



## ORIGINAL ARTICLE

# Prevalence and Pattern of Cardiovascular Symptoms and Diseases in Pediatric Patients: Insights from a Single-Center Observational Study with a Focus on Age and Gender

## Pediatric Hastalarda Kardiyovasküler Semptomların Ve Hastalıkların Yaygınlığı Ve Şekli: Yaş Ve Cinsiyete Odaklanan Tek Merkezli Gözlemsel Bir Çalışmadan Elde Edilen Veriler

<sup>1</sup>Fuat Polat , <sup>2</sup>Zeynettin Kaya 

<sup>1</sup>Department of Cardiology, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Education Research Hospital, İstanbul, Turkey

<sup>2</sup>Department of Cardiology, Antalya Yaşam Hospital, Antalya, Turkey

### Correspondence

Fuat Polat, Department of Cardiology, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Education Research Hospital, İstanbul, Turkey

E-Mail: [drfuatpolat@gmail.com](mailto:drfuatpolat@gmail.com)

### How to cite ?

Polat F, Kaya Z. Prevalence and Pattern of Cardiovascular Symptoms and Diseases in Pediatric Patients: Insights from a Single-Center Observational Study with a Focus on Age and Gender. Genel Tıp Derg. 2024;34(1):130-135.

### ABSTRACT

**Background/Aims:** This single-center, cross-sectional study aimed to investigate the prevalence and patterns of cardiovascular symptoms and findings among pediatric patients aged 1-18 years, focusing on age and gender as potential influencing factors.

**Methods:** Pediatric patients aged 1-18 years with cardiovascular symptoms grouped as murmur, dyspnea, chest pain, palpitation, syncope and cyanosis were examined, categorized by age (1-6, 7-12, 13-18) and gender (male and female) using electronic medical records, undergoing comprehensive clinical assessments including examinations, ECGs, and echocardiograms. Statistical analyses unveiled prevalence trends.

**Results:** 720 patients were included in the study and 53.9% of them were female. The prevalence of symptoms and diseases varied by age. Chest pain was more common in 13-18 group; cardiac murmurs linked to congenital defects were more common in 1-6 group; valve and pericardial/myocardial diseases were more common in the 7-12 age group. Gender had no significant effect on disease patterns.

**Conclusion:** The study emphasizes the importance of age-appropriate management and personalized management in cardiovascular diseases. Gender did not have a significant role in terms of cardiovascular diseases.

**Keywords:** Childhood, children, cardiovascular symptoms, age, gender

### ÖZ

**Arka Plan/Amaç:** Bu tek merkezli, kesitsel çalışma, yaş ve cinsiyete göre değişkenliğe odaklanarak, 1-18 yaş arası pediatrik hastalarda kardiyovasküler semptom ve bulguların prevalansını ve paternini araştırmayı amaçladı.

**Yöntemler:** Üfürüm, dispne, göğüs ağrısı, çarpıntı, senkop ve siyanoz olarak gruplandırılan kardiyovasküler semptomları olan 1-18 yaş arası pediatrik hastalar incelendi, elektronik tıbbi kayıtlar kullanılarak yaşlarına (1-6, 7-12, 13-18) ve cinsiyetlerine (erkek ve kadın) göre kategorize edildi; muayeneler, EKG'ler ve ekokardiyogramlar dahil kapsamlı klinik değerlendirmelerden yapıldı. İstatistiksel analizlerde yaş ve cinsiyet grupları karşılaştırıldı.

**Bulgular:** Çalışmaya 720 hasta dahil edildi ve bunların %53,9'u kadındı. Semptomların ve hastalıkların prevalansı yaşa göre değişmekteydi. Göğüs ağrısı 13-18 yaş grubunda; kardiyak üfürümler 1-6 yaş grubunda; kapak ve perikardiyal/miyokardiyal hastalıklar 7-12 yaş grubunda daha yaygındı. Cinsiyetin hastalık paternleri üzerinde anlamlı bir etkisi yoktu.

