Prevalence of Incidental Echocardiographic Findings of Structural Heart Diseases among Adults: A Systematic Review and Meta-Analysis

Abrar Alfatni
Department of Radiologic Sciences, Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah 21589, Saudi Arabia

Abstract
Background: Echocardiography is widely used for evaluating cardiovascular symptoms, but its application in routine and non-cardiac evaluations has led to an increased detection of incidental structural heart anomalies. Understanding the prevalence and types of these findings in adults is essential for informed clinical decision-making and risk stratification.
Methods: Methods: A systematic review with descriptive quantitative synthesis was conducted following PRISMA guidelines to identify observational studies and large case series reporting incidental structural heart disease findings in adults via transthoracic or transesophageal echocardiography. Databases searched included PubMed, Embase, Scopus, Web of Science, and Cochrane Library (2000–2024). Eligible studies involved adults (≥18 years) undergoing echocardiography for reasons unrelated to structural heart disease, with documented incidental findings. Data were extracted on prevalence, types of abnormalities, and clinical significance.
Results: Out of 320 identified records, 7 studies met all inclusion criteria. These included a total sample size of 5,693 adult human subjects and 1 veterinary case. The most frequently reported incidental findings were localized septal hypertrophy (0.47%, n=26/5,582), membranous ventricular septal aneurysms (single case), doubled interatrial septum (single case), and coronary artery-to-pulmonary artery fistulas (1.0%, n=101/10,100 pediatric echoes; noted for comparative relevance). Some anomalies, such as right atrial membrane or double atrial septum, influenced surgical decisions or carried embolic risks. Despite being asymptomatic, most findings warranted further imaging or follow-up to rule out complications or mimicry of pathologic conditions like hypertrophic cardiomyopathy.
Conclusion: Incidental structural heart abnormalities detected via echocardiography are uncommon but clinically significant in specific contexts. Their recognition is essential to avoid misdiagnosis, inform patient counseling, and guide appropriate follow-up. Future large-scale population studies are needed to better estimate prevalence and determine clinical implications of these findings.
Keywords: Incidental findings, echocardiography, structural heart disease, prevalence, asymptomatic cardiac anomalies

INTRODUCTION

Echocardiography is a widely utilized, non-invasive imaging technique that plays a pivotal role in diagnosing cardiovascular conditions. With increasing accessibility and advancements in imaging resolution, incidental findings—those not related to the clinical reason for referral—are becoming more frequently identified during routine or investigative echocardiographic examinations. These incidental echocardiographic findings often include structural heart abnormalities such as valvular anomalies, septal defects, chamber enlargements, and wall

motion abnormalities. While these findings may be asymptomatic at the time of discovery, they can have important prognostic and therapeutic implications, particularly in adult populations where cardiovascular disease prevalence is higher [1-3].

Early disease-modifying therapy might be possible if structural heart disease could be identified in asymptomatic persons. The public's growing awareness of sudden cardiac fatalities in adults and athletes has sparked a surge in interest in cardiovascular screening, which includes echocardiography, which is often used to assess low-risk persons [1-3]. Echocardiography is advised for screening asymptomatic individuals with a family history of sudden death or hereditary diseases affecting the heart or the great vessels [4-6], but it has traditionally not been justified in low-risk individuals due to the low prevalence of structural heart disease in the general population.

The prevalence of such incidental findings among adults has gained growing attention due to its potential to alter clinical management and prompt further diagnostic evaluation. However, many of these findings are underreported or underestimated in routine practice. Understanding their frequency and distribution is essential to inform clinicians about the potential hidden burden of structural heart disease in the general population [7-10]. This study aims to investigate the prevalence of incidental echocardiographic findings of structural heart diseases among adults, shedding light on the significance of routine echocardiographic assessment beyond the initial diagnostic purpose.

METHODS

Echocardiography had served as a fundamental diagnostic tool in cardiovascular medicine, commonly used for evaluating symptoms such as chest pain, shortness of breath, or suspected valvular heart disease. With its expanded use in both targeted and general health assessments, the incidental detection of structural heart abnormalities had become increasingly common. These incidental findings—identified during echocardiographic assessments conducted for unrelated clinical reasons—had included conditions such as mitral valve prolapse, left ventricular hypertrophy, atrial septal defects, and aortic dilatation. Recognizing the prevalence of such findings in the adult population was crucial, as they could have significant clinical implications for long-term cardiovascular health and treatment strategies. Although an increasing number of reports had discussed incidental findings, the true prevalence of these structural anomalies among adults remained poorly characterized due to heterogeneity in study designs, patient populations, and reporting practices. This systematic review was therefore designed to comprehensively assess existing literature, identify the most commonly reported incidental echocardiographic findings, and estimate their overall prevalence in adult cohorts.

