TRENDS IN CARDIOVASCULAR MORTALITY AMONG CHILDREN WHO WERE ADMITTED TO TIKUR ANBESSA SPECIALIZED HOSPITAL INSTITUTIONAL BASED CROSS SECTIONAL STUDY

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Acronyms and Abbreviations

-TASH----------Tikur Anbessa Specialized hospital

-CVDs----------Cardiovascular diseases

-PICU----------Pediatrics intensive care unit

-CICU ----------Cardiac intensive care unit

-CW----------Causality ward

-PR----------Pulse rate
-RR----------Respiratory rate
-T----------Temperature
-SPo2----------Oxygen saturation
-BP----------Blood pressure
-MUAC----------Mid upper arm cicumference
-CHD----------Congenital heart disease

-ECMO----------Extracorporeal membrane oxygenation

- CPR----------cardiopulmonary resuscitation

Abstract

Background: Cardiovascular diseases (CVDs) are a leading cause of mortality among children, particularly in low-resource settings like sub-Saharan Africa, where access to specialized care is limited. Despite the growing burden of pediatric cardiovascular conditions, there is a paucity of data on trends and outcomes in this region. This study aimed to analyze trends in cardiovascular mortality and identify factors associated with poor outcomes among children admitted to Tikur Anbessa Specialized Hospital, Ethiopia's largest tertiary care center.

Methods: A retrospective analysis was conducted using hospital records of children aged 0–14 years admitted with cardiovascular conditions from 2019 to 2025. Data on demographic characteristics, clinical variables, diagnoses, treatments, and outcomes were extracted. Descriptive statistics (percentages, means) were used to summarize variables, and frequencies of cardiovascular mortality causes were calculated with proportions (95% confidence intervals). Univariate analysis and linear regression were performed to identify factors associated with cardiovascular deaths.

Results: There were 1601 deaths documented during the study period. The yearly mean mortality was 16.5% with Standard deviation of 4.63.Congenital heart defects (87.2%) were the leading underlying cause of death, followed by Rheumatic Heart Disease (8.3%) and dilated cardiomyopathy (1.8%). Immediate causes of mortality included overwhelming sepsis (19.7%), refractory septic shock (17.0%), and refractory cardiogenic shock (12.4%).Sepsis (61.5%) was the most common comorbidity, followed by respiratory infections (17.4%) and neurological issues (5.5 The surgical or device intervention access and presence of arrhythmia predicted trends of CVS mortality and were significantly associated with outcomes ($p < 0.05$).

Conclusion: Cardiovascular mortality among children at Tikur Anbessa Specialized Hospital remains a significant public health concern, with congenital heart defects being the leading cause of death. The findings highlight the need for early diagnosis, improved access to specialized care, and targeted interventions to reduce preventable deaths. This study provides critical evidence to guide policy and clinical practice in addressing pediatric cardiovascular mortality in low-resource settings.

Introduction

1.1 Background

Cardiovascular diseases (CVDs) is a general term for conditions affecting heart or blood vessels. It includes cerebrovascular disease, heart failure, rheumatic heart disease, congenital heart diseases, cardiomyopathies ,peripheral vascular disease and coronary heart diseases[1].Childhood cardiovascular disorders including HF are associated with high morbidity and mortality especially in sub-Saharan Africa where palliative and definitive treatments seem far from reach[2-5].

Many developing countries with the highest burden of poverty and disease continue to lack routine, representative and high quality information on the levels and causes of death[6, 7]. mortality surveillance systems and demographic surveillance sites (DSS) using validated verbal autopsy procedures suggested being a cost-effective alternative method for ascertaining cause of death and sustainable medium-term solutions[8, 9] .The ICD is a system of categories to which morbid entities of either external or pathological causation are assigned according to established criteria. The ICD is developed collaboratively between the World Health Organization (WHO) and various international centers. In this study, Verbal autopsy methods and ICD codes will be used to identify the causes of the cardiovascular death in children.[10]

The most common age group for admission to pediatrics ward was under 2 years (65.8%) and common causes for admission were pneumonia (22.9%), bronchiolitis (8.6%), septicemia (7.9%), seizure disorders (6.9%) and CHD (6.7%)*.In patients aged one to four years, circulatory system malformations are among the top ten causes of hospitalization, accounting for 4% of pediatric admissions in São Paulo and Brazil[11].In 2020, congenital and rheumatic heart diseases accounted for 1.4% of admissions to the pediatric ward at Gadarif Hospital in Eastern Sudan[12].In the Ethiopian study, cardiac diseases were the fourth most common cause of admissions to the Pediatric Intensive Care Unit (PICU), accounting for 8.5% of admissions. The leading causes were respiratory diseases (42.9%), central nervous system diseases (17.5%), and infectious diseases/sepsis (15.6%)[13].Heart diseases, both acquired and congenital, with or without congestive heart failure (CHF), account for the fourth most common cause of admission to the pediatric emergency ward at TASH, making up 4.6% of admissions. This is following severe pneumonia (38.6%), meningitis (7.2%), and sepsis (5.6%)[14].

