Contents lists available at UGC-CARE

International Journal of Pharmaceutical Sciences and Drug Research

[ISSN: 0975-248X; CODEN (USA): IJPSPP]

journal home page : https://ijpsdronline.com/index.php/journal

Research Article

Exploring the Prevalence and Patterns of Valvular Lesions in Rheumatic Heart Disease: Insights from South Indian Cohort

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ARTICLE INFO

Article history:
Received: 11 November, 2024
Revised: 06 December, 2024
Accepted: 12 December, 2025
Published: 30 January, 2025

Keywords:
Aortic valve regurgitation, Echocardiogram, Rheumatic heart disease, Valvular lesions.

DOI:
10.25004/IJPSDR.2025.170110

ABSTRACT

Rheumatic heart disease continues to pose a considerable public health challenge globally, impacting approximately 40 million individuals, as reported by the World Health Organization. The present study intended to measure the spectrum of valvular lesions in patients with rheumatic heart disease (RHD) using echocardiography among a South Indian Cohort. A total of 216 patients from Dhanya Cardiac Center, Salem, South India were enrolled, with a mean age of 43.7 years and a median age of 43 years. The majority of patients (64.4%) were between 31 and 60 years old, and 61.6% were female. Nearly all patients (92.6%) had a history of rheumatic fever. Valvular stenosis was observed in 92.6% of the patients, with mitral stenosis being the predominant type at 90.3%, followed by aortic stenosis (10.2%) and tricuspid stenosis (0.5%). Additionally, 99.1% of patients exhibited valvular regurgitation, predominantly mitral regurgitation (97.2%), with aortic regurgitation seen in 72.7%. The severity of mitral regurgitation ranged from mild (60.6%) to severe (5.1%), while 42.1% of patients had mild aortic regurgitation. These findings underscore the significant burden of mitral valve involvement in RHD and highlight the need for targeted interventions in this population. The study adds to the understanding of regional variations in RHD presentation and suggests avenues for future research focused on optimizing diagnostic and therapeutic approaches.

Introduction

Rheumatic heart disease (RHD) continues to pose a considerable challenge to public health worldwide, with an estimated 40 million people currently affected, according to the WHO. Despite being largely preventable, RHD continues to produce significant morbidity and death, predominantly in low and moderate-income countries, including India, where approximately 200,000 deaths are attributed to the disease annually.[1] India, being home to a substantial portion of the global burden, presents a unique epidemiological profile with marked regional variations. Among these regions, the South Indian population has shown an especially high prevalence of RHD, making it a focal point for public health interventions and scientific inquiry.[2] RHD is a long-term consequence of acute rheumatic fever, which results from untreated streptococcal infections. The disease primarily affects the heart valves, leading to progressive valvular lesions that can cause heart failure, stroke, and premature death.[3] Echocardiography has become the gold standard for diagnosing and monitoring valvular damage in RHD. The technique is favored for its non-invasive features and its capability to give real-time images of cardiac structures.[11] Despite the availability of echocardiography for diagnosing RHD, regional variations in clinical presentation and the progression of valvular lesions, it is vital to emphasize the

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

need for focused research to gain a deeper understanding of its effects on particular populations. Given the high burden of RHD in the South Indian population, the present study seeks to fill a critical gap in understanding the spectrum of valvular lesions within this demographic. With the aid of echocardiography, the research seeks to offer an in-depth understanding of the numerous types. Severity and distribution of valvular damage in patients with RHD. By focusing on the South Indian population, the findings of this study could inform region-specific healthcare policies, contributing to more effective screening, diagnosis, and treatment protocols. Although significant advancements have been made in the early detection and treatment of RHD, the disease continues to disproportionately affect socioeconomically disadvantaged populations.

