

## **Epidemiology of and Factors Associated with Innocent Heart Murmurs in Children between 2 Months and 18 Years: A Cross Sectional Study (2017 - 2018), Specialist Children Hospital, Dubai**

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### **Abstract**

**Objective:** Investigate the epidemiology of innocent heart murmurs in children and analyse their characteristics with regards to the development of symptoms and heart abnormalities on tests, in Aljalila Children Specialty hospital in Dubai, United Arab Emirates (UAE).

**Methods:** This is a cross sectional study that was conducted on 610 patients in Aljalila Children Specialty hospital in Dubai, UAE between 1 January 2017 and end of December 2018. Data was collected from patients' files and analysed on SPSS. The variables collected included demographic data like age and gender. It also included variables specific to the murmur like the type of murmur, its intensity and associated symptoms. We also looked at multiple tests like Echocardiogram, electrocardiogram and chest X-ray.

**Results:** From the total 610 patients, only 48 had cardiovascular symptoms. Moreover, all patients either had normal Echocardiogram without any finding or had accidental physiological findings like a closing Patent foramen ovale, mild tricuspid regurgitation or small atrial septal defect. None of the 610 patients showed major abnormalities or defects in the heart. Most of the patients who had murmurs were between the age of 2 months and 5 years old (71.3%).

**Conclusion:** This study showed that innocent heart murmurs are more likely to occur in younger children. It also concluded that innocent heart murmurs are asymptomatic and do not show any abnormality in the heart on echocardiogram, electrocardiogram and chest X-ray. These results can aid healthcare professionals in classifying murmurs. Thus, they minimize unnecessary investigations and reduce anxiety and costs on the patient's family.

**Keywords:** Heart Murmurs; Echocardiogram; Electrocardiogram

### **Introduction**

Heart murmurs are sounds heard upon auscultation of the heart [1]. They are due to disturbance or turbulence of blood as it travels in the heart chambers, through the valves or in the vasculatures surrounding the heart [2]. It was originally thought that all murmurs reflect a structural or functional heart abnormality. However, in the beginnings of the 20<sup>th</sup> century, it was understood that patients may have murmurs yet be completely healthy [3]. From then onwards, heart murmurs were divided into pathological and non-pathological or "innocent" murmurs [4]. Pathological murmurs are usually the result of an underlying heart disease [5] and are associated with symptoms like chest pain, fatigue and exercise intolerance [6]. While innocent murmurs are usually due to movement of blood across normal

structures. They can be heard in healthy individuals and thus, are not suggestive of a heart pathology and are usually asymptomatic [5,6]. Innocent heart murmurs are divided into multiple subtypes [7]. Those subtypes include: 1. Still murmur which is the most common type of innocent heart murmurs. It is an ejection systolic murmur described as soft, musical and low pitched and is best heard at the left lower sternal border and apex. It is benign, and thus, its intensity is less than 3/6 [8]. 2. Innocent pulmonary flow murmur is the second most common type. It is also an ejection systolic murmur but is described as soft, blowing murmur. Best heard at the left upper sternal border. It also has an intensity less than 3/6 [3,9,10]. 3. Peripheral pulmonary artery stenosis: most commonly found in neonates and is a mid-systolic murmur best heard at the upper sternal borders [3,9,10]. 4. Arterial supraclavicular murmur: as the name alludes, this murmur is best heard at the supraclavicular fossa. It is common in late childhood [3]. There are also 2 types of continuous innocent murmurs and those include venous hum which is more common and mammary soufflé which is rare and found in young adult women [3,11].

Heart murmurs are heard in both children and adults. However, they are more common in children [12]. This is mainly due to the fact that children have thinner chests so the heart would be closer to the stethoscope. Thus, the murmur is more likely to be heard and detected [13]. Heart murmurs are a highly prevalent occurrence amongst paediatric patients visiting GPs [14]. It is thought that 72% of children will have a murmur at some point in their life [3]. However, only 1% of these murmurs are pathological and have underlying heart disease [14] and up to 90% or more are benign and occur in healthy individuals [15]. Thus, it is important for the physician to correctly classify the murmur as pathological or innocent to reduce the unnecessary investigations of innocent heart murmurs.

