as an important contributor to underlying cardiac alterations.

Keywords: Cardiac activity screening, Cardiovascular disease, Geriatric population, Ventricular hypertrophy

INTRODUCTION

The CVDs continue to be the leading cause of illness and death worldwide. As reported by the World Health Organisation (WHO), around 17.3 million fatalities in 2008 were linked to CVDs, with 7.3 million resulting from coronary artery disease and 6.2 million from strokes [1]. In India, the incidence of cardiovascular-related deaths has shown a significant upward trend, rising from 1.17 million in 1991 to more than two million by 2010 [2]. This increasing prevalence is particularly alarming in rural areas, where barriers such as inadequate healthcare infrastructure, lower educational attainment, and financial hardship hinder timely diagnosis and treatment [3,4].

Although the ECG is a simple, affordable, and non invasive tool to detect cardiac disorders, its use remains limited in community health settings. Identifying these abnormalities at an early stage enables primary healthcare providers to act promptly, thereby improving outcomes and reducing long-term risks [5]. The ECG is an established method for detecting cardiac anomalies such as arrhythmias, myocardial ischemia, and LVH, including in individuals who do not present symptoms [6,7].

As the human body undergoes aging, the cardiovascular system encounters progressive anatomical and functional alterations, making it more susceptible to heart-related conditions [8]. Although age-related changes in ECG readings are well-documented, their interpretation can be inconsistent across different populations, particularly those with varying sociodemographic profiles, healthcare access, and cultural habits [9]. The ECG patterns can vary noticeably

between men and women due to differences in biology, hormones, and lifestyle [10]. These variations can influence how ECG results are interpreted and may sometimes limit the effectiveness of using a single diagnostic standard for everyone.

Despite India's significant burden of CVD, there is a noticeable gap in research focusing on ECG abnormalities among healthy elderly adults in rural settings. Most studies to date have concentrated on urban populations [1,2] or on individuals already exhibiting symptoms, leaving a critical void in our understanding of asymptomatic rural elderly groups.

This study was designed to address the lack of research on cardiac screening in healthy elderly individuals living in rural India. Specifically, it investigates how age and gender relate to ECG abnormalities in a demographic that has traditionally been underserved. By providing age and sex-disaggregated data on ECG findings within this group, the study delivers valuable insights that can enhance early detection strategies and tailor screening approaches in primary healthcare. This research contributes novel evidence to the existing literature by focusing on an asymptomatic, rural geriatric population—an area where data remains scarce but increasingly relevant.

The primary aim was to evaluate ECG patterns in healthy elderly individuals and to examine how these patterns relate to factors such as age and gender. The study focused on elderly individuals aged 60 years and above residing in rural regions, predominantly from low socioeconomic backgrounds.

MATERIALS AND METHODS

This cross-sectional study was carried out at Jawaharlal Nehru Medical College in Belagavi district, Karnataka, India over a period of six months from May to November 2017, catering to a low socioeconomic rural population. The study was initiated after receiving approval from the Institutional Ethics Committee of Jawaharlal Nehru Medical College, Belagavi (Ref. No. MDC/DOME/118). The study was undertaken during routine health screenings organised in a rural area of Belagavi district, Karnataka, in collaboration with local health authorities.

Inclusion criteria: Healthy subjects above 60 years old, asymptomatic during screening with no history of smoking or alcohol consumption, and who provided written informed consent to participate in the study were enrolled.

Exclusion criteria: Individuals with current chronic diseases or those receiving treatments that may potentially affect ECG outcomes were excluded from the study. These conditions included CVDs such as previous Myocardial Infarction (MI), arrhythmias, diabetes mellitus, renal insufficiency, and chronic respiratory diseases such as Chronic Obstructive Pulmonary Disease (COPD). Endocrine diseases like hypothyroidism and hyperthyroidism, as well as neurological conditions such as a history of stroke, were also criteria for exclusion. Additionally, patients taking medications that are known to interfere with the interpretation of the ECG were excluded. These medications included anti-arrhythmic drugs, diuretics, and corticosteroids.

Sample size calculation: The sample size was calculated using a biostatistical formula based on a 38% prevalence of ECG abnormalities in a previous study. The total sample size of 200 was determined as follows:

$n = 4pq/d^2$ Where p =prevalence of ECG abnormalities in the elderly population, 38% [1].

$q = 100 - p = 100 - 38$, $q = 62\%$, d =relative error=20% of $P = 7.6 \sim 7$ (95% is the confidence level and 4.9% is the confidence interval)

$n = (4 \times 38 \times 62) / 7^2 = 192$. Thus, $n = 192 \sim 200$.

Therefore, a total sample size of 200 was taken.

Participants who fulfilled the inclusion requirements at the time of clinic attendance were chosen for the study using a non probability purposive sampling technique.

