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ORIGINAL ARTICLE

Epidemiological analysis of hospital admissions in the SUS due to congenital heart disease, and transthoracic echocardiography, in the city of São Paulo.

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Keywords:
Heart Defects, Congenital, Echocardiography, Heart septal defects.

Abstract

Objective: To analyze hospital admissions in the SUS due to congenital heart disease - CHD, as well as the number of transthoracic echocardiograms - ECHO TT performed from 2015 to 2023, in the city of São Paulo. **Methodology:** Epidemiological, retrospective and descriptive study, with a total of 8,279 hospital admissions due to CHD in children under 1 year of age. In the data analysis, the Chi-square test was applied, with information from DATASUS. **Results:** Hospitalizations due to Congenital Heart Disease were analyzed, 8,279 (0.59% of live births) from 2015 to 2023. Of the congenital malformations, the one that stood out was ICD Q21 = 3354 with 40.51% of hospital admissions, with p <0.0001. The TT ECO in children under 1 year of age had a total of 32,009, the year 2020 (9.48%) and 2023 (14.31%), p < 0.0001. In the variable related to sex, (51.55%) refers to the male sex. In the color/race variable, (65.78%) were white. **Discussion:** In this study, the highest number of hospital admissions was for Congenital malformations of the cardiac septa, ICD10 Q21. The increase in TT ECO can be explained by improvements in access to services and technology, but there is still a distance from the ideal condition. In the variables sex, color/race, the male sex and white color predominate. Conclusion: Hospital admissions in congenital heart disease, in the 9-year interval, had ICD Q21 as the main diagnosis. Furthermore, ECO TT procedures, during the same period, had an increase, except in the year 2020.

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INTRODUCTION

Congenital heart disease (CHD) is defined as a structural malformation of the heart and great vessels with functional consequences. It accounts for approximately 40% of all congenital defects[1]. Cardiac abnormalities may result from disturbances in embryonic development or incomplete structural formation[2]. According to the Brazilian Ministry of Health, approximately 1% of live births are affected by congenital heart disease—corresponding to an estimated 29,000 children per year—and about 6% of these children die within the first year of life. In severe cases, CHD accounts for 30% of deaths[3].

Regarding hospital admissions, the average length of stay in the intensive care unit (ICU) is approximately 16 days, although this duration varies depending on the number of associated anomalies and the severity of each case[2].

Early investigation and diagnosis are essential to prevent complications such as cardiac arrest, shock, or neurological impairment[4]. When congenital heart disease is suspected, complementary examinations are fundamental following clinical history and physical examination. Initial evaluation typically includes laboratory tests, followed by chest radiography, electrocardiography, and echocardiography[5].

The establishment of a structured line of care beginning in the prenatal period highlights the importance of screening through obstetric ultrasonography, fetal echocardiography, and neonatal echocardiography in pre- and postnatal assessment, respectively[4]. Article 2 of the 2017 Ministry of Health Ordinance established the National Plan for the Care of Children with Congenital Heart Disease, structured around the following axes: prenatal diagnosis; neonatal diagnosis; safe transport of newborns and children with CHD; surgical care; and multidisciplinary assistance to guide the organization of care for children with congenital heart disease[6].

Modern echocardiography originated from Lord Rayleigh's theory of sound. His work was initially applied during World War I for submarine navigation and later used for non-military purposes in the steel industry. The initial medical application of ultrasound imaging is attributed to pioneers Dorothy and Douglas Howry, who first developed the examination in a water bath and subsequently introduced the use of conductive gel, a method still employed today[7]. In Brazil, the first echocardiography machine was imported in 1974 by Egas Armelin to Hospital da Beneficência Portuguesa in São Paulo[8].

Currently, transthoracic color Doppler echocardiography is a widely disseminated imaging modality that provides detailed anatomical and physiological cardiac assessment[9]. It also offers hemodynamic information, including estimation of pulmonary artery pressure and evaluation of ventricular function[10]. It is considered an essential examination for the initial assessment and diagnosis of congenital heart diseases[11].