The population of the United Arab Emirates (UAE) presents with little to no studies investigating the epidemiology of Innocent Heart murmurs. Therefore, this study aims to fill the gap in the literature by assessing the patterns of innocent heart murmurs in paediatric patients (from 2 months to 18 years) in AlJalila Children's Specialty hospital (AJCSH) from January 2017 till December 2018.

## **Aims and Research Question**

This study aims to evaluate the presentation of innocent heart murmurs in children between the age of 2 months and 18 years in AJCSH.

## **Objectives of the Study**

The objective of this study is to analyse the characteristics of innocent heart murmurs in children with regards to symptoms and results of echocardiogram, ECG and chest X-ray. Moreover, to assess the occurrence of innocent heart murmur in relation to age and gender.

## **Methods**

### **Ethical statements**

Ethical approval was obtained from the review board of the Mohammed Bin Rashid University of Medicine and Health Sciences before the initiation of the study. Since this is an observational study that does not require any interaction with the patients neither does it include invasive methods of data collection, the committee concluded that no written consent from the patients is required. The only ethical consideration in this study was confidentiality of the patients' information. Thus, patients' name and any other identifying information were kept anonymous. Moreover, patients' files were only accessible within the hospital premises.

### **Study design**

This is a cross-sectional study that was conducted to assess patterns of innocent heart murmurs in Children that presented to Paediatricians within Al Jalila Children's Speciality Hospital in Dubai, UAE from the 1<sup>st</sup> of January 2017 to the 31<sup>st</sup> of December 2019. This study was reported using the: Strengthening The Reporting of Observational studies in Epidemiology (STROBE) guidelines [16].

### **Setting**

The study was conducted in the Paediatric cardiology clinic In Al Jalila Children specialty hospital in Dubai, United Arab Emirates. The study took approximately 10 months to be completed. Starting from January 2019 and ending October 2019. Within the first 2 months, the approval was obtained then data collection was initiated. Data collection was completed in August 2019 and was followed by data analysis. The results of the analysis were communicated with the supervisor of the study (Dr. Mahmood Al Soufi). After that, reporting of the results using STROBE guidelines was done.

### **Participants**

Data collection included all inpatients and outpatients who visited AJCSH with a heart murmur between January of 2017 and December 2018. The patient had to be between the age of 2 months (to exclude the transitional period between fetal and post-natal circulation which can cause murmurs) and 18 years to be included in the study. The murmur had to be an innocent murmur with an intensity of 1/6 to 3/6. All patients included were either asymptomatic or had minor cardiovascular symptoms. Patients with murmurs associated with congenital heart disease or other pathologies were excluded from the study.

### **Variables**

The collected variables included the age at which the patient developed the murmur, clinical examination, murmur grade, results of 3 tests: echocardiogram, Electrocardiogram and Chest X-ray. Clinical examination represented the doctors' reporting of the murmur and it was of 3 types: systolic ejection murmur, soft systolic murmur, and pansystolic murmur. Murmur grade described the intensity of the murmur over 6 and it included only those with the lowest intensities: 1/6, 2/6 and 3/6. As for the echocardiogram and ECG results, they were reported as either "normal", "accidental physiological finding" or "abnormal". The Chest X-ray results were reported as either normal or with an increased cardiothoracic ratio.

### **Data source**

Data was collected from the Electronic medical records of patients between the ages of 2 months and 18 years who visited AJCSH between Jan 2017 to Dec 2018. The program used in AJCSH to keep records of patients' files is Cerner and is only accessible within the hospital's premises. Thus, data collection was conducted in the hospital and patient files were not extracted elsewhere.

### **Bias**

As this study included data from only one hospital in the UAE, the results may not be representative of the entire population within the UAE. Moreover, the hospital was a private institution, and therefore, data collected may not be representative of all classes of the society within the UAE.

Another type of bias found in this study is reporting bias. Not all patients were assessed by the same physician. Thus, patients had different reporting of their murmur. Moreover, different tests were requested from patients. This resulted in some not having an ECG and/or X-ray done. However, all patients had Echocardiogram. Lastly, since the examination depended on the experience of the physician, we are likely to have misleading outcomes if the doctor does not perform the appropriate physical examination and catch the murmur.