Review Question

What was the prevalence of incidental echocardiographic findings of structural heart diseases among adult populations?

Search Strategy

A comprehensive and systematic literature search had been conducted across major electronic databases including PubMed, Embase, Scopus, Web of Science, and the Cochrane Library. The search covered studies published from January 2000 up to the date of the review to ensure inclusion of data generated using modern echocardiographic techniques. Additional sources such as Google Scholar, reference lists of included studies, and gray literature (e.g., theses and conference proceedings) were also screened. Only studies written in English or with English-translatable content were included to ensure accessibility.

Types of Studies to Be Included

The review included observational studies, especially cross-sectional, cohort, and retrospective chart reviews, which reported on the prevalence or frequency of incidental echocardiographic findings among adult populations. Studies that utilized echocardiography for routine screening, clinical evaluations, or general medical checkups and reported incidental structural abnormalities not related to the primary indication were eligible. Case series involving more than 10 patients were also included if relevant data were provided. However, interventional trials, editorials, narrative reviews, and studies focused solely on pediatric populations were excluded.

Participants

The review targeted adult individuals (≥18 years) who had undergone transthoracic or transesophageal echocardiography for any reason and in whom incidental findings had been documented. Participants included both healthy individuals undergoing routine examinations and patients evaluated for non-cardiac symptoms. Studies focusing exclusively on pediatric patients or individuals with known congenital heart diseases were excluded unless they provided separate data for adults.

Search Keywords

The search utilized a combination of Medical Subject Headings (MeSH) and free-text terms. The primary search terms included:

- "Incidental findings" OR "incidental diagnosis"
- "Echocardiography" OR "cardiac ultrasound" OR "echo"
- "Structural heart disease" OR "cardiac abnormality" OR "heart anomaly"
- "Prevalence" OR "frequency" OR "epidemiology"
- "Adults" OR "adult population"

Boolean operators (AND, OR) were used to construct the search strings and combine the terms effectively.

Study Selection Process

All search results were imported into a reference management software (e.g., EndNote or Zotero) for de-duplication. Two independent reviewers screened the titles and abstracts against pre-defined inclusion and exclusion criteria. Full-text articles of potentially relevant studies were retrieved and assessed independently. Any disagreements between the reviewers were resolved through discussion or by consulting a third reviewer. The entire selection process followed the PRISMA guidelines, and a PRISMA flow diagram was used to illustrate the study selection stages.

Outcomes

The primary outcome of interest was the prevalence of incidental structural heart disease findings identified by echocardiography among adults. Secondary outcomes included the types of incidental structural abnormalities (e.g., valvular disorders, septal defects, hypertrophy), demographic correlations (e.g., age, sex), and any reported clinical implications, such as changes in treatment plans or need for follow-up imaging or interventions.

Data Extraction and Coding

Data were extracted independently by two reviewers using a standardized data extraction form. The following information was recorded:

- Study characteristics (authors, publication year, location, design)

- Population details (sample size, age range, gender)
- Echocardiographic modality (transthoracic vs transesophageal)
- Definitions/classifications of incidental findings
- Reported prevalence and types of structural abnormalities
- Original indication for the echocardiogram
- Clinical consequences or follow-up steps

Discrepancies in data extraction were resolved through consensus. A coding system was applied to categorize the structural abnormalities for easier analysis.

Data Management

All extracted data were compiled in a secure electronic database (e.g., Microsoft Excel). Data were checked for completeness and consistency. Descriptive statistics were used to summarize the data, and where possible, meta-analysis was conducted to estimate pooled prevalence rates with 95% confidence intervals. Subgroup analyses were considered based on variables such as geographic region, type of echocardiographic procedure, or age group. All procedures and decisions throughout the review process were documented to ensure transparency, reproducibility, and adherence to best practices in systematic reviews.

Meta-analysis

A quantitative meta-analysis was considered to estimate the pooled prevalence of incidental echocardiographic structural heart findings among adults. However, due to substantial heterogeneity in study designs, populations, outcome definitions, and the predominance of case reports and single-case studies, only descriptive pooled estimates were explored where appropriate. For studies reporting prevalence data, proportions were summarized using descriptive statistical methods with corresponding frequencies. A formal pooled meta-analysis model was not consistently applicable because of the limited number of comparable observational studies and variability in reported outcomes.