**Sonuç:** Çalışma, kardiyovasküler hastalıklarda yaşa göre ve kişiye özel yönetimin önemini vurgulamaktadır. Cinsiyetin kardiyovasküler hastalıklar açısından anlamlı bir rolü izlenmemiştir.

**Anahtar Kelimeler:** Çocukluk çağı, çocuklar, kardiyovasküler semptomlar, yaş, cinsiyet

## Introduction

Despite significant technological progress, the cornerstone of identifying cardiac disorders in children remains reliant on clinical assessment<sup>1-2</sup>. While most cardiovascular symptoms in pediatric cases typically present as benign, a subset—comprising chest pain, palpitations, irregular heart rhythms, and syncope—could potentially signal underlying cardiac issues. Observable indicators such as murmurs, irregular heart sounds, cyanosis, jugular vein distention, and peripheral edema serve as potential

markers of cardiac pathology across different age groups, warranting attention regardless of the child's developmental stage<sup>3</sup>. When children exhibit symptoms that raise concerns about their cardiac health, the initial evaluation typically falls under the purview of general pediatricians. Should the need arise, they may direct the case to specialized care offered by pediatric or adult cardiologists<sup>4</sup>. These specialists often employ a comprehensive set of fundamental tests, including blood analyses, telecardiography, electrocardiography

(ECG), and echocardiography, guided by the child's symptomatic profile, aiding in accurate diagnosis and tailored treatment decisions<sup>5</sup>.

However, despite considerable advancements, the nuanced impact of age and gender on cardiovascular symptoms and signs within pediatric cardiology remains an underexplored area. It's marked by a paucity of comprehensive studies, leaving substantial gaps in our understanding<sup>6</sup>. This underscores the significance of investigations like the present study, aspiring to unravel and delineate age and gender-associated trends in cardiovascular symptoms and findings among the pediatric demographic.

The primary goal of this study is to unravel the prevalence and nuances of cardiovascular symptoms and findings in the pediatric population aged 1-18. It specifically focuses on exploring age and gender as potential influential factors. By shedding light on these intricate trends, this research aims to bridge the existing knowledge gap, leading to more precise, effective diagnostic, and preventive strategies for young patients presenting with cardiac concerns.

## Methods

### Study Design

This retrospective, single-center, cross-sectional study was conducted in the pediatric cardiology clinic between April 2019 and May 2021. The study aimed to investigate the frequency and variability of cardiovascular symptoms and findings in pediatric patients, with a focus on age and gender as potential influencing factors.

### Study Population

The study included pediatric patients aged 1-18 years who presented with cardiovascular symptoms. Patients were identified through electronic medical records and were categorized into subgroups based on age, specifically 1-6 years, 7-12 years, and 13-18 years. Patients were also stratified by sex, including male and female patients.

The inclusion criteria for this study conducted in a pediatric cardiology clinic were pediatric patients aged 1-18 years who presented with cardiovascular symptoms and were identified through electronic medical records. Exclusion criteria included patients who did not undergo a comprehensive clinical evaluation, including clinical examination, ECG, and echocardiography, patients with contraindications for echocardiography, such as poor acoustic windows or inability to cooperate with the procedure, patients with known cardiovascular diseases or previous cardiac surgeries, and patients with incomplete or missing data in the medical records. Only isolated cardiac defects were considered among all congenital heart defects. Patients with complex cardiac defects were excluded from the study.

