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Original article

Clinical Characteristics of Chest Pain in Children and Adolescents Referred to a Pediatric Cardiology Unit

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Abstract
In contrast to adults, chest pain in children is typically benign; however, symptoms may persist for a considerable period even in benign cases. Therefore, a thorough diagnostic evaluation is crucial to exclude potentially life-threatening causes that require urgent management. To assess the etiology of chest pain and analyze the clinical characteristics of children referred to the Pediatric Cardiology Clinic at the Sirte Oncology Center in Sirte, Libya. Study design: A retrospective analysis of the medical records of Children with chest pain presenting to the Pediatric Cardiology Outpatient Clinic at the Sirte Oncology Center, Sirte, Libya, between January 2022 and March 2026 was conducted. The study protocol was reviewed and approved by the Sirte Oncology Center Ethics Committee. This study included 215 patients: 116 males (53.95%) and 99 females (46.05%). The patients' ages ranged from 3 to 18 years, with a mean ± SD of 8.62 ± 3.91 years. A total of 3 participants (1.4%) were found to have cardiac chest pain. The prevalence of non-cardiac chest pain among participants was 98.6% (212 participants). Idiopathic causes were the most common, reported in 52.09% of patients (112 patients), followed by musculoskeletal causes (21.86%, 47 patients), pulmonary causes (11.63%, 25 patients), gastrointestinal causes (7.44%, 16 patients), and miscellaneous causes (6.98%, 15 patients). Chest pain is a common presenting symptom that can arise from both cardiac and non-cardiac conditions. Despite a comprehensive assessment, the etiology of chest pain remains unidentified in a significant number of children. Cardiac-related causes of chest pain in children, while uncommon, can be clinically significant and potentially life-threatening.
Keywords. Chest Pain, Pediatric, Etiology, Diagnosis**,** Chest X-ray, Electrocardiography, Echocardiogram.

Introduction

Chest pain is a common primary complaint in the emergency department, affecting both the adult and pediatric populations. In adults, several potentially life-threatening cardiac conditions may present with chest pain. Therefore, chest pain is frequently regarded as indicative of cardiac disease, a concern that may also apply to pediatric patients [1–3]. The precise frequency of pediatric chest pain remains unclear; recent studies indicate it may account for 0.5–1% of all pediatric emergency visits [1-4]. Chest pain in children may arise from cardiac or non-cardiac etiologies. The primary non-cardiac causes encompass gastrointestinal, musculoskeletal, psychogenic, and respiratory factors. In certain cases, the exact etiology may remain undetermined, resulting in the diagnosis of idiopathic chest pain [2,5]. However, merely 0.3–8.0% of children and adolescents experiencing chest pain are diagnosed with cardiac diseases. Although chest pain in children is infrequently associated with cardiac etiology, significant factors must be considered when reviewing past medical records or taking a history [1,6,7-10].

Children and adolescents presenting with chest pain may undergo various diagnostic assessments, such as an electrocardiogram (ECG), chest radiograph, cardiac troponin measurement, and echocardiogram; nonetheless, the majority of conditions can be diagnosed with thorough history-taking and physical examination. Individuals presenting with additional symptoms and signs exhibited a higher positivity rate on ECG and chest radiograph compared to those reporting solely chest pain [1,11,12].

A personal history of congenital or previously diagnosed cardiac disease, a family history of sudden cardiac death or premature cardiac disease, abnormal findings on physical examination, abnormal electrocardiographic findings, or chest pain that is exacerbated by exertion and relieved by rest may suggest a cardiac origin of chest pain in children. Referral to a pediatric cardiologist is crucial when a cardiac etiology is suspected [13].

To improve diagnostic and management strategies, this retrospective study assessed the causes of chest pain, related factors, and clinical features in children. This study aimed to assess the causes, demographics, and clinical manifestations of children's chest pain. This study aimed to assess the etiology of chest pain and to analyze the clinical characteristics of children referred to the pediatric cardiology clinic at the Sirte Oncology Center in Sirte, Libya.

Methods

Study design: A retrospective analysis was conducted using the medical records of children presenting with chest pain at the Pediatric Cardiology Outpatient Clinic at the Sirte Oncology Center, Sirte, Libya, from January 2022 to March 2026. The study protocol was reviewed and approved by the Ethics Committee of the hospital and Sirte University before data collection. Following ethical approval, purposive sampling was performed. The sample size was calculated using the Epi Info online calculator (ref). Based on an expected frequency of 5.2% reported in a previous study, the minimum required sample size was estimated to be 213 patients with chest pain.

The inclusion criteria for the participants were as follows:

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a) Age ranging from 3 to 18 years
b) Chest pain is the primary reason for referral. Patients were also required to have no previous cardiology evaluation and no pre-existing cardiac diagnosis.

Exclusion criteria were as follows:

a) Patients younger than 3 years or older than 18 years were excluded from the study.

Permission from the Pediatric Department was obtained prior to data collection. The survey was entirely anonymous to protect patients' privacy. The study evaluated demographic data, patients' medical history, age, sex, clinical presentation, family history, chest pain characteristics, symptom duration, associated symptoms, and time from symptom onset to hospital visit. Laboratory tests, including chest radiography, electrocardiography (ECG), and echocardiography, were performed.

Data management and statistical Analysis

Data were collected, coded, revised, and entered into R statistical software (RStudio) version 4.4.0 (R Project for Statistical Computing, Vienna, Austria). The data were presented as numbers and percentages for qualitative data and as means, standard deviations, and ranges for quantitative data with parametric distributions, and as medians with interquartile ranges (IQRs) for quantitative data with nonparametric distributions. The Shapiro-Wilk test was used to assess the normality of the distribution. The Chi-square test was used to compare two groups with qualitative data. Fisher's exact test was used instead of the Chi-square test when the expected count in any cell was less than 5.