Echocardiographic evaluation comprises multiple modalities, including one- and two-dimensional imaging, pulsed and continuous spectral Doppler, and color flow mapping. These components are fundamental for diagnostic formulation and are available in transthoracic and transesophageal echocardiography, as well as stress, contrast-enhanced, fetal, intraoperative, and intracardiac studies[12].

Therefore, understanding the profile of hospitalized children with congenital heart disease and identifying the most prevalent types, while prioritizing less invasive diagnostic methods such as transthoracic echocardiography—the gold standard for cardiac disease diagnosis—may reduce complications and prolonged hospitalizations. Additionally, transthoracic echocardiography is essential for the longitudinal follow-up of children with CHD, as it supports timely and effective clinical decision-making, contributing to reduced morbidity and mortality. Accordingly, the objective of this study is to analyze hospital admissions within the Brazilian Unified Health System (SUS) due to congenital heart diseases, as well as the number of transthoracic echocardiograms performed between 2015 and 2023 in the municipality of São Paulo.

METHODS

This study is a retrospective epidemiological analysis with a quantitative and descriptive approach, conducted through statistical analysis of secondary data.

Data were collected from the DATASUS (Tabnet) database, covering the period from 2015 to 2023 in the municipality of São Paulo. Complementary literature searches were performed in the Virtual Health Library (BVS), SciELO, PubMed, and relevant textbooks. The inclusion criterion was children under 1 year of age with a diagnosis of congenital heart disease.

The study population comprised a total of 8,279 hospital admissions due to congenital heart disease in children under 1 year of age between 2015 and 2023.

The research was conducted in three stages and concluded with statistical analysis. In the first stage, data were extracted, cross-referenced, and selected from the Tabnet/DATASUS system. In the second stage, hospital admissions due to congenital heart diseases were analyzed according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10), specifically codes Q20, Q21, Q22, Q23, Q24, and Q25 as primary diagnoses. The variables sex and race/ethnicity were subsequently associated with these diagnoses.

Additionally, outpatient procedures of transthoracic echocardiography performed in children under 1 year of age during the same period were analyzed.

In the third and final stage, all records were subjected to statistical analysis. The chi-square test for contingency tables and the chi-square goodness-of-fit test were applied[13]. Subsequently, tables and graphs were constructed.

RESULTS

Records of hospital admissions and the main diagnoses in children under 1 year of age were analyzed. In accordance with the International Classification of Diseases (ICD-10), these were: Q20: Congenital malformation of cardiac chambers and connections; Q21: Congenital malformations of the cardiac septa; Q22: Congenital malformations of the pulmonary and tricuspid valves; Q23: Congenital malformations of the aortic and mitral valves; Q24: Other congenital malformations of the heart; Q25: Congenital malformations of the great arteries[14].

Live births (LB) in the Municipality of São Paulo over the last 9 years (2015–2023) totaled 1,381,412. The total number of admissions due to CHD, according to the specified diagnoses, was 8,279 (0.59% of LB) during the same period. Among these, the ICD-10 codes for congenital malformations were as follows: Q20 = 763 hospital admissions, corresponding to 9.21%; Q21 = 3,354 with 40.51%; Q22 = 882 with 10.65%; Q23 = 680 with 8.21%; Q24 = 796 with 9.61%; and Q25 = 1,804, representing 21.79% of hospital admission cases, with p<0.0001 (Table 1 and Figure 1).

In the Municipality of São Paulo, transthoracic echocardiograms, regardless of age, corresponding to the period from 2015 to 2023, totaled 2,038,852 over the 9-year interval. In 2015, n=196,248 (9.62%) of the procedures were performed; in 2016, n=210,754 (10.33%); in 2017, n=233,774 (11.46%); in 2018, n=240,750 (11.80%); in 2019, n=229,228 (11.24%); in 2020, n=154,277 (7.56%); in 2021, n=223,139 (10.94%); in 2022, n=252,508 (12.38%); and in 2023, n=298,174 (14.62%).

The year 2023 shows the highest percentage of approved procedures among the periods, and 2020 the lowest rate. In the chi-square test for one sample, X2=54,703.44 and p<0.0001.