### Clinical Evaluation

Comprehensive clinical evaluation was performed

on all patients by experienced adult cardiologists. This included routine clinical examination, electrocardiography (ECG), and echocardiography. The clinical examination involved a thorough assessment of cardiovascular symptoms, such as chest pain, dyspnea, palpitations, syncope, cyanosis, and the presence of murmur. ECG was performed to assess for any electrical abnormalities, and echocardiography was conducted to evaluate cardiac structure and function. Cardiovascular diseases were grouped as main headings: valvular heart disease, structural heart disease, electrical heart disease, heart failure, pericardial or myocardial heart diseases, tachycardia or premature beats and atrioventricular block or bradycardias. Valvular heart disease was defined as more than mild stenosis or regurgitation in at least one of the valves. MVP and rheumatic valve diseases, which are the most common valve diseases, were evaluated under the subheading as etiology. Structural heart disease and electrical heart disease were evaluated under subheadings according to the specific disease type. Tachycardia or premature beats and atrioventricular block or bradycardias were evaluated under subheadings according to their specific subtypes.

### Echocardiography

Echocardiography, a crucial element of the comprehensive clinical assessment, was conducted by experienced adult cardiologists. Employing a high-resolution ultrasound machine featuring a pediatric-specific transducer, enabled the visualization of various cardiac structures, including heart chambers, valves, and blood vessels. The procedures adhered to the standard protocols recommended by the American Society of Echocardiography Guideline, with patients positioned in a supine or left lateral decubitus posture (7). Echocardiographic studies were performed by 2D and 3D data with a commercially available echocardiographic system (Philips CX50 Ultrasound Machine) and echocardiography probes (S5-1). Echocardiographic images were obtained using parasternal, apical, and subcostal views to assess cardiac structure and function. Parameters such as left ventricular dimensions, interventricular septal thickness, posterior wall thickness, and heart valve dimensions were evaluated based on these images. Additionally, Doppler echocardiography was used to analyze blood flow velocities and patterns for irregularities. The results of the echocardiograms were systematically documented, including images, measurements, and interpretations, both in the patient's electronic medical record and in the case report form for subsequent analysis. These findings were evaluated by experienced adult cardiologists, who were blinded to the patient's clinical symptoms and other test results. Any atypical findings or disparities were meticulously reviewed and discussed among the cardiologists to reach a consensus. To maintain the quality and precision of echocardiographic measurements, a range of quality control measures were implemented, including regular calibration of the ultrasound machine, adherence to

standardized imaging protocols, and periodic review of echocardiographic images by experienced adult cardiologists.

### Data Collection

Relevant clinical data, including demographic information, medical history, and results of clinical examinations, ECG, and echocardiography, were collected and recorded in a standardized case report form. Data were entered into a secure electronic database for analysis.

### Ethical Considerations

The study was started with the decision of the Local Ethics Committee meeting dated 03/10/2022 and numbered 2022/0710-915. The study was conducted following the principles of the Declaration of Helsinki. Informed consent was obtained from the parents or legal guardians of all participating patients.

### Statistical Analysis

Descriptive statistics, such as mean, standard deviation, and frequency, were used to summarize the characteristics of the study population. The frequency and variability of symptoms and findings were analyzed using appropriate statistical methods, including chi-square test, t-test, and analysis of variance (ANOVA), as appropriate. Age and gender were examined as potential influencing factors on the frequency and variability of symptoms and findings. Statistical analysis was performed using SPSS software version 25.0 (SPSS, Inc, Chicago, IL). Statistical significance was set at  $p < 0.05$ .

### Results

Our study enrolled a cohort of 720 patients who were referred from the pediatrics clinic to the cardiology clinic for screening of cardiovascular disease. Out of these patients, 332 (46.1%) were boys and 372 (53.9%) were girls. The median age of the patients was 10 years, with an interquartile range (IQR) of 6 to 14 years. Detailed clinical characteristics of the patients are presented in Table 1.