An independent t-test was used to compare two groups with quantitative data and a parametric distribution, and the Wilcoxon-Mann-Whitney test was used to compare two groups with quantitative data and a nonparametric distribution.

The confidence interval was set to 95%, and the accepted margin of error was 5%. So, the p-value was considered significant as follows: $P > 0.05$: Non-significant (NS), $P < 0.05$: Significant (S), and $P < 0.01$: Highly significant (HS).

Results

The study included 215 participants. Their ages ranged from 3 to 18 years, with a mean ± SD (8.62 ± 3.91) years. The mean age was 8.00 years. Regarding sex distribution, 116 participants (53.95%) were males, while 99 participants (46.05%) were females, as shown in (Table 1) and (Figure 1).

Table 1. Distribution of all participants studied according to demographic characteristics

Demographic characters	N = 215
Age in years	
Min.- Max.	3.00 - 18.00
Mean ± SD	8.62 ± 3.91
Median (IQR)	8.00 (5.50, 11.00)

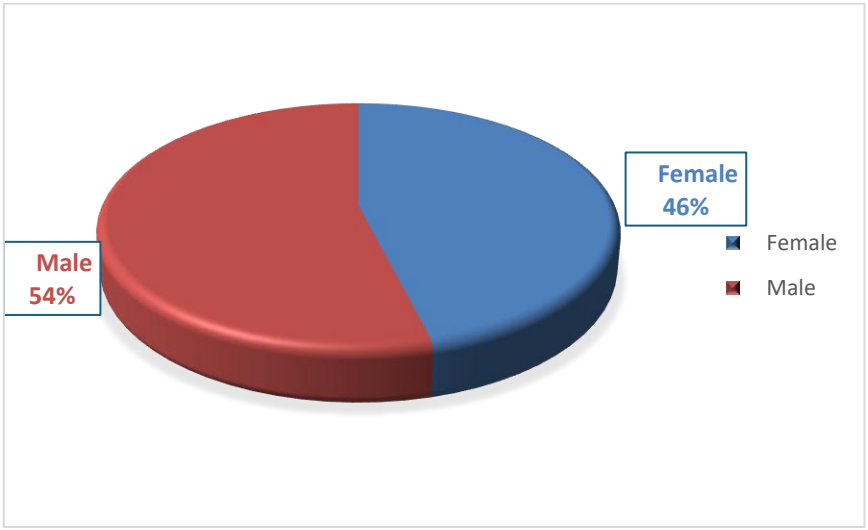

Figure 1. Distribution of sex among all studied participants

Cardiac chest pain was identified in 3 patients (1.40%), whereas non-cardiac chest pain was identified in 212 patients (98.60%), as shown in (Figure 2).

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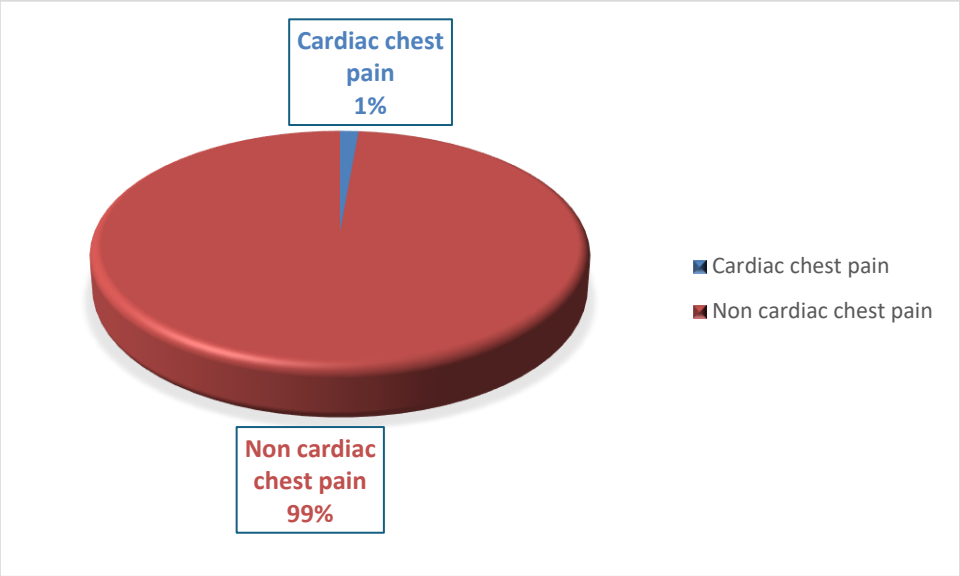

Figure 2. Distribution of all participants studied according to Cardiac chest pain.

Regarding associated symptoms, cough was the most frequent (9.30%, 20 participants), followed by fever (6.98%, 15 participants), dyspnea (4.65%, 10 participants), abdominal pain (4.19%, 9 participants), and vomiting (3.72%, 8 participants).

Regarding the causes of chest pain, idiopathic causes were the most common in 52.09% (112 participants), followed by musculoskeletal causes (21.86%, 47 participants), pulmonary causes (11.63%, 25 participants), gastrointestinal causes (7.44%, 16 participants), and miscellaneous causes (6.98%, 15 participants), as shown in (Table 2).