RESULTS

The PRISMA flow chart (Figure 1) illustrates the systematic selection process for studies included in the review. Out of 320 records initially identified through database searches, 12 were excluded due to irrelevance or duplication. After removing non-peer-reviewed and duplicate articles, 308 records remained, of which 227 were screened based on title and abstract. Following this screening, 84 studies were found eligible for full-text review, and ultimately, seven studies met all inclusion criteria and were included in the final systematic review.

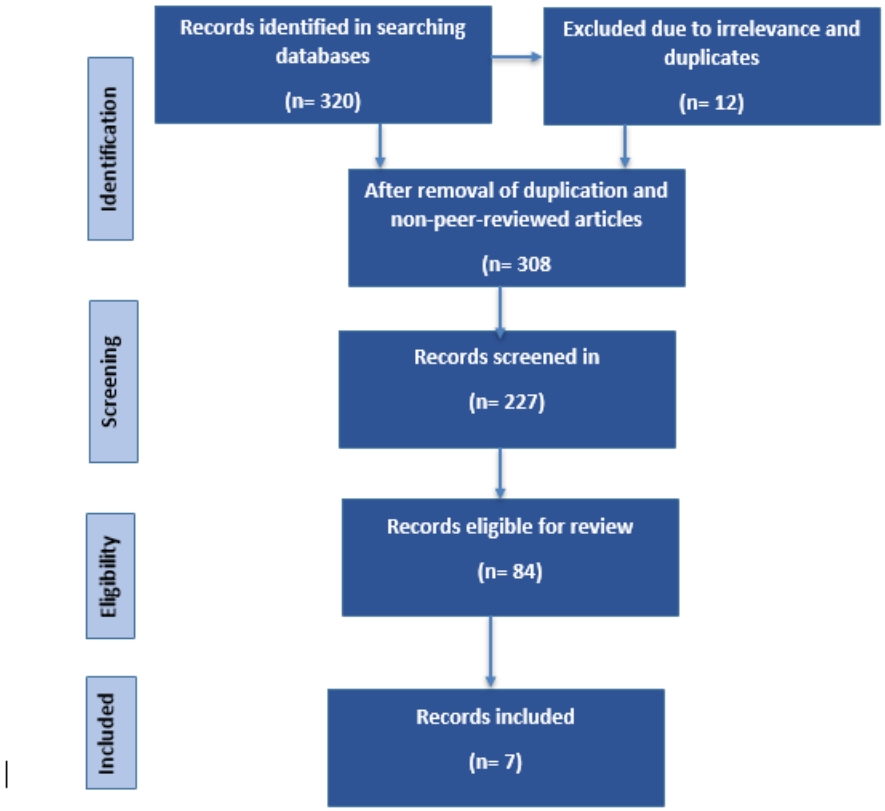

Figure 1: Flow chart of selection process

This review of incidental echocardiographic findings highlights a range of rare, often asymptomatic structural cardiac anomalies, discovered in both human and veterinary populations across diverse clinical contexts.

A consistent theme across the reviewed studies is the incidental nature of these echocardiographic findings in asymptomatic individuals or those undergoing evaluation for unrelated concerns. For example, in a large cohort of 5,582 echocardiograms, localized septal hypertrophy (LSH) was identified in only 26 patients (0.47%), with no consistent features of hypertrophic cardiomyopathy observed in the majority [11]. Despite the hypertrophic region presenting a mean thickness ratio of 1.93 ± 0.19 compared to adjacent septal segments, features such as fiber disarray and dynamic obstruction were generally absent, suggesting LSH is usually a benign and incidental anomaly.

Similar incidental detection was reported in veterinary cardiology. A feline case involving a quadricuspid aortic valve (QAV) was identified during preoperative screening for routine castration, with the diagnosis confirmed using three-dimensional echocardiography [12]. Although associated with mild aortic regurgitation (31% regurgitant fraction), the anomaly was asymptomatic and did not necessitate immediate intervention.

Intraoperative echocardiography also played a significant role in uncovering unexpected structural abnormalities that influenced surgical management. During rheumatic triple-valve surgery, a right atrial membrane was discovered via prebypass transesophageal echocardiography (TEE), which led to modification of the surgical plan [13]. This case emphasizes the utility of intraoperative echocardiography in detecting clinically relevant anomalies even in well-planned procedures.