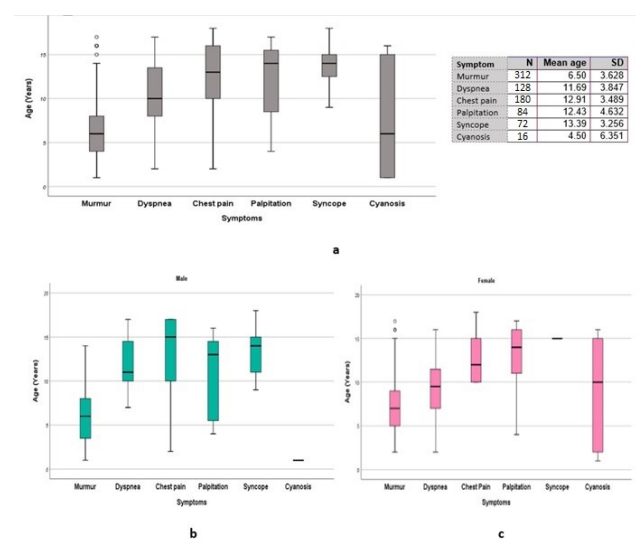
After the patients were divided into groups according to age (1-6, 7-12, 13-18 years) and sex, their clinical and demographic characteristics were analyzed (Table 2).

The sex distribution was similar across all three age groups. Murmurs were most prevalent in the 1-6 year age group, with a decreasing frequency observed with increasing age (78.8% at 1-6 years, 44.3% at 7-12 years, and 10.3% at 13-18 years,  $p < 0.001$ ). Conversely, dyspnea, chest pain, palpitations, and syncope were most commonly reported in the 13-18 year age group ( $p = 0.03$ ,  $p < 0.001$ ,  $p = 0.001$ , and  $p = 0.001$ , respectively). Cyanosis was observed in a total of 16 patients, with 12 of them belonging to the 1-6 year age group. The first-degree relative of 12 patients (1.7%) had congenital heart disease. Congenital heart defects were most frequently observed in the 1-6 year age group (19.2%,  $p = 0.05$ ), while valvular heart disease was more prevalent in the 7-12 year age group (31.4%,  $p = 0.03$ ).

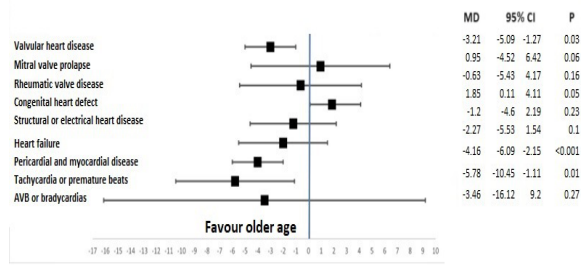
Mitral valve prolapse (MVP), rheumatic valve disease, structural or electrical heart disease, and heart failure showed similar prevalence across age groups ( $p = 0.06$ ,  $p = 0.16$ ,  $p = 0.23$ , and  $p = 0.10$ , respectively). Pericardial and myocardial diseases were most common in the 7-12 year age group (15.7%), and least common in the 1-6 year age group (3.8%). Tachycardia or premature beats and atrioventricular block (AVB) or bradycardias were most frequently observed in the 13-18 year age group (6.9%,  $p = 0.01$ , 3.4%,  $p = 0.27$ , respectively). No arrhythmia or AV block was detected on electrocardiogram (ECG) in patients aged 1-6 years. Clinical and demographic characteristics were comparable between females and males.

The frequency of symptoms by age in all patients and gender subgroups is depicted in Figure 1 using a box plot graph. The most commonly observed cardiac physical examination finding was murmurs, which were present in 312 patients, with a mean age at diagnosis of  $6.5 \pm 3.7$  years. The most frequently reported symptoms included chest pain (180 patients, 25%), dyspnea (128 patients, 17.8%), palpitations (84 patients, 11.7%), syncope (72 patients, 10%), and cyanosis (16 patients, 2.2%), respectively. Clinical features of patients were similar between the genders.