Table 2. Distribution of all participants studied according to associated symptoms and causes of chest pain

Associated symptoms	**N= 215**
Abdominal pain	9.00 (4.19%)
Cough	20.00 (9.30%)
Dizziness	1.00 (0.47%)
Dyspnea	10.00 (4.65%)
Fever	15.00 (6.98%)
Headache	1.00 (0.47%)
Weakness	5.00 (2.33%)
Rhinorrhea	5.00 (2.33%)
Syncope	1.00 (0.47%)
Vomiting	8.00 (3.72%)
None	140.00 (65.12%)
Causes of chest pain	
Cardiac	3.00 (1.4%)
Gastrointestinal	16.00 (7.44%)
Hematological	2.00 (0.93%)
Idiopathic	112 (52.09%)
Miscellaneous	15.00 (6.98%)
Musculoskeletal	47.00 (21.86%)
Psychological disorders	5.00 (2.33%)
Pulmonary	25.00 (11.63%)
Trauma	8.00 (3.72%)

Regarding diagnostic findings, electrocardiographic (ECG) results were normal in 98.60% of cases, with only 1.40% (3 participants) showing abnormalities. Similarly, echocardiographic findings were normal (90.70%). The reported echocardiographic abnormalities included atrial septal defect and pulmonary stenosis (1.86% each, 4 participants), bicuspid aortic valve and patent foramen ovale (1.40% each, 3 patients), and trivial mitral regurgitation (1.86%, 4 participants). Chest X-ray findings were also normal in 91.63% (197 participants), while 8.37% (18 participants) showed abnormal results, as shown in (Table 3).

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Table 3 Distribution of all participants studied according to diagnostic findings

Diagnostic findings	N= 215
Electrocardiographic ECG findings	
Abnormal	3.00 (1.40%)
Normal	212.00 (98.60%)
Echocardiographic findings	
Atrial septal defect	4.00 (1.86%)
Bicuspid aortic valve	3.00 (1.40%)
Mitral valves prolapse	1.00 (0.47%)
Patent foramen ovale	3.00 (1.40%)
Pulmonary stenosis	4.00 (1.86%)
Reduced ejection fraction	1.00 (0.47%)
Trivial mitral regurgitation	4.00 (1.86%)
Normal	195.00 (90.70%)
Chest x ray	
Abnormal	18.00 (8.37%)
Normal	197.00 (91.63%)

The predominant duration of chest pain symptoms was days, as reported by 120 patients (55.81%), followed by weeks in 65 patients (30.23%) and months in 30 patients (13.95%). Regarding pain type, undefined pain was the most frequent (41.39%), followed by sharp pain (33.95%), pressure sensation (11.16%), and stabbing pain (9.77%). Less commonly reported types included burning (2.79%), whereas heartburn and squeezing pain were rarely reported, each accounting for 0.47%.

Regarding aggravating factors, most patients reported no clear aggravating factor (61.40%). Among patients with identifiable triggers, exercise was the most common (19.53%), followed by breathing (9.30%), feeding (5.12%), cough (1.86%), and physical activity (1.40%), while inspiration was rarely reported (0.47%).

Regarding alleviating factors, 54.42% reported no relieving factor. Among those who experienced relief, rest (18.14%) and pain relievers (16.74%) were the most common, followed by with massage (5.58%), antibiotics (3.72%), while antiarrhythmic use and physical activity were rarely reported (0.47% each).

Regarding pain localization, the left chest was the most common site (36.74%), followed by the right side (26.05%) and both sides of the chest (22.33%). Finally, most patients reported no radiation of pain (70.70%), while radiation to the back was the most common pattern (19.53%), followed by the left arm (7.91%), shoulder (1.40%), and rarely the neck (0.47%), as shown in (Table 4).

Table 4 Distribution of all participants studied according to chest pain characteristics

Chest pain characteristics	N= 215
Duration	
Days	120.00 (55.81%)
Months	30.00 (13.95%)
Weeks	65.00 (30.23%)
Types of pain	
Burning	6.00 (2.79%)
Heart burn	1.00 (0.47%)
Pressure sensation	24.00 (11.16%)
Squeezing	1.00 (0.47%)
Sharp	73.00 (33.95%)
Stabbing	21.00 (9.77%)
Undefined	89.00 (41. 39%)
Aggravating factors	
Breathing	20.00 (9.30%)
Cough	4.00 (1.86%)
Exercise	42.00 (19.53%)
Feeding	11.00 (5.12%)
Inspiration	1.00 (0.47%)
None	137.00 (63.72%)
Alleviating factors	
Antiarrhythmic	1.00 (0.47%)
Antibiotic	8.00 (3.72%)

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With massage	12.00 (5.58%)
Pain reliever	36.00 (16.74%)
Physical activity	1.00 (0.47%)
With rest	39.00 (18.14%)
With sleeping	1.00 (0.47%)
No relieving factor	117.00 (54.42%)
Localization of pain	
Both sides of the chest	48.00 (22.33%)
Breast	16.00 (7.44%)
Epigastrium	13.00 (6.05%)
Left side of the chest	79.00 (36.74%)
Middle of the chest	3.00 (1.40%)
Right sides of chest	56.00 (26.05%)
Radiating.to	
Back	42.00 (19.53%)
Left arm	17.00 (7.91%)
Neck	1.00 (0.47%)
Shoulder	3.00 (1.40%)
None	152.00 (70.70%)

Regarding comorbidities, most patients had no reported comorbid disease (87.44%). Among patients with comorbidities, congenital heart disease was the most common (5.12%), followed by bronchial asthma (2.79%), allergic rhinitis (2.33%), and atopic dermatitis (1.40%). Regarding treatment received, most participants did not receive any treatment (60.00%). Among those who did, analgesics were the most used (18.60%), followed by proton pump inhibitors (5.12%), conservative treatment (4.65%), and other treatments (7.44%). Regarding medical history, most participants had no significant past medical history (93.49%). Bronchial asthma was the most frequently reported condition (5.12%), while allergic rhinitis, hypothyroidism, and sickle cell disease were rarely reported, accounting for 0.47% each. Similarly, most patients had no relevant family history (86.05%). Among patients with a positive family history, bronchial asthma and cardiac disease were the most commonly reported conditions, accounting for 4.19% each, followed by sudden death (1.86%) and sickle cell anemia (1.40%), as shown in (Table 5).