Transthoracic echocardiography (TTE) in children aged <1 year in the Municipality of São Paulo totaled 32,009. In 2015 it was (9.72%); 2016 (8.45%); 2017 (9.25%); 2018 (10.09%); 2019 (12.24%); 2020 (9.48%); 2021 (13.28%); 2022 (13.14%); and 2023 (14.31%). The latter shows the highest number of procedures, p<0.0001 (0.01%), (Table 2 and Chart 2).

For the sex variable, it is noted that among all diagnoses of congenital heart diseases, with a total of 8,279 admissions, n=4,268 (51.55%) were male and n=4,011 (48.44%) were female.

In detail, for each diagnosis/ICD-10 code, Q20: n=452 (59.23%) and n=311 (40.76%) corresponded to males and females, respectively. Q21: n=1,668 (49.73%) male and n=1,686 (50.26%) female. Q22: n=434 (49.20%) male and n=448 (50.79%) female. Q23: both n=340 (50%) male and female. Q24: n=399 (50.12%) male and n=397 (49.87%) female. Q25: n=975 (54.04%) male and n=829 (45.95%) female. In the chi-square test, X2=30.25 and p<0.0001.

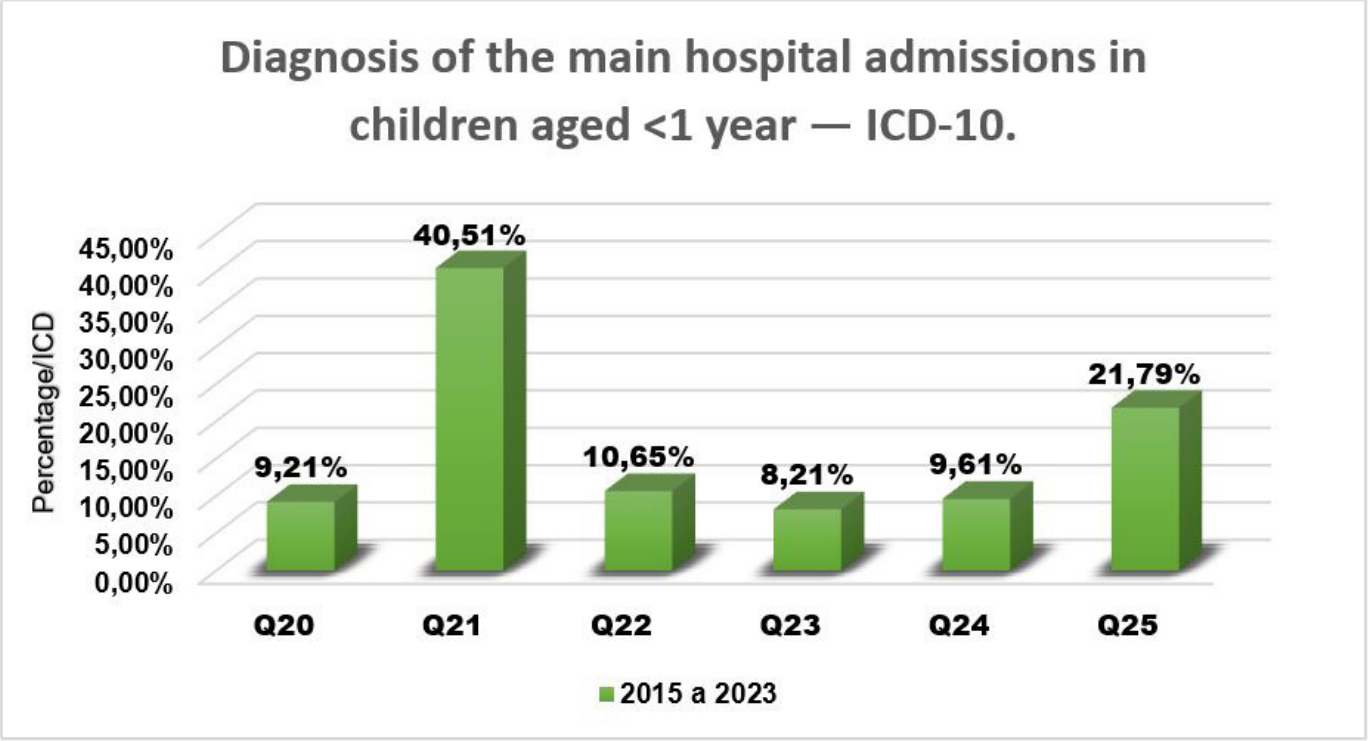
For the race/color variable, of the total admissions for heart diseases (8,279 cases) in children under 1 year of age, 5,446 (65.78%) were White, 378 (4.56%) Black, 1,386 (16.74%)