The trend of variability in cardiac diseases according to age is illustrated in Figure 2 using a forest plot graph. Congenital heart defects tended to decrease with age (mean difference [MD] 1.85, 95% confidence interval [CI] 0.11-4.11,  $p = 0.05$ ). Conversely, valvular heart disease, myocardial and pericardial disease, and tachycardia or premature beats tended to increase with age (Valvular heart disease MD -3.21, 95% CI 0.53-9.93,  $p = 0.03$ ; myocardial and pericardial disease MD -4.16, 95% CI 0.11-4.11,  $p < 0.001$ ; tachycardia or premature beats MD -5.78, 95% CI 0.11-4.11,  $p = 0.001$ ).



**Figure 1.** Box plot of the distribution of symptoms by age in the whole population (a), males (b), and females (c).



**Figure 2.** Forest plot graph: Assessing the Impact of Age on Cardiovascular Diseases in the Study Population

**Table 1.** Baseline clinical characteristics of the study population

Patients Characteristics	n=720
<b>Age (years)</b> (median, IQR)	10 (6-14)
Sex (male) (%)	332 (46.1)
CHD in first-degree relative (%)	12 (1.7)
Murmur (%)	312 (43.3)
Dyspnea (%)	128 (17.8)
Chest pain (%)	180 (25.0)
Palpitation (%)	84 (11.7)
Syncope (%)	72 (10.0)
Cyanosis (%)	16 (2.2)
<b>Congenital heart defect (%)</b>	<b>76 (10.6)</b>
ASD (n)	20
PFO (n)	12
VSD (n)	40
PDA (n)	4
<b>Valvular heart disease (%)</b>	<b>156 (21.7)</b>
MVP (%)	12 (1.7)
Rheumatic valve disease (%)	16 (2.2)
<b>Structural or electrical heart disease (%)</b>	<b>32 (4.4)</b>
HCM (n)	8
AC (n)	4
Brugada syndrome (n)	4
WPW (n)	8
Tetralogy of Fallot (n)	4
Cor triatriatum (n)	4
<b>Heart failure (%)</b>	<b>8 (1.1)</b>
Pericardial or myocardial disease (%)	84 (11.7)
<b>Tachycardia or premature beats (%)</b>	<b>16 (2.2)</b>
SPB (n)	8
VPB (n)	4
SVT (n)	4
VT (n)	0
<b>Atrioventricular block or bradycardias (%)</b>	<b>12 (1.7)</b>
First-degree AVB (n)	8
Second-degree AVB (n)	0
Third-degree AVB (n)	0
Sinus bradycardia (n)	4

AC: Arrhythmogenic cardiomyopathy, ASD: Atrial septal defect, AVB: Atrio-ventricular block, CHD: Congenital heart disease, HCM: Hypertrophic cardiomyopathy, IQR: Interquartile range, MVP: Mitral valve prolapse, PDA: Patent ductus arteriosus, PFO: Patent foramen ovale, SPB: Supraventricular premature beats, SVT: Supraventricular tachycardia, VPB: Ventricular premature beats, VSD: Ventricular septal defect, VT: Ventricular tachycardia, WPW: Wolf-Parkinson-White syndrome