Table 5 Distribution of all participants studied according to non-clinical examination

Non-clinical examination	**N= 215**
Comorbid diseases	
Allergic rhinitis	5.00 (2.33%)
Atopic dermatitis	3.00 (1.40%)
Bronchial asthma	6.00 (2.79%)
Congenital heart disease	11.00 (5.12%)
Hypothyroid	1.00 (0.47%)
None	189.00 (87.79%)
Treatment used	
Analgesia	40.00 (18.60%)
Antiarrhythmic	2.00 (0.93%)
Antibiotic	2.00 (0.93%)
Conservative treatment	10.00 (4.65%)
No treatment	129.00 (60.00%)
Others	16.00 (7.44%)
Proton pump inhibitor	11.00 (5.12%)
Medical history	
Allergic rhinitis	1.00 (0.47%)
Bronchial asthma	11.00 (5.12%)
Hypothyroidism	1.00 (0.47%)
None	201.00 (93.49%)
Sickle cell disease	1.00 (0.47%)
Family history	
Allergic disease	2.00 (0.93%)
Bronchial asthma	9.00 (4.19%)
Cardiac disease	9.00 (4.19%)

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Genetic disorder	1.00 (0.47%)
Gastroesophageal reflux disease	1.00 (0.47%)
None	185.00 (86.05%)
Peptic ulcer	1.00 (0.47%)
Sickle cell anemia	3.00 (1.40%)
Sudden death	4.00 (1.86%)

Regarding clinical examination findings, general examination findings were normal in most patients (83.72%). Abnormal findings were relatively uncommon; tachypnea was the most frequent abnormality (10.23%), followed by fever (1.40%) and irregular rhythm (0.93%).

Cardiac examination findings were normal in most patients (90.23%). Among the abnormal findings, cardiac murmurs were the most common (5.12%), followed by tachycardia (3.72%), whereas bradycardia was rarely observed (0.47%). Chest examination findings were also normal in most patients (78.60%). The most frequent abnormalities were chest wall tenderness and decreased air entry, each observed in 6.51% of patients, followed by breast tenderness (3.26%), as shown in (Table 6).

Table 6 Distribution of all participants studied according to clinical examination

Clinical examination	**N= 215**
General examination	
Fever	3.00 (1.40%)
Irregular rhythm	2.00 (0.93%)
Normal	187.00 (86.97%)
Pallor	1.00 (0.47%)
Tachypnea	22.00 (10.23%)
Cardiac examination	
Bradycardia	1.00 (0.47%)
Murmur	11.00 (5.12%)
Normal	195.00 (90.69%)
Tachycardia	8.00 (3.72%)
Chest examination	
Breast tenderness	7.00 (3.26%)
Chest wall tenderness	14.00 (6.51%)
Decreased air entry	14.00 (6.51%)
Distress	2.00 (0.93%)
Epigastric tenderness	1.00 (0.47%)
Normal	174.00 (80.93%)
Wheezing	3.00 (1.40%)

The seasonal distribution indicated that most cases were recorded in winter (34.88%), followed by autumn (27.44%), spring (20.00%), and summer (17.67%). Regarding the year of presentation, most participants were recorded in 2024 (26.98%), followed by 2025 (25.12%) and 2023 (22.79%). Fewer cases were reported in 2022 (14.42%), while the lowest proportion was observed in 2026 (10.70%), as shown in (Table 7).

Table 7 Distribution of all participants studied according to the seasonal distribution of cases

Seasonal distribution of the cases	**N= 215**
Autumn	59.00 (27.44%)
Spring	43.00 (20.00%)
Summer	38.00 (17.67%)
Winter	75.00 (34.88%)
Year of presentation	
2022	31.00 (14.42%)
2023	49.00 (22.79%)
2024	58.00 (26.98%)
2025	54.00 (25.12%)
2026	23.00 (10.70%)

There were no statistically significant differences in age or sex between patients with non-cardiac chest pain and those with cardiac chest pain (p=0.4, p=0.6, respectively).

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Table 8 Comparison between participants with cardiac chest pain and Demographic characteristics

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
Age in years			0.4[w]
Min.- Max.	3.00 - 18.00	6.00 - 14.00	
Mean ± SD	8.59 ± 3.91	10.67 ± 4.16	
Median (IQR)	8.00 (5.38, 11.00)	12.00 (9.00, 13.00)	
Sex			0.6[c]
Female	97.00 (45.75%)	2.00 (66.67%)	
Male	115.00 (54.25%)	1.00 (33.33%)	

There were statistically significant differences between patients with non-cardiac and cardiac chest pain regarding electrocardiographic (ECG) and echocardiographic findings ($p < 0.001$). All patients with cardiac chest pain had abnormal ECG findings (100%), whereas no ECG abnormalities were detected in the non-cardiac group. Similarly, echocardiographic abnormalities were more frequent among patients with cardiac chest pain. Mitral valve prolapse and reduced ejection fraction were each observed in 33.33% of patients with cardiac chest pain. In contrast, most patients with non-cardiac chest pain had normal echocardiographic findings (91.51%). There was no statistically significant difference between the two groups regarding chest X-ray findings ($p = 0.2$), as shown in (Table 9), (Figure 3, 4).