Table 1. Diagnosis of the main hospital admissions in children under 1 year of age, in the Brazilian Unified Health System (SUS) in the Municipality of São Paulo, period (2015–2023).

ICD - 10	Year									Total (n= 8,279)
	2015	2016	2017	2018	2019	2020	2021	2022	2023	
Q20: Congenital malformation of cardiac chambers and connections	82	62	70	110	112	81	76	94	76	763
Q21: Congenital malformations of the cardiac septa	398	344	354	348	398	325	349	381	457	3354
Q22: Congenital malformations of the pulmonary and tricuspid valves	106	85	97	108	99	82	109	68	128	882
Q23: Congenital malformations of the aortic and mitral valves	54	40	54	53	59	68	111	103	138	680
Q24: Other congenital malformations of the heart	83	80	60	104	83	93	109	80	104	796
Q25: Congenital malformations of the great arteries	232	228	155	156	189	183	171	214	276	1804

Source: Prepared by the authors, using data from DATASUS.
Legend: Chi-square test: X2=178.65; *p*<0.0001.

Chart 1: Diagnosis of the main hospital admissions in children under 1 year of age, according to ICD-10



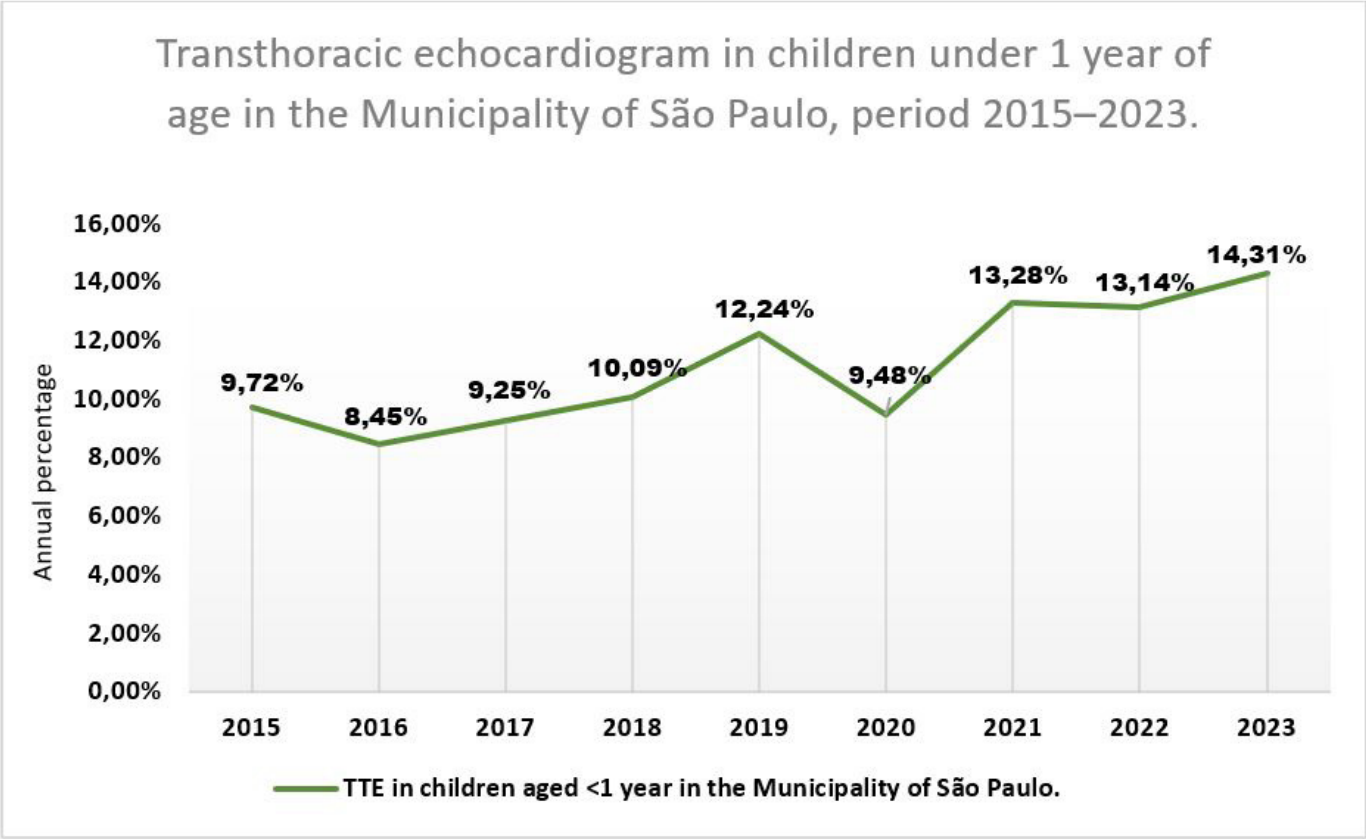
Source: Prepared by the authors, using data from DATASUS. Q20: Congenital malformation of cardiac chambers and connections; Q21: Congenital malformations of the cardiac septa; Q22: Congenital malformations of the pulmonary and tricuspid valves; Q23: Congenital malformations of the aortic and mitral valves; Q24: Other congenital malformations of the heart; Q25: Congenital malformations of the great arteries.