Several studies have laid the groundwork for understanding the role of echocardiography in evaluating valvular lesions in RHD patients[10] provided comprehensive references for the usage of echocardiography in RHD assessment, emphasizing its critical role in diagnosing and monitoring valvular lesions. The report, highlighted the importance of early detection through echocardiography (American Society), particularly in endemic regions. However, while their study focused on global RHD populations, there remains a gap in specific regional studies that explore the nuances of valvular damage in South Indian cohorts. Arjun and his team conducted a prospective observational study on the clinical presentation and cardiac involvement in RHD patients.[7] Their findings underscored the variability in disease manifestation across different populations, with significant differences in the severity and types of valvular lesions. This study, however, was limited to clinical presentations without the integration of echocardiographic data, suggesting a need for more comprehensive studies combining clinical, echocardiographic, and genetic data. Alam and his team explored the range of valvular lesions in recently diagnosed RHD patients, providing valuable insights into the types and progression of valvular damage.[5] Their study, conducted in Bangladesh, emphasized that the most widespread indicator was the participation of the mitral valve, which prospered by tricuspid and aortic valve damage. While this study was critical in understanding valvular lesion patterns in a South Asian context, it did not explore the genetic factors influencing disease progression or examine regional differences within India. Topçu and Ucar discussed the current challenges in echocardiographic screening of RHD, noting that while echocardiography has revolutionized RHD diagnosis, there are still limitations in access to this technology in low-resource settings.[13] They also highlighted the need for more robust data on the genetic and environmental factors influencing valvular damage. Similarly, Lamichhane and his team in 2023 contributed a narrative assessment on the detection and management of latent RHD, arguing for the inclusion of genetic studies to better understand disease progression, but this remains an area lacking sufficient research.

While existing literature has contributed significantly to understanding the epidemiology and clinical presentation of RHD, there is a clear gap in studies that integrate echocardiographic assessment, particularly in specific regional populations like South India. The present study seeks to address these breaks by giving an inclusive evaluation of valvular lesions in RHD patients using echocardiography while also investigating the potential genetic markers associated with disease severity and progression. The aim of existing study is to evaluate the range of valvular abnormalities in patients with rheumatic heart disease in South India using echocardiography.

Materials And Methods

This investigation was carried out as a hospital-based analytical study, retaining a cross-sectional strategy. The cross-sectional technique was preferred to assess the range of valvular lesions in patients with RHD by utilizing echocardiography at a chosen point in time. This design allowed for the efficient evaluation of the prevalence, severity, and type of valvular lesions among a well-defined South Indian population, providing a comprehensive snapshot of the disease burden. The study took place at Dhanya Cardiac Center and Hospital located in Salem, Tamil Nadu, India. This multi-specialty hospital serves a large and diverse population, making it an ideal location for this study. All study participants were recruited from the Dhanya Cardiac Center, either as outpatients or inpatients. The hospital's cardiology unit, equipped with advanced diagnostic tools and experienced clinicians, provided the infrastructure necessary for high-quality echocardiographic assessments.

Methodology and Participant Selection

The study included participants diagnosed with long-lasting rheumatic heart disease, recognized by a vigorous observing system integrating echocardiography established screening. Eligible participants were either in preoperative or postoperative stages, ensuring a comprehensive range of disease severity. All participants provided their informed consent in writing to take part in the study. The criteria for exclusion included such as patients with congenital valvular diseases to avoid confounding with non-rheumatic conditions, those with rheumatoid arthritis or other autoimmune diseases that could independently affect heart valves, individuals with chronic inflammation or renal failure that might complicate cardiac assessments, and those unwilling to provide informed agreement. The calculation of the sample size was derived from information obtained in a prior cross-sectional study (5), where 65% of patients exhibited isolated valvular lesions, and 88.7% had mitral

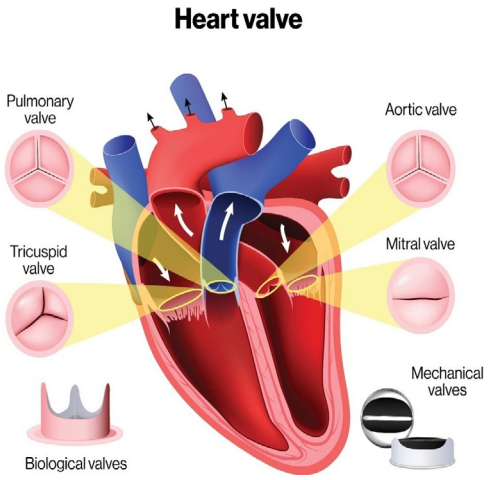
valve involvement. With an absolute precision of 10%, a 5% alpha error, and 80% power, the projected size of the sample was 216. A 10% non-response rate was also factored in, ensuring sufficient power to determine the distribution of valvular lesions in patients with RHD.