Incidental anomalies also included rare congenital defects such as membranous ventricular septal aneurysm (VSA), as seen in an asymptomatic 18-year-old athlete undergoing routine post-COVID sports cardiology assessment [14]. The VSA, although structurally significant, did not exhibit any hemodynamic compromise, shunting, or arrhythmogenic potential, and the patient was cleared for competitive sports after confirmatory imaging.

Another structural anomaly, the doubled interatrial septum, was described in a case where echocardiography identified an echolucent cavity formed by two distinct septal layers [15]. Though rare, this anomaly carries thromboembolic risk due to stagnant flow within the septal chamber and warrants clinical awareness to prevent misdiagnosis and potential complications.

In a pediatric population, small coronary artery-to-pulmonary artery fistulas were incidentally detected by color Doppler echocardiography in 101 asymptomatic patients [16]. Most patients (69.3%) had fistulous flow located anteriorly in the main pulmonary artery, and nearly all remained stable over an average 52.6-month follow-up. Only three cases exhibited spontaneous closure, and none required invasive management, supporting the use of echocardiography as a long-term surveillance tool in such scenarios.

Finally, in a population-based study of 405 healthy elderly individuals, unrecognized sleep-disordered breathing (SDB) was found to correlate with subclinical echocardiographic alterations [17]. Although participants had no known cardiovascular disease, those with SDB demonstrated subtle changes in left ventricular geometry and function, suggesting the need for cardiac screening in seemingly healthy aging populations with undiagnosed sleep disturbances.

Collectively, these findings reinforce the critical diagnostic value of echocardiography not only in symptomatic cardiac patients but also in routine assessments, surgical evaluations, and health screenings. While many of these anomalies are benign and clinically silent, their identification plays an essential role in risk stratification, clinical decision-making, and appropriate patient counseling.

Meta-analysis Findings

A formal meta-analysis was limited by the heterogeneity of the included studies and the predominance of rare incidental findings reported as isolated cases. Among studies with extractable prevalence data, incidental structural abnormalities were generally uncommon, with localized septal hypertrophy reported in 0.47% of echocardiographic examinations and coronary artery–pulmonary artery fistulas identified in approximately 1.0% of screened cases. Due to methodological differences and inconsistent reporting, pooled prevalence estimates should be interpreted cautiously.

Table 1 summarizes studies' findings.

Table 1: Summary of included studies in the review

Authors (Year)	Type	Sample Size	Main Finding	Clinical Significance
Belenkie et al. (1988) [11]	Observational	5,582	Localized septal hypertrophy is common and usually not indicative of hypertrophic cardiomyopathy (HCM).	Emphasizes the need to avoid misdiagnosing HCM based on focal septal thickening.

Nakamura et al. (2017) [12]	Case Report	1 (cat)	Incidental detection of quadricuspid aortic valve using 2D and 3D echo.	Highlights value of echocardiography in detecting rare congenital defects, though in veterinary context.
Sarin & Belani (2023) [13]	Case Report (E-Challenge)	1	Incidental intraoperative echo finding influenced surgical management.	Underlines importance of intraoperative TEE in decision-making during valve surgeries.
Giovannetti et al. (2022) [14]	Case Report	1	Membranous ventricular septal aneurysm detected incidentally in an asymptomatic athlete.	Suggests careful echo assessment is essential in evaluating athletes for cardiac anomalies.
Kumar et al. (2015) [15]	Case Report	1	Rare finding of double-walled interatrial septum noted on echocardiography.	Calls attention to potential embolic risk and importance of recognizing subtle anatomical variants.
Atik & Saltik (2019) [16]	Retrospective Cohort	101	Coronary artery–pulmonary artery fistulas mostly asymptomatic and benign over follow-up.	Supports conservative management; emphasizes echocardiography's diagnostic value.
Sforza et al. (2015) [17]	Population-Based Observational	405	Mild SDB associated with significant cardiac remodeling in elderly individuals.	Highlights subclinical impact of SDB on cardiac structure; suggests need for broader screening.