Table 2. Transthoracic echocardiography in children under 1 year of age in the Municipality of São Paulo, period (2015–2023).

Transthoracic echocardiography in children under 1 year of age in the Municipality of São Paulo, period (2015–2023).	
Year	**Number (n) of procedures**
2015	3.114
2016	2.707
2017	2.964
2018	3.231
2019	3.918
2020	3.036
2021	4.252
2022	4.206
2023	4.581
TOTAL	32.009

Source: Prepared by the authors, using data from DATASUS.
Legend: One-sample chi-square test: X2=1049.12; p<0.0001.

Chart 2: Transthoracic echocardiogram in children under 1 year of age in the Municipality of São Paulo, period 2015–2023.



Source: Prepared by the authors, using data from DATASUS. TTE – Transthoracic echocardiogram.

Brown, 31 (0.37%) Yellow, 2 (0.05%) Indigenous, and 1,036 (12.51%) had no information.

Specifically, Q20: (67.88%) White, (4.06%) Black, (16.38%) Brown, (0.39%) Yellow, no Indigenous cases, and (11.27%) no information. Q21: (66.99%) White, (3.48%) Black, (17.32%) Brown, (0.41%) Yellow, no Indigenous cases, and (11.77%) no information. Q22: (70.97%) White, (4.98%) Black, (12.35%) Brown, (0.22%) Yellow, (0.11%) Indigenous, and (11.33%) no information. Q23: (75.29%) White, (7.20%) Black, (10.29%) Brown, (0.58%) Yellow, no Indigenous cases, and (6.61%) no information. Q24: (44.84%) White, (4.39%) Black, (26%) Brown, (0.12%) Yellow, no Indigenous cases, and (24.62%) no information.

For the last classification, Q25: (65.74%) White, (5.65%) Black, (16.29%) Brown, (0.38%) Yellow, (0.05%) Indigenous, and (11.86%) no information. The race/color variable was subjected to the chi-square test, X2=278.91 and p<0.0001.