### **Study sample size**

The total number of patients found to have presented with innocent heart murmurs in the established time frame were 800. However, after excluding all those that did not meet the criteria, we ended up with a total of 610 patients.

### **Quantitative data**

The quantitative measures collected from patients' files included age and murmur grade. The age of the patients ranged from 2 months to 18 years. Murmur's grade represented the intensity of the murmur. Since only innocent murmurs were included, murmur grade measures reported only those with intensity of 1/6, 2/6 or 3/6.

## Statistical methods

Data was collected on Microsoft excel sheet and was then transferred and analysed on statistical package for social sciences SPSS, version 24 [17]. For analysis, we used chi square, frequency distribution and exact fisher test when appropriate. Statistical significance was set at  $P < 0.05$ . Sampling methods were not applicable.

## Results

### Participants

A total of 610 patients were included in the study. This number was arrived at after excluding any patient with a murmur that did not meet the criteria of innocent murmurs. Excluded patients were those who had a murmur with intensity more than 3/6, major cardiovascular symptoms and/or association with an underlying heart disease.

### Descriptive data

Out of the total 610 patients in the study, 303 (49.7%) were males and 307 (50.3%) were females (Table 1). the distribution of innocent heart murmurs across males and females was very similar. The distribution amongst the 3 different types of murmur also showed similar percentages. Mean age of the study population was 3.6 years old.

Variables	Frequency	Percent
<b>Gender</b>		
Male	303	49.7
Female	307	50.3
<b>Age</b>		
0 to 5	435	71.3
6 to 10	125	20.5
11 to 15	47	7.7
16 to 18	3	0.5
Total	610	100

**Table 1:** Age and gender distribution.

To allow for further analysis of the data, age was grouped into 4 categories. Those categories were: 0 to 5, 6 to 10, 11 to 15 and 16 to 18 which had percentages of 71.3%, 20.5%, 7.7% and 0.5% respectively (Table 1). The percentage decreased as age increased which suggests that innocent heart murmurs are more common in the younger population.

## Main results

### Echo results

All of the patients included in our study had an Echo done. The percentage of patients with a normal echo result was only 39.7% of the total ( $p \leq 0.001$ ). However, upon further checking of the echo results, all the findings were considered to be physiological and require no intervention.

Those findings included: small patent foramen ovale (PFO), small ASD or mild tricuspid regurgitation. Most of the findings were associated with pansystolic murmur which had a percentage of 100%. This may suggest that pansystolic murmur is more severe than ejection systolic murmur and soft systolic murmur (Table 2).

Variables n (%)	Frequency	Percentage	Symptoms		Echo	
			Symptomatic	Asymptomatic	Normal	Abnormal
<b>Clinical Exam</b>						
Ejection systolic murmur	181	29.70%	12 (6.6%)	169 (93.4%)	46 (25.4)	135 (74.6%)
Pansystolic murmur	25	4.10%	3 (12%)	22 (88%)	0 (0%)	25 (100%)
Soft systolic murmur	404	66.20%	33 (8.2%)	371 (91.8%)	196 (48.5%)	208 (51.5%)
Total	610	100%	48 (7.9%)	562 (92.1%)	242 (39.7%)	368 (60.3%)
<b>Intensity</b>						
(1/6)	68	23.20%	(-)	(-)	35 (51.5%)	33 (48.5%)

**Table 2:** Distribution of symptoms and echo results among the 3 murmur types.

The total number of patients who had their murmur grade reported was only 293 of the total. This is because different physicians had different methods of reporting the detected murmur. The incidental physiologic findings on echo make up 48.5%, 68% and 89.4% of murmurs that have a grade of 1/6,2/6 and 3/6 respectively ( $p \leq 0.001$ ). This shows that with increasing severity of the murmur, more structural and functional findings are likely to be found on echo (Table 2).

**ECG results**

Out of the 610 patients included in the study, 353 had ECG done. This again is due to the fact that patients were assessed by different physicians and each one asked for different tests. 79% of the 353 patients showed normal ECG results. 0% of those with pansystolic murmur had normal ECG ( $p \leq 0.001$ ) (Refer to appendix, table 1).