Study Procedure

Each participant underwent an initial health evaluation prior to study enrollment, which comprised the following assessments: To screen for hypertension, blood pressure was measured with a calibrated digital sphygmomanometer; height and weight were recorded to calculate Body Mass Index (BMI); and a systemic examination was performed, including evaluations of the neurological, respiratory, and cardiovascular systems, to ensure that participants were asymptomatic and fit for an ECG. The ECG recording process was only available to those who passed the initial health evaluation.

The Modified Kuppuswamy Socioeconomic Status Scale [11] was used to assess the participants' socioeconomic standing.

ECG recording protocol: ECGs were recorded for this research using the BPL Cardiart 108T-MK2, a portable 12-lead ECG machine manufactured by BPL Medical Technologies Pvt. Ltd., Bengaluru, India. This model is popular for its use in clinical and community healthcare services due to its lightweight design and ease of operation, especially during rural outreach clinics. Additionally, it can be set to record in both manual and automatic modes, offers multiple channel options (1/3/6/12), and includes a built-in thermal printer for enhanced tracings. Recordings were taken at a paper speed of 25 mm/s with a signal amplitude of 10 mm/mV.

Prior to ECG acquisition, the procedure was explained to each participant, and written informed consent was obtained. Subjects

were requested to rest in a calm and quiet setting for at least 10 minutes to eliminate muscle artifacts or sympathetic stimulation effects. The ECG recording was taken with subjects comfortably lying in the supine position. Standard 12-lead ECG placement was used after cleaning the designated electrode sites with alcohol swabs to maximise electrode-skin contact and reduce impedance.

Standard settings (paper speed of 25 mm/s and gain of 10 mm/mV) were used to calibrate the ECG machine. When required, noise-reduction filters were applied to enhance signal clarity without sacrificing data integrity. The machine's built-in 12-lead ECG was then simultaneously recorded and printed. The data collected (ECG recordings) were evaluated by an expert physician. In cases of any disparity in interpretation, a cardiologist was consulted to ensure minimal variability among observers and greater accuracy.

An ECG was considered abnormal if it exhibited one or more of the following indicators, based on the guidelines provided by the American Heart Association (AHA) and the Minnesota Code Manual [12]:

- Ectopic beats, atrial fibrillation, and atrial flutter are examples of rhythmic disorders.
- Abnormalities in conduction, such as Atrioventricular (AV) or bundle branch blocks.
- Ischaemic changes manifested as pathological Q waves, T-wave inversions, or depression or elevation of the ST segment.
- Hypertrophy of the Left Ventricle (LVH).
- Prolonged intervals of PR, QRS, or QT.
- Deviation of more than $\pm 30^\circ$ to $\pm 90^\circ$ from the left or right axis.

The abnormal ECG group consisted of participants who displayed any of these abnormalities. The study participants were split into two age groups: those aged 70 and above, and those aged between 60 and 69. To investigate any significant associations, the prevalence of abnormal ECG patterns was compared between these age groups as well as between males and females.

STATISTICAL ANALYSIS

For statistical analysis, Statistical Package for Social Sciences (SPSS) version 20 was used, and the chi-square test was employed. A p -value < 0.05 was considered statistically significant.

RESULTS

As this study was conducted in a rural area, the majority of participants belonged to the lower and upper-lower socioeconomic classes. In the present study, all participants belonged to lower socioeconomic classes: 168 (84%) in the lower class and 32 (16%) in the upper-lower class. Among the 200 participants, 74 (37%) were male and 126 (63%) were female. The 60-64 years age group had the highest number of participants, while the least number of subjects were in the age group of 75 and above [Table/Fig-1].

Variables	Number of subjects	Percentage
Socioeconomic status		
Upper	0	0
Upper middle	0	0
Lower middle	0	0
Upper lower	32	16
Lower	168	84
Age groups		
60-64	70	35
65-69	54	27
70-74	45	22.5
75+	31	15.5
Mean age (years)	66.89 $\pm$ 5.78	

Gender		
Male	74	37
Female	126	63

[Table/Fig-1]: Sociodemographic details of study participants.

[Table/Fig-2] shows the different types of ECG abnormalities observed among the elderly participants. Of the subjects, 35 (17.5%) exhibited changes suggestive of LVH, 9 (4.5%) showed changes indicative of MI, 8 (4%) had changes suggesting sinus bradycardia, and 7 (3.5%) of the subjects displayed sinus tachycardia.

Abnormalities	Number	Parentage
LVH	35	17.5
MI	9	4.5
RBBB	2	1
LBBB	3	1.5
PVC'S	2	1
Prolonged QT	2	1
LAE	1	0.5
LAFB	1	0.5
I AV Block	1	0.5
Multiple Abnormalities	7	3.5
Sinus bradycardia	8	4.0
Sinus tachycardia	7	3.5
Total	78	39

[Table/Fig-2]: Prevalence of ECG abnormalities among elderly population.
LVH: Left Ventricular Hypertrophy; MI: Myocardial Infarction; RBBB: Right Bundle Branch Block; LBBB: Left Bundle Branch Block; PVC: Premature Ventricular Contraction; LAE: Left Atrial Enlargement; LAFB: Left Anterior Fascicular Block; AV Block: Atrioventricular Block.