**Table 2.** Patient characteristics according to age and sex.

Patient characteristics	Age (years)			P value	Sex		P value
	1-6	7-12	13-18		Male (n=332)	Female (n=388)	
<b>Age (years)</b> (median, IQR)	-	-	-	-	9 (6,14)	10 (6,15)	0.99
Sex (male) (%)	46.2	45.7	46.6	0.99	-	-	-
CHD in first-degree relative (%)	1.9	0	3.4	0.20	1.2	2.1	0.56
Murmur (%)	78.8	44.3	10.3	<0.001	43.4	56.7	0.99
Dyspnea (%)	5.8	22.9	22.4	0.03	18.1	17.5	0.92
Chest pain (%)	1.9	27.1	43.1	<0.001	21.7	27.8	0.34
Palpitation (%)	9.6	2.9	24.1	0.001	8.4	14.4	0.21
Syncope (%)	1.9	5.7	22.4	0.001	12.0	8.2	0.40
Cyanosis (%)	5.8	0	1.7	0.07	2.4	2.1	0.88
Congenital heart defect (%)	19.2	9.6	5.2	0.05	13.3	8.2	0.28
Valvular heart disease (%)	11.5	31.4	19.0	0.03	20.5	22.7	0.72
MVP (%)	0	4.3	0	0.06	1.2	2.1	0.56
<b>Rheumatic valve disease (%)</b>	<b>0</b>	<b>4.3</b>	<b>1.7</b>	<b>0.16</b>	<b>2.4</b>	<b>4.1</b>	<b>0.08</b>
Structural or electrical heart disease (%)	5.8	1.4	6.9	0.23	7.2	2.1	0.09
Heart failure (%)	0	0	3.4	0.10	1.2	1.0	0.71
Pericardial or myocardial disease (%)	3.8	15.7	8.6	<0.001	13.3	10.3	0.07
Tachycardia or premature beats (%)	0	0	6.9	0.01	3.6	1	0.25
AVB or bradycardias (%)	0	1.4	3.4	0.27	1.2	2.1	0.56

AVB: Atrio-ventricular block, MVP: Mitral valve prolapse, CHD: Congenital heart disease

**Discussion**

The findings of this single-center observational study provide valuable insights into the prevalence and pattern of cardiovascular symptoms and diseases among pediatric patients, with a focus on age and gender as potential influencing factors.

One of the key findings of this study is the variability of cardiovascular symptoms and findings concerning age. Frequent visits to pediatric cardiology clinics involve complaints of chest pain, prompting thorough cardiac assessments. However, it's important to note that in children, chest pain is typically non-cardiac and benign, with cardiac issues being a rare occurrence. Hence, there's a crucial need to explore the common origins of chest pain in children and establish effective diagnostic protocols to alleviate the anxiety of both children and their families.8 In our study chest pain was found to be the most common symptom, with the highest prevalence observed in the 13-18 age group. This is consistent with previous studies that

have reported chest pain as a common symptom in adolescents.<sup>9,10</sup>

Typically, normal heart sounds encompass S1 and S2, while heart murmurs can be classified into two main categories. Pathological murmurs arise from irregular blood flow through malfunctioning heart valves, septal defects, or constricted arteries within the heart. Innocent murmurs, on the other hand, stem from physiological factors outside the heart. Pathological murmurs are linked to various heart conditions, including valve stenosis, regurgitation, septal defects, patent foramen ovale, tetralogy of Fallot, pulmonary stenosis, and patent ductus arteriosus. Consequently, heart auscultation serves as a valuable tool for diagnosing and monitoring heart diseases.<sup>11</sup> Congenital heart defects were most commonly found in the 1-6 age group, which is consistent with previous studies reporting that congenital heart defects are typically diagnosed in early childhood.<sup>12,13</sup> In our study, murmur was detected in a higher proportion of patients in the 1-6 age group, which may be attributed to the higher prevalence of congenital heart defects in this age group.

Research focused on cardiovascular risk factors should consistently include data on the prevalence and associations of these factors during childhood, as they play an essential role in identifying individuals at risk. The recognition of risk factors in asymptomatic children holds the potential to curb the emergence of cardiovascular diseases. Even though coronary heart disease typically manifests in adulthood, early identification of risk factors during childhood is critical for prognosis and the prevention of damage to vital organs in adulthood. Consequently, early detection and preventive measures should commence in childhood, a phase where lifestyle modifications can significantly reduce the occurrence and severity of heart-related conditions. Educational institutions, particularly schools, are pivotal in accomplishing this important health objective.<sup>14</sup> The distribution of cardiovascular diseases also showed variability with age. Heart valve diseases and pericardial and myocardial diseases were most common in the 7-12 age group, which may be related to the increased risk of rheumatic heart disease in this age group. Tachycardia or premature beats and atrioventricular block (AVB) or bradycardias were most common in the 13-18 age group, which may be related to hormonal changes during adolescence and increased participation in physical activities. These findings highlight the importance of considering age-specific risk factors and clinical manifestations when evaluating pediatric patients with cardiovascular symptoms.<sup>15-17</sup>