There is difference in causes and frequency of CVD by age, race and ethnicity. The most common cardiovascular causes of death in children included congenital heart diseases,40.8% ;arrhythmias(27.1%) , myocarditis(4.6%),congestive heart failure(3.6%),and coronary artery anomalies,2.2% [15].

In low- and middle-income countries (LMICs), the delayed detection and presentation of congenital heart defects (CHDs) present significant hurdles, including challenges in assessing operability, unique surgical complexities during operations, and difficulties in post-operative care. Factors contributing to late detection include delayed diagnosis and referrals, limited healthcare resources, geographic barriers to specialized care, and lack of awareness leading to inappropriate medical advice. The outcome of late-presenting CHDs is closely linked to proper evaluation of operability as many will not be operable. Late presentation in natural history of the

underlying cardiac defect results in irreversible and permanent changes that may impact the medical and surgical treatment and outcome [16]
Heart disease in children spans from common issues to complex conditions such as single-ventricle physiology, acute myocarditis, and heart transplantation. Among the most frequent concerns for children with congenital heart disease (CHD) presenting at health facilities are feeding intolerance, cyanosis, chest pain, palpitations, and syncope. These issues are often initially addressed in primary care settings, where providers play a crucial role in diagnosing, managing, and referring children with CHD[17]

1.2 Statement of the problem

-Cardiovascular Disease (CVD) is one of the leading cause of early childhood death and disability worldwide. There is no reliable epidemiological data on mortality from Africa about CVD as such there is no epidemiological data about pediatrics CVD in Ethiopia. The majority of the data about pediatrics CVD came from high income countries: the research attempts to provide insight about the common causes of pediatrics CVD. It also assesses the trends of morality through time.

1.3 Significance of the study

Determination of trends of CVD mortality will
-Help to understand magnitude of the problem among children admitted at ward, PICU,CICU and CW

-Identify the common causes of CVD mortality and helping in tailored care and follow up

-Also provide baseline for future studies

2. Literature Review

A study conducted in Philadelphia, Pennsylvania, USA, analyzed cardiovascular-related deaths among children and adolescents. The average age of affected individuals was 4.8 years. Among these cases, 55.3% were under 1 year old, and 24.6% were 10 years old or older. Males accounted for 58% of the cases. Nearly half (48.5%) of the patients had pre-existing cardiovascular conditions, including congenital heart disease (23%), cardiomyopathies (4.6%), arrhythmias (1.7%), and congestive heart failure (1.6%). The majority of deaths occurred in urban settings (49.2%), followed by hospitals (40.4%). Other locations included homes (26.1%) and school/work/sports environments (4.8%).There were disparities in the availability and response of emergency medical services based on age, race, ethnicity, and location. The leading cardiovascular causes of death were congenital heart disease (40.8%), arrhythmias (27.1%), cardiomyopathy (11.8%), myocarditis (4.6%), congestive heart failure (3.6%), and coronary artery anomalies (2.2%).These findings emphasize the need for improved emergency medical services and targeted preventive measures for children with pre-existing cardiovascular conditions[15].

A systematic review and meta-analysis evaluated 2,574 studies, ultimately including 25 studies with 131,724 patients and 18 studies in the meta-analysis. The review focused on children with cardiac disease in the ICU.5% of children with cardiac disease in the ICU experienced IHCA (95% CI, 4%-6%).The pooled in-hospital mortality rate for these children was 51% .39% of children did not achieve return of spontaneous circulation .Increased incidence of IHCA and mortality odds were associated with factors such as neonatal age, prematurity, co-morbidities, univentricular physiology, arrhythmias, pre-arrest mechanical ventilation or ECMO, and higher surgical complexity.[18]

A retrospective cross-sectional study at The Aga Khan University Hospital's PICU in Karachi, Pakistan, revealed the median age at presentation was 5 months. Seventy-four percent of the infants had congenital heart disease (CHD) with increased pulmonary blood flow (shunt lesions). Despite none meeting the strict criteria for sepsis or pneumonia, 74% were admitted with a diagnosis of pneumonia or sepsis. Only 15% were admitted with congestive heart failure as the primary diagnosis.94% of the patients received oxygen therapy. Fifty-nine percent of the patients expired during admission. Of those who expired, 95% had multiorgan dysfunction.[19]

A study of 2,000 children admitted to Hawassa University Hospital in Ethiopia revealed that HF accounted for the tenth of pediatric admissions 10.8% of pediatric admissions (216 cases), with 51.9% being male. The median age of these patients was 6 years[20].

3. Objectives

3.1 General objectives

-To assess the trends in cardiovascular mortality among children who had admission at Tikur Anbessa specialized Hospital.