Data Collection and Echocardiographic Assessment Methodology

Data were gathered utilizing a pre-structured, semi-structured and pre-tested questionnaire. This captured patients' sociodemographic characteristics, detailed clinical history, and findings from both physical and systemic examinations. Patients underwent detailed transthoracic two-dimensional (2D) echocardiography and frequency studies like Doppler. Echocardiographic assessments were directed in acquiescence with the standards recognized by the American College of Cardiology and the American Heart Association. Two progressive ultrasound schemes, such as GERT 6800 and another one is Siemens ACUSON CV - 70, were used to ensure accuracy and dependability. These systems are recognized for their high-quality cardiac imaging capabilities, which enable detailed visualization of valvular lesions. Echocardiograms were reviewed by an experienced cardiologist at Dhanyaa Cardiac and Diabetic Centre, Salem, Tamil Nadu, to ensure accurate diagnosis and classification of the lesions. The data from these echocardiograms formed the basis for further analysis.

Ethical Considerations

Ethical approval for this study was obtained from the Official Ethical Committee of Vinayaka Mission's Kirupananda Variyar Medical College and Hospitals, located in Salem, Tamil Nadu (Ref. No: VMKVMC&H/IEC/21/008). Informed consent, obtained in written format, was acquired from all participants prior to their enrolment in the present study. The information sheet of participants was provided in the local language and read to the participants to ensure full understanding before consent was given.



This figure represents the structural elements and functional interconnections of the four primary heart valves: the aortic, mitral, tricuspid, and pulmonary valves. The labels denote the leaflets, cusps, chordae tendineae, and papillary muscles related to each valve.

Fig. 1: Anatomy of different valves

Statistical Analysis

The gathered data were input manually into Microsoft Excel prior to being coded, recoded, and analyzed utilizing the Statistical Package for Social Sciences. (SPSS) version 23. Categorical variable quantity was abridged using frequencies and percentages, whereas constant variables were described as means (± standard deviation) or medians (with interquartile ranges), depending on the normality of the data. Normality was measured by Kolmogorov-Smirnov and Shapiro-Wilk tests. For statistical significance, the analysis used Fisher's exact test or Chi-square test or for definite variables, whereas independent t-tests were applied to assess continuous outcomes. Ultimately *p-value* of under 0.05 was significant.

Results

Patient Features and Study Population

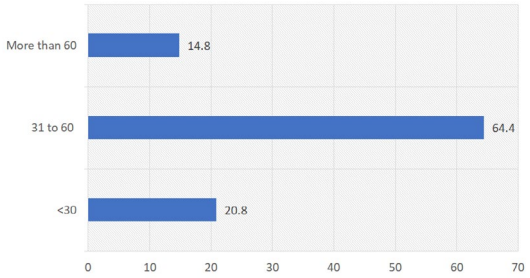
The current study included 216 patients diagnosed with RHD, with an average age of 43.7 years and a median age of 43 years. The mainstream participants (64.4%) were between the ages of 31 and 60, while 20.8% were under 30 years old, and 14.8% were over 60 years of age (Fig. 2). In terms of gender distribution, more than half of the participants were female (61.6%), while 38.4% were male. All participants were from Salem, Tamil Nadu, and had confirmed diagnoses of rheumatic heart disease, with 92.6% having a history of rheumatic fever (Fig. 3).

Valvular Involvement in RHD Patients

In terms of valvular involvement, 92.6% of patients had stenosis, with the majority (90.3%) experiencing mitral stenosis, followed by aortic stenosis (10.2%), and tricuspid stenosis in only 0.5%. Additionally, 99.1% of patients presented with valvular regurgitation, most commonly affecting the mitral valve (97.2%), with aortic regurgitation seen in 72.7%, and tricuspid regurgitation in 0.5% (Fig. 4).

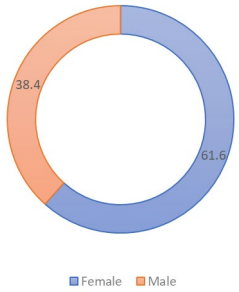
Severity of Mitral and Aortic Regurgitation in RHD Patients

When assessing the severity of mitral regurgitation, 60.6% of patients had mild regurgitation, 27.3% had moderate regurgitation, 5.1% had severe regurgitation, and 4.2% had trivial regurgitation. For aortic regurgitation, 42.1% had mild regurgitation, 30.6% had trivial regurgitation, and 27.3% had no aortic regurgitation (Fig. 5). These findings provide a detailed spectrum of valvular lesions in the studied population, with a predominance of mitral valve involvement, highlighting the critical need for