ECG					
		Normal		Accidental finding	Total
Clinical exam	Ejection systolic murmur	Count	69	38	107
		% within clinical exam	64.5%	35.5%	100.0%
		% within ECG	24.7%	51.4%	30.3%
	Pansystolic murmur	Count	0	6	6
		% within clinical exam	0.0%	100.0%	100.0%
		% within ECG	0.0%	8.1%	1.7%
	Soft systolic murmur	Count	210	30	240
		% within clinical exam	87.5%	12.5%	100.0%
		% within ECG	75.3%	40.5%	68.0%
Total		Count	279	74	353

**Appendix Table 1:** Clinical exam \*ECG crosstabulation.

**X-ray results**

In total, 201 patients had chest X-ray done. Out of these, 21 (10.4%) showed increased cardiothoracic ratio. The rest had normal results. The highest percentage of murmur with x-ray abnormality was in patients who had pan-systolic murmur which had a percentage of 26.7%.

Meanwhile, ejection systolic murmur and soft systolic murmur had percentages of 12.9% and 7.3% respectively (Refer to appendix, table 2).

Chest x-ray					Total
Normal			Accidental finding		
Clinical exam	Ejection systolic murmur	Count	54	8	62
		% within clinical exam	87.1%	12.9%	100.0%
		% within Chest x-ray	30.0%	38.1%	30.8%
	Pansystolic murmur	Count	11	4	15
		% within clinical exam	73.3%	26.7%	100.0%
		% within Chest x-ray	6.1%	19.0%	7.5%
	Soft systolic murmur	Count	115	9	124
		% within clinical exam	92.7%	7.3%	100.0%
		% within Chest x-ray	63.9%	42.9%	61.7%
Total		Count	180	21	201
% within clinical exam			89.6%	10.4%	100.0%
% within Chest x-ray			100.0%	100.0%	

**Appendix Table 2:** Clinical exam \*Chest x-ray crosstabulation.

### Symptoms

Out of the 610 patients included in our study, only 48 patients (7.9%) experienced cardiovascular symptoms ( $p \leq 0.001$ ). Chest pain was the most common symptom with a count of 19 patients across the 48 symptomatic patients. Other less common symptoms included fatigue, cyanosis, dyspnea, jaundice, tachycardia and tachypnea.

With regards to the relationship between the type of murmur and the development of symptoms: 12% of patients with pansystolic murmur were symptomatic. While, only 6.6% and 8.2% of patients with ejection systolic murmur and soft systolic murmur respectively had symptoms. This provides further evidence that pansystolic murmurs are more severe than the other 2 discussed in the study (Table 2).

Combining all the results, 38.9% of patients with innocent heart murmur had normal results for ECG, echo and chest X-ray. The rest showed accidental findings on tests. Those findings are considered normal and physiological. Thus, they are not the cause of the murmur. Only 1.6% of the patients with murmur showed accidental findings on all three tests (Table 3).

## **Discussion**

In this study, we managed to identify patterns of innocent heart murmur in children. Those murmurs were more likely to be found in children under the age of 5 years old. Out of the 610 patients included in our study, 435 (71.3%) were aged between 0 and 5 years of age. This is significant when compared with the other age groups where the highest percentage reached only 20.5% of the total. Moreover, this study showed that innocent heart murmurs usually present with no cardiovascular symptoms. Only 7.9% of the total number of patients in our study had mild cardiovascular symptoms. Furthermore, the study proved that innocent heart murmurs do not present with any structural or functional abnormalities of the heart. This was concluded because all the findings that were associated with examination of the heart were physiological findings that do not lead to the production of murmur. Furthermore, the study may suggest that out of the 3 types of murmurs discussed, pansystolic murmur was the most severe with increased chance of reporting findings on tests. In short terms, this study shows that innocent heart murmurs are benign, do not show symptoms, do not have underlying pathology and are likely to disappear as the child grows. Thus, when an innocent heart murmur is diagnosed, there is no need to do more investigations as that would only increase unnecessary costs. When the doctor gives a diagnosis of innocent murmur, he should assure the parents that this does not reflect a heart disease.