Table 9 Comparison between participants with cardiac chest pain and diagnostic findings

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
ECG findings			<0.001*[f]
Abnormal	0.00 (0.00%)	3.00 (100.00%)	
Normal	212.00 (100.00%)	0.00 (0.00%)	
Echocardiographic findings		<0.001*[f]	
Atrial septal defect	4.00 (1.89%)	0.00 (0.00%)	
Bicuspid aortic valve	3.00 (1.42%)	0.00 (0.00%)	
Mitral valves prolapse	0.00 (0.00%)	1.00 (33.33%)	
Normal	194.00 (91.51%)	1.00 (33.33%)	
Patent foramen ovale	3.00 (1.42%)	0.00 (0.00%)	
Pulmonary stenosis	4.00 (1.89%)	0.00 (0.00%)	
Reduced ejection fraction	0.00 (0.00%)	1.00 (33.33%)	
Chest x ray			0.2[f]
Abnormal	17.00 (8.02%)	1.00 (33.33%)	
Normal	195.00 (91.98%)	2.00 (66.67%)	

F: Fisher exact test

**: statistically significant p<0.05*

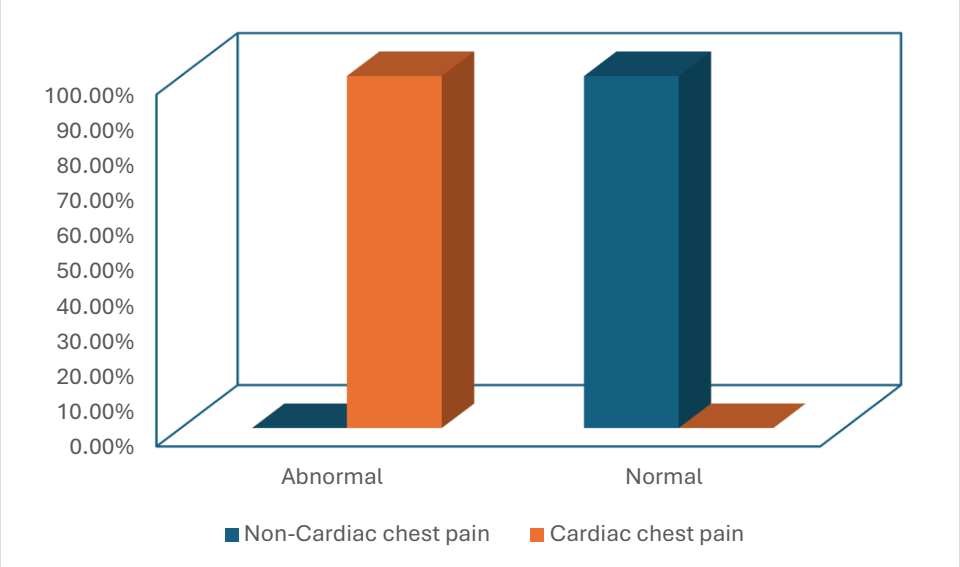

Figure 3. Distribution of electrocardiographic ECG findings between patients with cardiac chest pain and those without cardiac chest pain.

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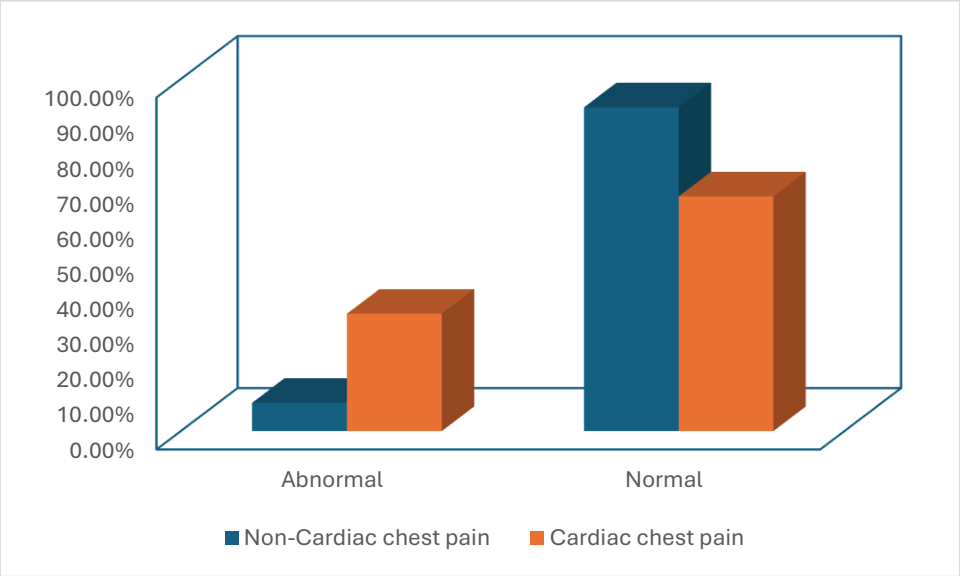

Figure 4. Distribution of Chest x-ray findings between patients with cardiac chest pain and those without cardiac chest pain

There were statistically significant differences between patients with non-cardiac and cardiac chest pain in associated symptoms and causes of chest pain ($p < 0.001$ for both). Palpitations were more frequent among patients with cardiac chest pain (66.67%), and syncope was reported exclusively in this group (33.33%). In contrast, most patients with non-cardiac chest pain had no associated symptoms (66.04%).

Regarding the causes of chest pain, arrhythmia (66.67%) and cardiac causes (33.33%) were observed only among patients with cardiac chest pain. In contrast, all other causes, including idiopathic, musculoskeletal, pulmonary, gastrointestinal, and others, were reported exclusively in the non-cardiac group, as shown in (Table 10).