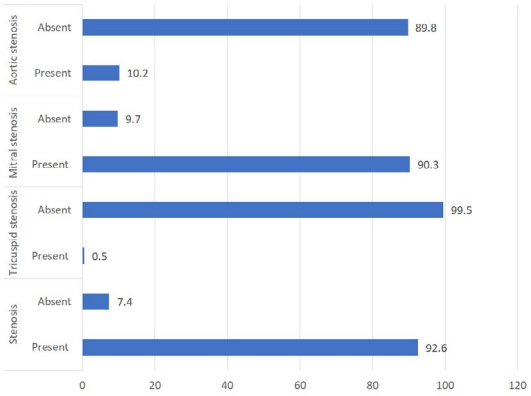
This histogram depicts the age distribution of the patients involved in the study. The x-axis denotes age in years, whereas the y-axis reflects the frequency or percentage of patients categorized by age group. The graph offers valuable insights into the age demographics of the study population.

Fig. 2: Distribution of patients, by age (in years)



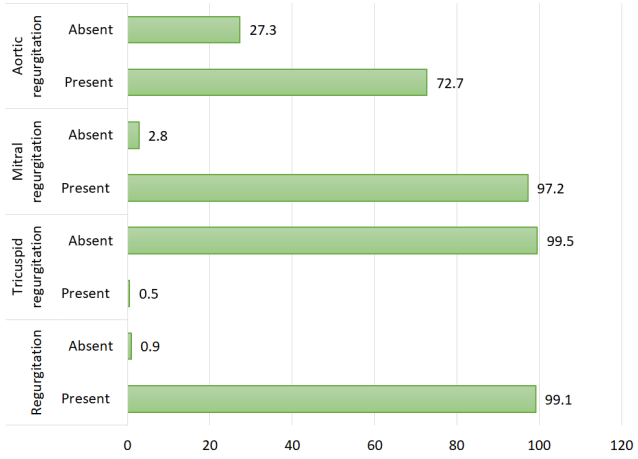
This circular chart illustrates the gender distribution among the participants in the study. This delineates the two gender categories, namely male and female, which reflects the frequency or percentage of individuals within each category. The graph offers valuable insights into the gender equilibrium of the study population.

Fig. 3: Distribution of patients, by gender



This horizontal describes the occurrence of stenosis and valvular involvement among the participants in the study. The x-axis categorizes the participants into distinct groups (such as no stenosis/no valvular involvement, stenosis/no valvular involvement, no stenosis/valvular involvement, and stenosis/valvular involvement), while the y-axis shows the frequency or percentage of patients in each category. The graph offers valuable insights into the simultaneous presence of these two conditions within the study population.

Fig. 4: Distribution of patients, by presence or absence of stenosis and valvular involvement



This chart depicts the occurrence of regurgitation and valvular involvement among the participants in the study. The x-axis delineates various categories whereas the y-axis reflects the frequency or percentage of patients in each category. The graph offers valuable insights into the simultaneous presence of these two conditions within the study population.

Fig. 5: Distribution of patients, by presence or absence of regurgitation and valvular involvement

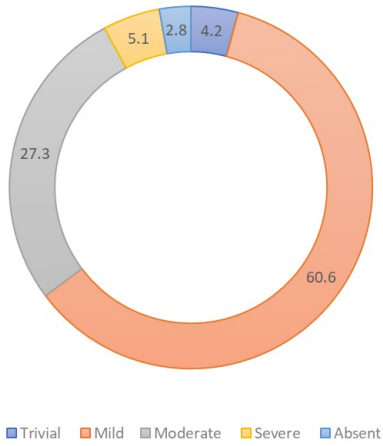
targeted interventions in managing RHD in this region (Fig. 6).

Outcome of Prevalence of Heart Valve Regurgitation in RHD individuals

Table 1. describes the distribution of regurgitation and total count of regurgitation," offers a detailed breakdown of the prevalence of various heart valve regurgitation conditions. Among the different types, mitral regurgitation is the most common, with mild mitral regurgitation accounting for 25.93% of cases. Combinations of mitral and aortic regurgitation are also prevalent, with mild mitral/mild aortic and mild mitral/trivial aortic accounting for 18.98 and 16.67% of cases, respectively. Moderate mitral/mild aortic and moderate mitral/trivial aortic combinations are less common but still account for a significant portion of the total. Severe mitral/mild aortic regurgitation is a relatively rarer occurrence, with only 5.09% of cases. Tricuspid regurgitation and trivial aortic/trivial mitral combinations are both infrequent, each accounting for 0.46 and 4.17% of cases, respectively. Overall, the table highlights the diverse nature of heart valve regurgitation, with mitral regurgitation being the most prevalent condition and various combinations of mitral and aortic regurgitation also contributing significantly to the overall distribution.