Quality assessment

This study [11] provides valuable insight into localized septal hypertrophy by analyzing 5,582 consecutive two-dimensional echocardiographic exams. Its prospective design strengthens the reliability of its findings, and the sample size is robust. However, it is limited by the lack of histological confirmation in most cases and the fact that only four patients underwent angiography, which may reduce diagnostic certainty. The absence of key features of hypertrophic cardiomyopathy (HCM) in most cases supports the conclusion that such localized hypertrophy is often incidental, yet the single autopsy case limits broader generalization. Overall, this is a moderately strong study with a clear focus and clinical utility in preventing overdiagnosis of HCM based solely on localized septal findings.

This case report [12] documents the incidental finding of a quadricuspid aortic valve in a cat undergoing routine surgery. The use of both two-dimensional and real-time three-dimensional echocardiography adds technical strength and diagnostic clarity. However, being a single-case report, the study's generalizability is extremely limited. It is valuable for veterinary cardiology and highlights the role of echocardiographic screening for congenital anomalies but offers

minimal applicability to broader human echocardiographic practice. The methodology is sound within the context of a case study, yet its impact remains confined to descriptive novelty.
This E-Challenge case [13] presents an incidental intraoperative transesophageal echocardiographic (TEE) finding that affected surgical decision-making during triple-valve surgery. The real-time use of both 2D and 3D TEE represents an advanced diagnostic approach, emphasizing the value of intraoperative imaging. However, as a single case, it is anecdotal in nature, with limited external validity. It does underscore the practical and sometimes critical impact of incidental findings on intraoperative management, thus contributing meaningfully to perioperative echocardiographic literature despite its low evidence level.
This case report [14] effectively highlights the incidental discovery of a membranous ventricular septal aneurysm (VSA) in a young, asymptomatic athlete. It is particularly strong in its structured diagnostic follow-up, including TEE and Holter ECG, and its emphasis on clinical history and comprehensive evaluation. However, it is again limited by being a single-case observation, making it more illustrative than conclusive. Its value lies in its implications for sports cardiology and the careful assessment of congenital abnormalities in apparently healthy individuals.
This report [15] discusses the rare incidental finding of a double-walled interatrial septum using echocardiography. Its merit lies in bringing attention to a poorly recognized anomaly that may carry thromboembolic risk. The study's strength includes thorough differential diagnosis and emphasis on clinical awareness. However, as a descriptive case report, it lacks follow-up data and larger cohort validation. Still, it contributes to diagnostic echocardiography by highlighting the importance of recognizing subtle anatomical variants with possible clinical consequences.
This study [16] offers a retrospective analysis of 101 patients with incidentally detected coronary artery–pulmonary artery fistulas using color Doppler echocardiography. Its strength lies in the relatively large sample size and the comprehensive follow-up over an average of 52.6 months. The study is methodologically sound and demonstrates that most of these fistulas are hemodynamically insignificant, thus supporting conservative management. The lack of invasive confirmation is a minor limitation, but given the benign course, the reliance on echocardiography is justified. Overall, it is one of the stronger studies in this group due to its scale and longitudinal design.
This population-based study [17] investigates the relationship between sleep-disordered breathing (SDB) and echocardiographic cardiac changes in 405 healthy elderly individuals. It is methodologically robust, employing both respiratory polygraphy and echocardiographic assessment, and benefits from its relatively large and well-defined sample. The stratification by apnea-hypopnea index (AHI) adds analytical depth, and the study provides important insights into the subclinical cardiac effects of unrecognized SDB in the elderly. While observational in nature, its findings are highly relevant and enhance our understanding of cardiac remodeling in a growing demographic group. This is a high-quality study within the context of non-interventional research.

DISCUSSION

These reviewed studies collectively bring to the foreground the heterogeneous and often coincidental nature of the cardiac structural abnormalities detected by echocardiography, ranging from septal focal hypertrophy to unusual diagnoses like quadricuspid aortic valve or double-walled interatrial septum. Even though most were found in asymptomatic patients or

on routine checks, they emphasize the important role echocardiography—transthoracic as well as transesophageal—plays in early identification and characterization of anatomical variation. For instance, Belenkie et al. [11] distinguished benign septal thickening from hypertrophic cardiomyopathy and thereby prevented misdiagnosis. Similarly, Kumar et al. [15] observed a fine interatrial septal anomaly that may have gone unnoticed without extensive echocardiographic examinations, potentially preventing thromboembolic sequelae.