Table 10 Comparison between participants with cardiac pain and associated symptoms and causes of pain

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
Associated symptoms		<0.001*[f]	
Abdominal pain	9.00 (4.25%)	0.00 (0.00%)	
Cough	20.00 (9.43%)	0.00 (0.00%)	
Dizziness	1.00 (0.47%)	0.00 (0.00%)	
Dyspnea	10.00 (4.72%)	0.00 (0.00%)	
Fever	15.00 (7.08%)	0.00 (0.00%)	
None	140.00 (66.04%)	0.00 (0.00%)	
Headache	1.00 (0.47%)	0.00 (0.00%)	
Palpitations	3.00 (1.42%)	2.00 (66.67%)	
Rhinorrhea	5.00 (2.36%)	0.00 (0.00%)	
Syncope	0.00 (0.00%)	1.00 (33.33%)	
Vomiting	8.00 (3.77%)	0.00 (0.00%)	
Causes of chest pain		<0.001*[f]	
Arrhythmia	0.00 (0.00%)	2.00 (66.67%)	
Cardiac	0.00 (0.00%)	1.00 (33.33%)	
Gastrointestinal	16.00 (7.55%)	0.00 (0.00%)	
Hematological	2.00 (0.94%)	0.00 (0.00%)	
Idiopathic	94.00 (44.34%)	0.00 (0.00%)	
Miscellaneous	15.00 (7.08%)	0.00 (0.00%)	
Musculoskeletal	47.00 (22.17%)	0.00 (0.00%)	
Psychological disorders	5.00 (2.36%)	0.00 (0.00%)	
Pulmonary	25.00 (11.79%)	0.00 (0.00%)	
Trauma	8.00 (3.77%)	0.00 (0.00%)	

*F: Fisher exact test; *: statistically significant p<0.05*

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Regarding pain characteristics, patients with cardiac chest pain did not differ from those without cardiac chest pain, except for alleviating factors (p = 0.004). Antiarrhythmic use, no resolution of symptoms, and relief with rest were each reported in 33.33% of patients with cardiac chest pain, whereas these findings were either absent or less common in the non-cardiac group, as shown in (Table 11).

Table 11 Comparison between participants with cardiac pain and characteristics of pain

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
Duration			0.2[f]
Days	118.00 (55.66%)	2.00 (66.67%)	
Months	29.00 (13.68%)	1.00 (33.33%)	
Weeks	65.00 (30.66%)	0.00 (0.00%)	
Types of pain			0.8[f]
Burning	6.00 (2.83%)	0.00 (0.00%)	
Heart burn	1.00 (0.47%)	0.00 (0.00%)	
Pressure sensation	24.00 (11.32%)	0.00 (0.00%)	
Squeezing	1.00 (0.47%)	0.00 (0.00%)	
Sharp	72.00 (33. 96%)	2.00 (66.67%)	
Stabbing	21.00 (9.91%)	0.00 (0.00%)	
Undefined	87.00 (41.04%)	1.00 (33.33%)	
Aggravating factors			
Breathing	20.00 (9.43%)	0.00 (0.00%)	0.12[f]
Cough	4.00 (1.89%)	0.00 (0.00%)	
Exercise	38.00 (17.92%)	1.00 (33.33%)	
Feeding	11.00 (5.19%)	0.00 (0.00%)	
Inspiration	1.00 (0.47%)	0.00 (0.00%)	
None	136.00 (64.15%)	1.00 (33.33%)	
physical activity	2.00 (0.94%)	1.00 (33.33%)	
Alleviating factors			
Antiarrhythmic	0.00 (0.00%)	1.00 (33.33%)	
Antibiotic	8.00 (3.77%)	0.00 (0.00%)	**0.004***[f]
No resolution	128.00 (60.37%)	1.00 (33.33%)	
Pain reliever	36.00 (16.98%)	0.00 (0.00%)	
Physical activity	2.00 (0.94%)	0.00 (0.00%)	
With rest	38.00 (17.92%)	1.00 (33.33%)	
Localization of pain			
Both sides of the chest	48.00 (22.64%)	0.00 (0.00%)	
Breast	16.00 (7.55%)	0.00 (0.00%)	
Epigastrium	13.00 (6.13%)	0.00 (0.00%)	
Left side of the chest	76.00 (35.85%)	3.00 (100.00%)	0.5[f]
Middle of the chest	3.00 (1.42%)	0.00 (0.00%)	
Right sides of chest	56.00 (26.42%)	0.00 (0.00%)	
Radiating to			
Back	42.00 (19.81%)	0.00 (0.00%)	
Left arm	16.00 (7.55%)	1.00 (33.33%)	
Neck	1.00 (0.47%)	0.00 (0.00%)	
None	150.00 (70.75%)	2.00 (66.67%)	0.4[f]
Shoulder	3.00 (1.42%)	0.00 (0.00%)	

*F: Fisher exact test. *: statistically significant p<0.05*

In terms of pain characteristics, patients with cardiac chest pain did not differ from those without, except for alleviating factors (p = 0.004). In patients with cardiac chest pain, antiarrhythmic use, absence of symptom resolution, and symptom relief with rest were each observed in 33.33% of cases, while these findings were absent or less frequent in the non-cardiac cohort, as illustrated in (Table 12).