In addition, the distribution of symptoms by age was similar for both sexes, with no statistically significant differences observed based on gender. This suggests that cardiovascular symptoms and diseases may not show significant gender-based differences in pediatric patients, and that similar diagnostic and management approaches can be applied regardless of gender. This

is consistent with previous studies that have reported similar prevalence and patterns of cardiovascular diseases in boys and girls.<sup>18, 19</sup>

The findings of this study have important clinical implications. Firstly, they emphasize the importance of a comprehensive clinical evaluation, including routine clinical examination, ECG, and echocardiography, in pediatric patients with cardiovascular symptoms. This allows for timely detection and management of cardiovascular diseases, especially those that may have different prevalence and patterns in different age groups. Secondly, the findings highlight the need for age-specific approaches in the evaluation and management of cardiovascular symptoms in pediatric patients. Healthcare providers should be aware of the different prevalence and patterns of cardiovascular diseases in different age groups, and tailor their diagnostic and management strategies accordingly. Finally, the findings of this study suggest that gender may not be a significant factor in the prevalence and patterns of cardiovascular symptoms and diseases in pediatric patients, and that similar approaches can be applied to both boys and girls.

There are limitations to this study. Firstly, this was a single-center study, which may limit the generalizability of the findings to other populations or settings. Multicenter studies with larger sample sizes are needed to confirm the findings of this study. Secondly, this was an observational study, and causality cannot be inferred from the findings. Further studies, including prospective studies and randomized controlled trials, are needed to establish causality and determine optimal diagnostic and management strategies in pediatric patients with cardiovascular symptoms. Finally, in our study, data was collected regarding the presence of congenital heart defects in the family, but no data was collected about consanguineous marriage.

In conclusion, this study provides insights into the prevalence and pattern of cardiovascular symptoms and diseases among pediatric patients, with a focus on age and gender as potential influences.

## Conclusion

This study offers valuable insights into the prevalence and patterns of cardiovascular symptoms and diseases among pediatric patients, particularly considering age and gender factors. The study highlights that while chest pain is most common among adolescents, murmurs are prevalent in younger children, often associated with congenital heart defects. Cardiovascular disease patterns differ by age, with valve diseases and pericardial/myocardial diseases more prominent in the 7-12 age group, potentially linked to rheumatic heart disease risks. Gender, however, seems to exert minimal influence on these patterns. The findings underscore the importance of thorough clinical evaluations, emphasizing tailored approaches based on age.

## Highlights

- Study examines cardiovascular symptoms in

pediatric patients aged 1-18, revealing age and gender influences.

- Chest pain is more common in the 13-17 age group, and murmur is more common in the 1-6 age group due to congenital heart defects.
- Heart valve and pericardial/myocardial diseases are more common in the 7-12 age group, possibly linked to rheumatic heart disease risks.
- Congenital heart defect is more common in the 1-6 age group, and tachycardia or premature beats are more common in the 13-17 age group.
- Gender has minimal impact on cardiovascular symptom prevalence, highlighting the importance of age-specific evaluation and management.

### Ethical Declarations

Ethics Committee Approval: The study was carried out with the permission of Ethical Committee of Faculty of XXXXXXX (Date: 03.10.2022, Decision No: 2022/0710-915).