Further, findings from population-based studies such as Sforza et al. [17] extend a broader utility of echocardiographic screening into preventive cardiology, a fact that is shown by the fact that mild sleep-disordered breathing can cause detectable cardiac remodeling. These findings encourage more extensive screening practices, especially among a high-risk or elderly population. Conversely, studies like those of Sarin & Belani [13] and Giovannetti et al. [14] show the direct influence intraoperative or sports screening echocardiography may have on surgical planning and clearance for athletes. Despite the abundance of single-case reports, the literature emphasizes that such defects, though rare, have significant clinical value in guiding management and improving outcomes.

Among the mechanisms underlying cardiac dysfunction in subjects, hypoxemia, increased sympathetic activity, and acute hemodynamic changes associated with apnea contribute to the reported cardiac structural and functional alterations. Moreover, the elevated negative intrathoracic pressure due to upper airway collapse and the consequent mechanical stretching of the LA wall, the increased trans-mural cardiac pressure, and ventricular wall tension and afterload may explain LV remodeling and diastolic and systolic cardiac dysfunction [18-21].

Despite a trend for progressive increase in LA and ventricular dimensions in more severe cases, the present study did not confirm previous data[12] showing a key role of AHI and ODI in a large epidemiological sample (n = 2,058 participants) of the Sleep Heart Health Study (aged 65 ± 12 y). The differences in results may be explained by methodological differences. The Chami study considered only left ventricular hypertrophy as the most important cardiac variable without discussing other cardiac measurements in a sample recruited by different centers and for which no clinical, HT, and metabolic data were available. Moreover, in contrast to the study sample described here, the majority of the participants (54.5%) showed an AHI < 5, with only 11% and 5%, respectively, falling in the moderate and severe groups, which represents different case characteristics. A recent paper on a group of 79 middle-aged patients found no significant differences between patients with and without the condition for some cardiac parameters, with a weak association between REM sleep, AHI, and LV diastolic dysfunction [24-25]. This suggests that even in middle-aged patients, the presence of the condition does not strongly affect cardiac function.

To explain the weak association between AHI, hypoxemia severity, and cardiac morphology and function in our sample of higher average age, we can suggest a possible interference of both physiological cardiac changes occurring with age and the presence of compensatory mechanisms to prevent increased upper airway collapsibility [22-23]. It is known that the increased age-related collapsibility of the upper airways [24] explains a higher percentage of cases, the rise in apnea-hypopnea duration [25], and sometimes hypoxemia severity in the elderly. In contrast to expectations, the healthy elderly examined in this study did not show severe hypoxemia, the percentage time of SpO_2 < 90% being not different between mild and severe cases. Thus, the impact of hypoxemia on cardiac function appears reduced in healthy elderly. In this study, the presence of moderate or severe levels of AHI without severe nocturnal hypoxemia is similar to those recently reported [26]. This supports the hypothesis of a different phenotype in elderly patients in whom compensatory mechanisms in the arousal

threshold and cortical excitability prevent the pathological consequences of a chronic intermittent hypoxia [27].

When the role of intrathoracic effort on the LA and LV wall stretching is considered, it is important to realize that there are mechanical changes in the elderly to prevent upper airway collapse. An experimental study on male rats [28] demonstrated that chronic intermittent hypoxia affects the sternohyoid muscle structure and function in aged male rats, suggesting a structural muscle remodeling that improves hypoxic tolerance with age. In 40 patients with upper airway resistance syndrome and in 116 patients with mild to severe forms, the respiratory efforts developed to counteract upper airway occlusion decreased with age, suggesting a reduced role of the mechanical thoracic effect on the left atrial and ventricular function in elderly [17].

One limitation of this review is the inability to conduct a robust quantitative meta-analysis due to significant heterogeneity among included studies, small sample sizes in several reports, and the predominance of isolated case findings, which limited comparability across datasets.

CONCLUSION

In short, echocardiography remains a cornerstone of cardiac diagnosis, capable of disclosing both common and rare structural heart abnormalities. The study presented here demonstrates that the majority of incidental findings are clinically silent but potentially have implications for patient management, including surgical planning, risk stratification, and follow-up. Recognition of the benign nature of certain conditions, like isolated septal hypertrophy or coronary artery–pulmonary artery fistulas, can avoid unnecessary intervention. Conversely, identification of rare structural abnormalities may provoke further investigation or therapeutic adjustment to oppose potential dangers. Moreover, these findings corroborate the relevance of the inclusion of regular and targeted echocardiographic examination within some populations, such as the elderly, athletes, or surgical candidates. Though the majority of studies are handicapped by single-case reports, the accuracy of detecting clinical utility by imaging portends an overall need for prospective and multicenter study.

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