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Table 12. Comparison between participants with cardiac pain and non-clinical examination

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
Comorbid diseases			0.9[f]
Allergic rhinitis	5.00 (2.36%)	0.00 (0.00%)	
Atopic dermatitis	3.00 (1.42%)	0.00 (0.00%)	
Bronchial asthma	6.00 (2.83%)	0.00 (0.00%)	
Congenital heart disease	11.00 (5.19%)	0.00 (0.00%)	
Hypothyroid	1.00 (0.47%)	0.00 (0.00%)	
None	186.00 (87.73%)	3.00 (100.00%)	
Treatment used		<0.001*[f]	
Analgesia	40.00 (18.87%)	0.00 (0.00%)	
Antiarrhythmic	0.00 (0.00%)	0.00 (0.00%)	
Antibiotic	2.00 (0.94%)	1.00 (33.33%)	
Conservative treatment	10.00 (4.72%)	0.00 (0.00%)	
None	144.00 (67.92%)	0.00 (0.00%)	
Others	0.00 (0.00%)	2.00 (66.67%)	
Proton pump inhibitor	11.00 (5.19%)	0.00 (0.00%)	
Tranquilizer	5.00 (2.36%)	0.00 (0.00%)	
Medical history			
Allergic rhinitis	1.00 (0.47%)	0.00 (0.00%)	0.9[f]
Bronchial asthma	11.00 (5.19%)	0.00 (0.00%)	
Hypothyroid	1.00 (0.47%)	0.00 (0.00%)	
None	198.00 (93.40%)	3.00 (100.00%)	
Sickle cell disease	1.00 (0.47%)	0.00 (0.00%)	
Family history			
Allergic disease	2.00 (0.94%)	0.00 (0.00%)	0.4[f]
Bronchial asthma	9.00 (4.25%)	0.00 (0.00%)	
Cardiac disease	8.00 (3.77%)	1.00 (33.33%)	
Genetic disorder	1.00 (0.47%)	0.00 (0.00%)	
Gastroesophageal reflux disease	1.00 (0.47%)	0.00 (0.00%)	
None	183.00 (86.32%)	2.00 (66.67%)	
Peptic ulcer	1.00 (0.47%)	0.00 (0.00%)	
Sickle cell anemia	3.00 (1.42%)	0.00 (0.00%)	
Sudden death	4.00 (1.89%)	0.00 (0.00%)	

*F: Fisher exact test. *: statistically significant p<0.05*

Regarding clinical examination, patients with cardiac chest pain showed statistically significant differences in general and cardiac examination findings compared with those with non-cardiac chest pain ($p < 0.001$ and $p = 0.049$, respectively). Irregular rhythm was observed exclusively among patients with cardiac chest pain (66.67%) and tachypnea (33.33%), whereas most patients with non-cardiac chest pain had normal general examination findings (88.20%).

Similarly, cardiac examination abnormalities were more evident in the cardiac chest pain group, including bradycardia (33.33%), whereas most patients in the non-cardiac group had normal cardiac examination findings (91.03%), as shown in (Table 13).

Table 13. Comparison between participants with cardiac pain and Clinical examination

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
General examination			<0.001*[f]
Fever	3.00 (1.42%)	0.00 (0.00%)	
Irregular rhythm	0.00 (0.00%)	2.00 (66.67%)	
Normal	187.00 (88.20%)	0.00 (0.00%)	
Pallor	1.00 (0.47%)	0.00 (0.00%)	
Tachypnea	21.00 (9.91%)	1.00 (33.33%)	
Cardiac examination			0.049*[f]
Bradycardia	0.00 (0.00%)	1.00 (33.33%)	
Murmur	11.00 (5.19%)	0.00 (0.00%)	
Normal	193.00 (91.03%)	2.00 (66.67%)	

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Tachycardia	8.00 (3.77%)	0.00 (0.00%)	
Chest examination			0.9 [f]
Breast tenderness	7.00 (3.30%)	0.00 (0.00%)	
Chest wall tenderness	14.00 (6.60%)	0.00 (0.00%)	
Decreased air entry	14.00 (6.60%)	0.00 (0.00%)	
Distress	2.00 (0.94%)	0.00 (0.00%)	
Epigastric tenderness	1.00 (0.47%)	0.00 (0.00%)	
Normal	171.00 (80.66%)	3.00 (100.00%)	
Wheezing	3.00 (1.42%)	0.00 (0.00%)	

F: Fisher exact test
**: statistically significant p<0.05*

There were no statistically significant differences between patients with non-cardiac chest pain and patients with cardiac chest pain regarding the seasonal distribution of cases or year of presentation (p=0.13, P=0.4, respectively), as shown in (Table 14).

Table 14. Comparison between participants with cardiac pain and seasonal distribution

Variables	No cardiac pain, N = 212	Cardiac pain, N = 3	p-value
Seasonal distribution of the cases			0.13 [f]
Autumn	59.00 (27.83%)	0.00 (0.00%)	
Spring	43.00 (20.28%)	0.00 (0.00%)	
Summer	36.00 (16.98%)	2.00 (66.67%)	
Winter	74.00 (34.91%)	1.00 (33.33%)	
Year of presentation			0.4 [f]
2022	31.00 (14.62%)	0.00 (0.00%)	
2023	47.00 (22.17%)	2.00 (66.67%)	
2024	58.00 (27.36%)	0.00 (0.00%)	
2025	53.00 (25.00%)	1.00 (33.33%)	
2026	23.00 (10.85%)	0.00 (0.00%)	

*F: Fisher exact test. *: statistically significant p<0.05*

Discussion

The findings of our study indicate that the mean age of children and adolescents experiencing medically significant chest pain is 8.62 ± 3.91 years, with a reported male-to-female ratio of (1.17:1). This finding is consistent with earlier observations reported by Khalilian et al. [14].

In this study, chest pain of cardiac origin was identified in only a small proportion of patients (1.4%). This finding is consistent with the study by Lasek et al. [15]. However, the proportion observed in the present study was higher than that reported in some previous studies [2,16]. In another study, only 1% of 761 children who presented to the emergency department with chest pain in 2020 were found to have a cardiac etiology [1]. In the present study, all patients were assessed by a pediatric cardiologist, and 98.6% of cases were classified as non-cardiac chest pain. These findings suggest that pediatric chest pain frequently prompts referral for cardiology assessment, despite the low prevalence of cardiac causes. Therefore, public education regarding pediatric chest pain, careful evaluation of its causes, and implementation of standardized diagnostic protocols may reduce unnecessary healthcare utilization.