[Table/Fig-3] shows a higher proportion of abnormal ECGs in participants aged 70 years and above (47.4%) compared to those aged 60-69 years (33.8%). This difference was a borderline value, very close to significance ($p=0.05$), indicating a possible trend towards significance. Male participants exhibited 43.2% abnormal ECG changes compared to 36.5% of females; however, this gender difference was not statistically significant ($p=0.346$).

Category	Subgroup	Normal ECG	Abnormal ECG	Total Participants	p-value
Age group	60-69 years	82 (66.1%)	42 (33.9%)	124	0.05
	>70 years	40 (52.6%)	36 (47.4%)	76	
Gender	Male	42 (56.8%)	32 (43.2%)	74	0.346
	Female	80 (63.5%)	46 (36.5%)	126	
Total	-	122	78	200	

[Table/Fig-3]: Distribution of Electrocardiogram (ECG) findings in different age groups and gender.

DISCUSSION

This study was conducted to identify the common ECG abnormalities among elderly populations living in rural areas. It was observed that the prevalence of abnormal ECG patterns increased with advancing age. Among the 200 participants, nearly half (47.4%) of those aged 70 and above exhibited ECG abnormalities, compared to 33.8% in the 60-69 age group. It was also noted that male subjects displayed more ECG abnormalities (43.2%) compared to female subjects (36.5%) although this difference was not statistically significant.

The findings of our study are consistent with other studies conducted in the past. A community-based survey held in Solapur city among asymptomatic adults aged 45-74 years reported a higher prevalence of pathological ECG changes in males (40%) compared to females (34%). The most common abnormal ECG findings included left axis deviation, LVH, and sinus bradycardia [1,2].

Similarly, a large-scale community-based study from South India, which recruited 4,630 participants aged 20-79 years, found an overall 39.9% prevalence of ECG abnormalities, with men exhibiting higher rates of abnormalities (47.2%) compared to women (34.9%). Additionally, it reported that male subjects had higher frequencies of QRS axis deviation, first-degree AV block, and incomplete right bundle branch block, while female subjects had a higher prevalence of sinus tachycardia [13].

The rise in ECG abnormalities with age observed in our study reflects the trends reported in other parts of the world. Research from rural South Africa showed that nearly half (47.6%) of older adults had atleast one significant ECG abnormality, with LVH being the most common. That study also found that men were more likely to display serious ECG issues such as LVH and Q wave changes, while women more often had prolonged QT intervals [14]. Another study focusing on a healthy younger population in an urban African region highlights the importance of portable and easy-to-use ECG machines for assessing cardiac health, especially in community settings. However, false positive results also need to be considered [15].

A large-scale study conducted in Tehran reported similar trends, indicating that both major and minor ECG abnormalities were more common in men. Additionally, major ECG changes were most frequently observed in individuals over the age of 65 [16]. The higher prevalence of LVH among the elderly population could be the result of cardiac changes due to the progressively increasing left ventricular afterload secondary to aging. The heart compensates through two mechanisms: by increasing contractile function and by undergoing structural adaptation, which further leads to ventricular hypertrophy [17]. Advancing age is influenced by oxidative stress, which results in cardiomyocyte loss that may be compensated for by cellular signaling pathways. These changes may further increase cardiac mass and hypertrophy, manifesting as abnormal ECG changes among aged individuals [18,19].

The ECG changes and gender differences among healthy subjects could be attributed to multiple factors, such as hormonal influences, genetic factors, and physical structure. The frequency and presentation of cardiac disease in male and female subjects may vary based on the interaction of gender and age factors over time [10]. However, one past study observed no variation in ECG patterns based on gender [20].

Recording ECG plays a crucial role in identifying cardiac pathology, which is reflected as abnormal ECG waves. This approach helps improve quality of life and reduces the overall disease burden in the aging population [21]. The present study supports the findings of the majority of studies conducted in the past, which have shown increasing ECG abnormalities with advancing age, and that males are more prone to heart diseases than females.

Limitation(s)

This study does not determine a cause-and-effect relationship, although it explores the association. The study also lacked confirmation with other diagnostic methods, such as echocardiography. Participants were recruited from health screening clinics, which meant that severely ill and less mobile elderly individuals were excluded from the study.

CONCLUSION(S)

This study underscores a distinct link between abnormal ECG patterns and advancing age among the elderly population in rural communities. The most common ECG abnormality was LVH, followed by signs indicative of past MI and slow cardiac rhythms. A higher number of ECG abnormalities were found in males compared to female subjects. This signifies the importance of routine ECG screenings in geriatric age groups, especially in rural areas where healthcare access may be limited. Early detection using simple,

non invasive tools like ECG can play a vital role in identifying asymptomatic heart disease and guiding timely management.

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