DISCUSSION

The epidemiological bulletin analyzed the situation of congenital anomalies in Brazil between 2010 and 2021; congenital heart diseases ranked second among the most prevalent anomalies in this period (11/10,000 live births), in the State of Amapá (2/10,000 live births), and in São Paulo (35/10,000 live births). Among the country's regions, the Southeast region showed congenital heart diseases as prevalent[15].

In this study, it was observed that, significantly, the highest number of hospital admissions was due to congenital malformations of the cardiac septa, Q21 (40.51%). According to the International Classification of Diseases (ICD-10), Q21 includes: ventricular septal defect (VSD) (Q21.0), atrial septal defect (ASD) (Q21.1), atrioventricular septal defect/defect of the atrioventricular septum (AVSD) (Q21.2), tetralogy of Fallot (TOF) (Q21.3), aortopulmonary septal defect (Q21.4), other congenital malformations of the cardiac septa (Q21.8), and unspecified congenital malformation of the cardiac septum (Q21.9)[14].

In a study of children hospitalized due to congenital heart disease, the most frequently observed diagnoses were septal defects—VSD and ASD[16]. Other descriptive studies on mortality indicate that malformations of the circulatory system are more notable in the first years of life[17,18]. Among the main congenital heart diseases in the neonatal period are those dependent on the ductus arteriosus[19–20].

The importance of comprehensive care for children with congenital heart disease begins with prenatal and postnatal care and follow-up[6], that is, considering prenatal and neonatal screening, as well as monitoring (fetal ultrasonography and fetal echocardiography, pulse oximetry screening, newborn echocardiogram)[4]. Diagnosis during the fetal period enables delivery in a hospital with appropriate infrastructure and a specialized team.

Echocardiography is a diagnostic method that is necessary for screening critical congenital heart diseases and, depending on the modality, can be performed prenatally or postnatally[10]. In this study, there was an increase over the 9-year interval in TTE in the Municipality of São Paulo, both overall and among children under 1 year of age, except in 2020.

The development and dissemination of the technique—echocardiography—supports improvements in the diagnosis of CHD; however, postnatal survival remains reduced[10]. Regarding the technological aspect, this research corroborates technical advances because the increase in TTE may have occurred due to improved access to services, implemented policies, and updates in health care and trained human resources. However, despite the cited benefits, there is still a gap from the ideal condition.

For both groups—overall TTE procedures and those in children under 1 year of age—the decline in 2020 coincides with the beginning of the COVID-19 pandemic. During this period, access to health services unrelated to COVID-19—medical evaluation and procedures/tests—was reduced due to fear of infection risk and virus spread[21], which can be observed throughout Brazil.

For the sex variable, this study showed a predominance of males, mainly with diagnoses Q20 and Q25, and of females in Q22, whereas ICD-10 codes Q21, Q23, and Q24 occurred in both sexes. In a descriptive cross-sectional study of children with CHD aged 5 to 13 years, 53.8% were female, and in that same study the diagnosis occurred at an age younger than 6 months[22]. In another study, males accounted for 52.09% of live births with CHD[23].

In this study, regarding the race/color variable, there was a predominance of White race/color among hospital admissions of children under 1 year of age with congenital heart disease. In an epidemiological study of live births with CHD, White race/color was prominent, accounting for 51.71%[22], consistent with the present study.

Congenital heart diseases are among the main causes of hospital admissions and mortality in children under 1 year of age. This study concludes that, over the 9-year interval, hospital admissions among children with congenital heart disease had ICD-10 code Q21 (VSD, ASD, AVSD, TOF, aortopulmonary septal defect, other congenital malformations of the cardiac septa, and unspecified congenital malformation of the cardiac septum) as the main diagnosis. Regarding the variables sex and race/color, there was a predominance of males, varying according to ICD-10 code, and of White race/color.

In addition, transthoracic echocardiogram procedures during the same interval increased, except in 2020. This increase may be explained by technological advances in the area, access to services, implemented policies, updates in health care, and trained human resources. However, there remains a gap from the ideal condition, given the importance of TTE for the diagnosis of CHD. The year 2020 was an exception due to the onset of the COVID-19 pandemic. Therefore, there is a continued need to develop epidemiological-profile research on CHD.

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