In the present study, idiopathic causes were the most common in 52.09%, followed by musculoskeletal causes (21.86%), pulmonary causes (11.63%), Gastrointestinal causes (7.44%) while miscellaneous causes (6.98%) These findings contradict the results of Aygun et al [9] who also observed that Musculoskeletal (33%) and Psychogenic (28.4) causes who had a higher proportion than idiopathic (11.6%)**.** However, several studies reported different results **[**1, 2, 11,14, 15].

In this study, 75 patients (34.61%) experienced associated symptoms. Cough was the most common associated symptom, reported in 20 cases (9.3%). In contrast, another study reported that palpitations were the most frequent symptom associated with chest pain [17]. In the present study, 140 children (65.12%) had no associated symptoms. Chun et al. [18] reported that 30% of cases had chest pain accompanied by associated symptoms, with cough being the most common symptom, occurring in 23.4% of cases. Lasek et al reported comparable results [15].

In the present study population, most patients reported no aggravating factor (61.40%). Among patients with identifiable triggers, exercise was the most common aggravating factor (19.53%), followed by breathing (9.30%), feeding (5.12%), cough (1.86%), and physical activity (1.40%), while inspiration was rarely reported (0.47%). Another study reported the aggravating factors in children and adolescents with chest pain: Physical activity was the most common (204, 12.29%), followed by breathing (194, 11.69%) and cough (15, 0.90%) [15].

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In the present study, the duration of chest pain was most commonly reported in days, observed in 120 patients (55.81%), followed by weeks in 65 patients (30.23%) and months in 30 patients (13.95%). Treatment was not required in most cases (60.00%), whereas 40.00% of patients received medical treatment. These findings are broadly consistent with previous research indicating that most cases of pediatric chest pain do not require intensive medical intervention. For example, Chen et al. reported that only 0.2% of children with chest pain required hospitalization [19]. Conservative management, including respiratory physiotherapy and dietary modification, was the most commonly used approach. Analgesics were administered to approximately 64.94% of patients who received treatment, particularly for musculoskeletal pain. Similar findings were reported by Pissarra et al. [1].

According to a preceding study, chest pain is frequently associated with pneumonia and asthma (17%) [20]. Asthma accounted for a significant proportion (5.12%) of the respiratory-related conditions. Consequently, careful history-taking is necessary to differentiate respiratory causes of chest pain from other etiologies [21]. Congenital heart diseases and Bronchial asthma were the most prevalent comorbidities among the 5.12% of the patients in our study, whereas allergic rhinitis, hypothyroidism, and sickle cell disease were rarely reported (0.47% each). Similar findings have been reported in the literature. Alnaim et al. (16) reported that 15.5% of patients with chest pain had hematologic disorders or chronic diseases, most commonly pulmonary conditions such as allergic rhinitis and asthma. Other studies have also reported comparable findings [15].

In another study, abnormal electrocardiographic and echocardiographic findings were reported in 1.2% and 7.7% of children with cardiac chest pain, respectively [9]. In the present study, abnormal diagnostic findings ranged from 1.4% for ECG abnormalities to 10% for echocardiographic abnormalities. Selbst et al. reported that 191 of 235 children with chest pain underwent ECG, of whom 31 cases (16%) had abnormal findings, whereas 139 of 235 underwent echocardiography, revealing 17 cases (12%) with abnormal findings [22].

Chest x-rays were conducted for all patients in our study. Abnormal chest x-rays were observed in 18 patients (8.37%). In a previous study, chest radiographs were obtained in only 21.5% of patients, of which 16.2% showed abnormal findings [14].

In the current study, 23 participants (9.5%) had mild congenital heart diseases. Mitral valve prolapse (MVP) was diagnosed in 1 patient and may have contributed to their chest pain symptoms. Chest pain is less common in the other conditions. The patient may perceive nonspecific MVP symptoms, such as chest pain or discomfort. One (0.47%) of our patients had an MVP diagnosis. Although MVP was detected incidentally on echocardiography in the present study, it was not classified as a cause of cardiac chest pain.

Conclusion

In conclusion, chest pain is a common presenting symptom in children and may result from both cardiac and non-cardiac conditions. Even after thorough evaluation, the etiology remains unidentified in a significant number of pediatric patients. Although cardiac causes of chest pain are uncommon in children, they may be clinically significant and, in rare cases, life-threatening. Idiopathic chest pain was the most frequent cause of chest pain among Libyan children referred to a pediatric cardiology clinic, with only a minor percentage of cases linked to cardiac disease. A thorough history, careful physical examination, and appropriate screening with electrocardiography (ECG) and echocardiography are important for ruling out uncommon yet potentially severe cardiac etiologies of chest pain in children.

Limitations

This study has some limitations. First, it was a retrospective, single-center study, so the relevant data were affected by the hospital size, first-line specialty, source, and other aspects. Consequently, the findings may not be fully generalizable to all pediatric patients with chest pain in Libya.

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Declarations

All methods were carried out in accordance with relevant guidelines and regulations.

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Authors' contributions

Hawa Gamaa: Conceptualization, Methodology, Software, Supervision, Formal analysis, Writing- Original draft preparation, Writing- Reviewing and Editing. Najat .A. Hasan: Methodology, Software, Investigation, Validation, Writing- Reviewing and Editing. All authors reviewed and approved the final article.

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