Discussion

The present study provides an in-depth echocardiographic examination of valvular lesions in 216 patients with RHD from the South Indian population. Our key findings exposed that the mean age of the group was 43.7 years,



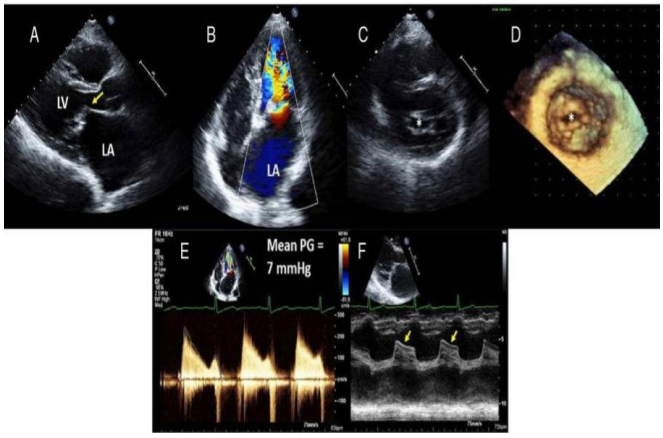
This bar chart depicts the distribution of various severities of mitral regurgitation among the participants in the study. The x-axis delineates the different levels of severity (such as mild, moderate, and severe), whereas the y-axis reflects the frequency or percentage of patients classified within each severity category. The graph offers valuable insights into the prevalence of mitral regurgitation severity within the study cohort.

Fig. 6: Distribution of patients, by severity of mitral regurgitation

Table 1: Distribution of Regurgitation and Total Count of Regurgitation

Regurgitation	*Count of Regurgitation*
Mild aortic	1.39%
Mild mitral	25.93%
Mild mitral/mild aortic	18.98%
Mild mitral/trivial aortic	16.67%
Moderate mitral/mild aortic	17.13%
Moderate mitral/trivial	0.46%
Moderate mitral/trivial aortic	9.72%
Severe mitral/mild aortic	5.09%
Tricuspid regurgitation	0.46%
Trivial aortic/trivial mitral	4.17%
Grand total	100.00%

This table presents a detailed analysis of the different types of regurgitation identified among the study participants. The initial column enumerates the various combinations of regurgitation, whereas the subsequent column specifies the total number of patients displaying each combination. This table serves to illuminate the prevalence and trends of regurgitation within the studied population.



Two-dimensional echocardiographic images (A-F) were obtained from a 35-year-old female patient diagnosed with rheumatic mitral stenosis. Images A and C depict mild mitral regurgitation, while image B demonstrates nodular calcification of the mitral valve leaflets in the parasternal short-axis view. Image D presents continuous wave Doppler echocardiography. Image E features a box highlighting the anterior leaflet, which exhibits limited tip motion, characterized by the "hockey stick" appearance associated with rheumatic mitral stenosis. Finally, image F illustrates the assessment of the mitral valve area using the three-dimensional planimetry technique.

Fig. 7: Two-dimensional echocardiogram images recording with Doppler echocardiography

with most patients (64.4%) between 31 and 60 years of age. In terms of gender, 61.6% were female, highlighting a potential gender predisposition in RHD, a trend commonly observed in global epidemiology. The study also found a high prevalence of mitral valve involvement, with 90.3% of patients exhibiting mitral stenosis and 97.2% showing mitral regurgitation. These results are consistent with prior studies (8), in which they reported predominant mitral valve damage in their cohort of Ethiopian RHD patients, reflecting a universal pattern of RHD across different populations.