## **Limitations of the Study**

Discussing limitations is important in this study as it affects our ability to generalize the results. Multiple limitations were identified and those were:

- 1) The study included only one private hospital in the United Arab Emirates.
- 2) There were multiple doctors examining patients and assessing the murmur. This led to differences in reporting the murmur as well as differences in the investigations done
- 3) Data on nationality and ethnicity was not collected. This can impact the generalizability of the study especially since the UAE is an international country with expatriates from all over the world.
- 4) The study included data from 2 years only (2017 - 2018) and
- 5) The study was conducted in 10 months only. This limited our ability to include more patients in the study.

## **Generalizability and strengths**

This study is the first in the United Arab Emirates. As mentioned earlier, this study is conducted only on one healthcare centre and thus, we are unable to generalize our results among the whole UAE population. However, the study could be representative of children in the upper and middle classes of both expatriates and UAE citizens in the time frame of the study (2017- 2018).

## **Comparison with previous studies**

As mentioned earlier, this study is the first in the United Arab Emirates. Nevertheless, similar studies were conducted in other countries. This includes a one year observational study done in Egypt which looked at 183 paediatric patients presenting with innocent or pathologic murmur [7]. The study showed that innocent heart murmurs were more prevalent amongst younger children. 55.94% of innocent murmurs were found in children aged between 2 months and 2 years. In addition, 21.51% of innocent murmurs were found

in the age group 2-6 years. This is consistent with the findings of our study which showed that 71.3% of innocent heart murmurs were in children between the age of 2 months and 5 years. With regards to symptomatology of innocent murmurs, the study done in Egypt concluded that the main reason for referring a patient with an innocent murmur to a cardiologist was due to physician's anxiety (70.4%) rather than any symptoms [7]. This again agrees with the findings in our study which showed that 92.1% of patients were asymptomatic.

A study which analysed the characteristics of innocent murmurs showed that they are usually systolic and are almost never of the diastolic type [9]. Another study matched this and showed that innocent murmurs are more likely to be systolic [18]. These findings agree with our study where 100% of innocent murmurs were systolic in nature.

A study done in the US by Dr. Arpan R Doshi, a paediatric cardiologist, showed that innocent heart murmurs are benign and do not reflect any heart abnormality [19]. Moreover, Dr. Doshi also pointed out that even after the diagnosis of innocent murmur is given, physicians still proceeded with several testing as part of investigating the murmur. This further investigation was unnecessary and worrisome to the parents. Our study can be used to reinforce Dr. Doshi's conclusion since all the patients included in our study had innocent murmurs yet, all of them had an 'unnecessary' echocardiogram done. This further explains the need to educate physicians on innocent murmurs in order for them to be more confident about their diagnosis. Thus, enabling them to assure the parents of children with innocent murmurs.

### **Implications for public health clinicians**

By understanding the usual presentation of innocent heart murmurs, clinicians will be able to recognize and diagnose an innocent murmur solely by conducting a physical examination. This will reduce the referrals of patients to cardiologists. Furthermore, it will reduce unnecessary costs and reassure patients.

### **Areas for future research**

Future research can work on identifying the incidence of innocent heart murmurs in the United Arab Emirates so that we can better understand the burden of this occurrence. Moreover, a prospective study can be done on patients with innocent murmurs. The study would follow those children for a period of time in order to see whether innocent murmurs disappear, remain there or develop into a heart pathology.

### **Conclusion**

This study analysed the characteristics of innocent heart murmurs in children who presented to AlJalila Children Specialty hospital. The study showed that innocent heart murmurs are not associated with symptoms nor cardiovascular abnormalities. It also proved that innocent murmurs are more likely to occur in younger children. These results help in reducing costs and improving patients' care.

### **Key Messages**

#### **What is already known about this subject?**

- Innocent Heart murmurs are more common in children.
- Innocent Heart murmur are asymptomatic and do not have an underlying disease.

#### **What does this study add?**

- This study analyses innocent heart murmurs in the United Arab Emirates.
- Shows the distribution of innocent heart murmurs according to age and gender.

### **How might this impact on public clinical practice?**

- Understanding the characteristics of innocent heart murmurs enables physicians to recognize an innocent murmur simply by conducting a proper physical examination.
- Assure parents that innocent murmurs are not reflective of a heart disease.

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