**Informed Consent:** Informed consent was obtained from the parents or legal guardians of all participating patients.

**Reviewer Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

**Author Contributions:** All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

### References

- 1.Chelo D, Nguetack F, Menanga AP, et al. Spectrum of heart diseases in children: an echocardiographic study of 1,666 subjects in a pediatric hospital, Yaounde, Cameroon. *Cardiovasc Diagn Ther.* 2016;6(1):10-19.
- 2.De Ferranti SD, Steinberger J, Ameduri R, Baker A, Gooding H, Kelly AS, et al. Cardiovascular risk reduction in high-risk pediatric patients: a scientific statement from the American Heart Association. *Circulation.* 2019;139(13):e603-34.
- 3.Sharkey AM, Clark BJ. Common complaints with cardiac implications in children. *Pediatr Clin North Am.* 1991;38(3):657-666.
- 4.Khushu A, Kelsall AW, Usher-Smith JA. Outcome of children with heart murmurs referred from general practice to a paediatrician with expertise in cardiology. *Cardiology in the Young.* 2015;25(1):123-127.
- 5.Geggel RL. Conditions leading to pediatric cardiology consultation in a tertiary academic hospital. *Pediatrics.* 2004;114(4):e409-e417.
- 6.Benun J, Fisher SD, Orav EJ, et al. Cardiac management by pediatricians versus pediatric cardiologists in an inpatient academic center. *Am Heart J.* 2003;145(3):424-429.
- 7.Porter TR, Mulvagh SL, Abdelmoneim SS, et al. Clinical Applications of Ultrasonic Enhancing Agents in Echocardiography: 2018 American Society of Echocardiography Guidelines Update. *J Am Soc Echocardiogr.* 2018;31(3):241-274.
- 8.Chen L, Duan H, Li X, et al. The Causes of Chest Pain in Children and the Criteria for Targeted Myocardial Enzyme Testing in Identifying the

- Causes of Chest Pain in Children. *Front Cardiovasc Med.* 2021;8:582129.
- 9.Kaden GG, Shenker IR, & Gootman N. Chest pain in adolescents. *J Adolescent Health.* 1991;12(3):251-255.
- 10.Aygun E, Aygun S, Uysal T, Aygun F, Dursun H, Irdem, A. Aetiological evaluation of chest pain in childhood and adolescence. *Cardiology in the Young.* 2020;30(5):617-623.
- 11.Wang J, You T, Yi K, et al. Intelligent Diagnosis of Heart Murmurs in Children with Congenital Heart Disease. *J Healthc Eng.* 2020;2020:9640821.
- 12.Kaemmerer H, Hess J. Adult patients with congenital heart abnormalities: present and future. *Deutsche Medizinische Wochenschrift.* 2005;130(3):97-101.
- 13.Akhmedov AT, & Sh, N. Congenital heart defects in children and comorbidity. In *E-Conference Globe.* 2021;(pp. 102-102).
- 14.Rodrigues AN, Abreu GR, Resende RS, Goncalves WL, Gouvea SA. Cardiovascular risk factor investigation: a pediatric issue. *Int J Gen Med.* 2013;6:57-66.
- 15.Friedli B. Indikationen zur kinder-kardiologischen Abklärung [Indications for pediatric cardiology evaluation]. *Therapeutische Umschau. Revue therapeutique.* 2001;58(2):65-69.
- 16.Baruteau AE, Perry JC, Sanatani S, Horie M, & Dubin AM. Evaluation and management of bradycardia in neonates and children. *Eur J Pediatr.* 2016;175(2):151-161.
- 17.Fink CM, Cua CL, Nandi D, Hart SA. Capture rate of congenital heart defects in the Pediatric Health Information System database. *Birth Defects Res.* 2020;112(18):1541-1544.
- 18.Mosca L, Barrett-Connor E, Wenger NK. Sex/gender differences in cardiovascular disease prevention what a difference a decade makes. *Circulation.* 2011;124(19):2145.
- 19.Manios Y, Dimitriou M, Moschonis G, et al. Cardiovascular disease risk factors among children of different socioeconomic status in Istanbul, Turkey: Directions for public health and nutrition policy. *Lipids Health Dis.* 2004;3:11.