Our findings correlated with previous works (4,5), where high prevalence of mitral stenosis (88.7%) in newly diagnosed RHD patients, underscoring the global burden of mitral valve involvement in RHD cases. Additionally, the pattern of mitral regurgitation severity in our study, where 60.6% of patients had mild regurgitation, followed by moderate (27.3%) and severe cases (5.1%) in connection with previous work[14] they found similar distributions in their echocardiography for RHD in high-risk regions. The high incidence of mild to moderate mitral regurgitation may reflect early-stage disease or effective medical management, whereas the smaller percentage of severe cases illustrates the importance of early intervention in RHD management. Interestingly, our study also reported aortic stenosis in 10.2% of patients and aortic regurgitation in 72.7%, findings that are consistent with the results of Rwebembera and his team[12] they observed aortic involvement in approximately 15% of RHD patients in their cohort. This similarity indicates that aortic involvement, although less frequent than mitral valve damage, is a significant feature of RHD progression. However, the aortic regurgitation rate in our study was notably higher than that reported by Ali and his colleagues [6,9] who observed aortic regurgitation in about 50% of their RHD patients undergoing evaluation for percutaneous balloon mitral

valvuloplasty. This discrepancy could be attributed to differences in patient selection criteria, disease severity, or regional variations in disease progression, suggesting that aortic valve involvement may be more pronounced in the South Indian population.

Both molecular and developmental factors can explain the predominance of mitral valve lesions in RHD. Rheumatic heart disease is a sequela of severe rheumatic fever, an autoimmune reaction initiated by an infection caused by group A streptococcus. The mitral valve is particularly susceptible to immune-mediated damage due to its anatomical position and the high hemodynamic stress it endures, which could exacerbate inflammation and fibrosis.[15] Additionally, molecular mimicry between streptococcal antigens and cardiac myosin proteins leads to targeted immune responses, resulting in chronic valve damage, particularly in the mitral and aortic valves. Over time, these immune reactions cause thickening and calcification of the valves, leading to stenosis and regurgitation.[16] High incidence of slight and modest regurgitation detected in our study may reflect early or moderate disease stages, where inflammatory processes have yet to cause significant scarring or calcification. The high prevalence of rheumatic fever history (92.6%) within our cohort further validates this observation, signifying that these patients are suffering the chronic phase of RHD, during which valvular participation becomes progressively significant. Furthermore, genetic and environmental factors specific to South Indian populations may contribute to these findings, as suggested by Regmi and team,[11] they identified regional variations in the progression and presentation of RHD in school children across Nepal.

One of the prime strengths of present study rely on its focus on a specific regional population, providing valuable insights into the burden and progression of RHD in South India. By utilizing advanced echocardiographic techniques and adhering to established guidelines,[12] the study offers a detailed and accurate assessment of valvular lesions. Moreover, the inclusion of both preoperative and postoperative patients allowed for a comprehensive understanding of RHD's clinical spectrum. However, this study is not without limitations. The cross-sectional design provides a snapshot of disease at one point in time, limiting our ability to assess disease progression longitudinally. Furthermore, while the study provides crucial data on valvular involvement, it does not delve into the genetic or socio-environmental factors that may influence the progression of RHD in this population. Future studies incorporating genetic analysis, as suggested by Alam and team,[5] could shed light on the molecular underpinnings of disease severity. Additionally, the study's focus on a single hospital setting in which the findings may have limited applicability to other regions of India due to the specific context of Tamil Nadu.

Conclusion

In conclusion, this study confirms that mitral valve involvement, particularly mitral stenosis and regurgitation, remains the hallmark of RHD in the present South Indian Cohort study, consistent with global findings. The high prevalence of aortic involvement, both stenosis and regurgitation, further highlights the systemic nature of valvular damage in RHD. While the study offers valuable data on the spectrum of valvular lesions, future research should aim to explore genetic and environmental effects that disturb the development of diseases, along with the longstanding results for patients exhibiting different levels of valvular impairment.

Acknowledgment

The authors would like to express their sincere gratitude to Dhanya Cardiac Centre. Salem, Tamil Nadu, for providing the necessary resources and support to conduct this study.

Statement of Informed Consent

Informed consent was obtained from all individuals prior to their enrolment in the study. The PIS was made available in the local language and was read aloud to the participants to guarantee comprehensive understanding before consent was provided.

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HOW TO CITE THIS ARTICLE: Shivapriya NR, Kumar BS, Gandhi SJ, Sangeetha S. Exploring the Prevalence and Patterns of Valvular Lesions in Rheumatic Heart Disease: Insights from South Indian Cohort. Int. J. Pharm. Sci. Drug Res. 2025;17(1):67-73. **DOI:** 10.25004/IJPSDR.2025.170110