3.2. Specific objectives

- To assess the common etiologies of cardiovascular mortality.
- To identify factors affecting the trends of CVS mortality.
- To determine the overall trend in cardiovascular mortality,

4.Methods and Materials

4.1 Study Area

The study was conducted at TASH, Addis Ababa University's College of Health Sciences. Tikur Anbessa Hospital, a referral hospital situated in the heart of Addis Ababa, is part of the university. The pediatric department at this hospital caters to follow-up cases, emergencies, and referrals from other hospitals and health facilities across the country, serving children under fifteen. As the national referral hospital, Tikur Anbessa Hospital offers open-heart surgeries and interventions for a wide range of cardiovascular conditions in children. The facility is staffed with skilled pediatric cardiologists, cardiac and cardiothoracic surgeons, cardiac anesthesiologists, and cardiovascular nurses.

4.2 Study Design

An institutional based cross sectional descriptive study with retrospective data collection

4.3 Source population=All pediatric cardiovascular diseases cases who were admitted to TASH.
4.4 Study population=All pediatric cardiovascular diseases cases who were admitted and died at TASH
4.5 Inclusion criteria All admitted pediatrics cardiovascular disease cases aged 0–14 years

4.6 Exclusion Criteria-Patients with incomplete medical records and patients with suspected structural heart disease with no echocardiography

4.7Sample size determination

-The following formula were used to calculate sample size by considering the 95% CI and 5% margin of error

-Considering the overall prevalence of CVD mortality 19% from study conducted in TASH,Addsis Abeba ,Ethiopia [21]

$N=Z2xP(1-p)/D2 =237$

N=sample size

Z=Z score

P-population proportion,19% from previous conducted study

D=margin of error

4.8 Sampling method=Convenient sampling method was used and all children with cardiovascular diseases who had admission at TASH were included

4.9 Study variables

4.9.1 Dependent variable:

-Proportion of CVS deaths/year

4.9.2 Independent variable:

-Sociodemographic (Age, sex, address)
-Admission vitals(PR,RR,T,SPo2,BP....),
-Nutritional status,
-Heart failure, endocarditis, arrhythmia,pneumonia, arrhythmia,
-Type of cardiac illness(acquired vs congenital), type of CHD
-Intervention for primary cardiac disease,Type of cardiac surgery
-Number of previous admission, clinical syndromes,
-PICU admission, CICU admission, Fellowship program,Cath lab

5.Data collection method and tool

-Medical records of study subjects was retrieved from the central medical records archive.

-Demographic, clinical and echocardiographic data was collected from medical records of study subjects using questionnaires developed by a data collector

6.Data analysis

-Data extracted from patient's medical charts was coded, cleaned and the registry was entered into computer using SPSS version 27 software programs for further analysis. Descriptive statistics such as percentages, mean was used to analyze the variables. Frequencies for the various causes of cardiovascular mortality was added up within the specified time periods and proportions (including 95% confidence intervals) of the individual conditions generated. These proportions was used in subsequent analyses. Univariate association between dependent variable and independent variable will be assessed. Linear regression analysis will be used to determine factors associated with CVS deaths. The analyzed data will be described using tables, graphs and figures accordingly

7. Ethical considerations

-Ethical clearance to conduct was obtained from the Pediatrics and Child Health, Department's Research Ethics Committee, College of Health Sciences, Addis Ababa University. Confidentiality was fully maintained during Data Collection and further analysis and dissemination of results.

8. Dissemination of findings

-The output of this study was displayed both in tabular and graphical presentations. The finding of the study will be presented on was the research defense day and a formal report will be submitted to the Department of Pediatrics and Child Health with both soft and hard copy. The research output will also be published in reputable scientific journals.

9. Operational Definitions

-Cardiovascular diseases(CVDs);is a conditions affecting heart or blood vessels. It includes cerebrovascular disease, heart failure, rheumatic heart disease, congenital heart diseases

10.Results

10.1. Sociodemographic data

Most patients had been diagnosed at a very young age with 39.0 %(85) being <1 month and 36.7% (80) between 2-12 months. The most frequent age of death was the 2-12 months age group, which accounted for 43.6 %(95) of all deaths, followed by infants <1 month of age 24.3 %(53).Regarding sex distribution, we had a male predominance (52.8 % (115) male vs. 47.2% (103) female). Most of the patients were from Addis Ababa 53.7 %(117), while the rest were from regions such as Oromia 24.8% (54), Amhara 9.6 %(21), and others. A minority of patients were from further afield, including Somalia and Dire Dewa. The majority of the patients were transferred from other hospitals representing 78.9% (172) of the admission. A smaller fraction came through self-referral 19.3% (42), and 1.8% (4) of cases had an unknown referral source.

Table1: Sociodemographic of database

Variable	Category	Frequency	Percent
Age at diagnosis	<1 month	85	39.0
	2-12months	80	36.7
	13-36 months	12	5.5
	37-132 months	41	18.8
Age at Death	< 1 month	53	24.3
	2-12 month	95	43.6
	13-36 month	30	13.8
	37-132 month	38	17.4
	>133	2	.9
Sex	Female	103	47.2

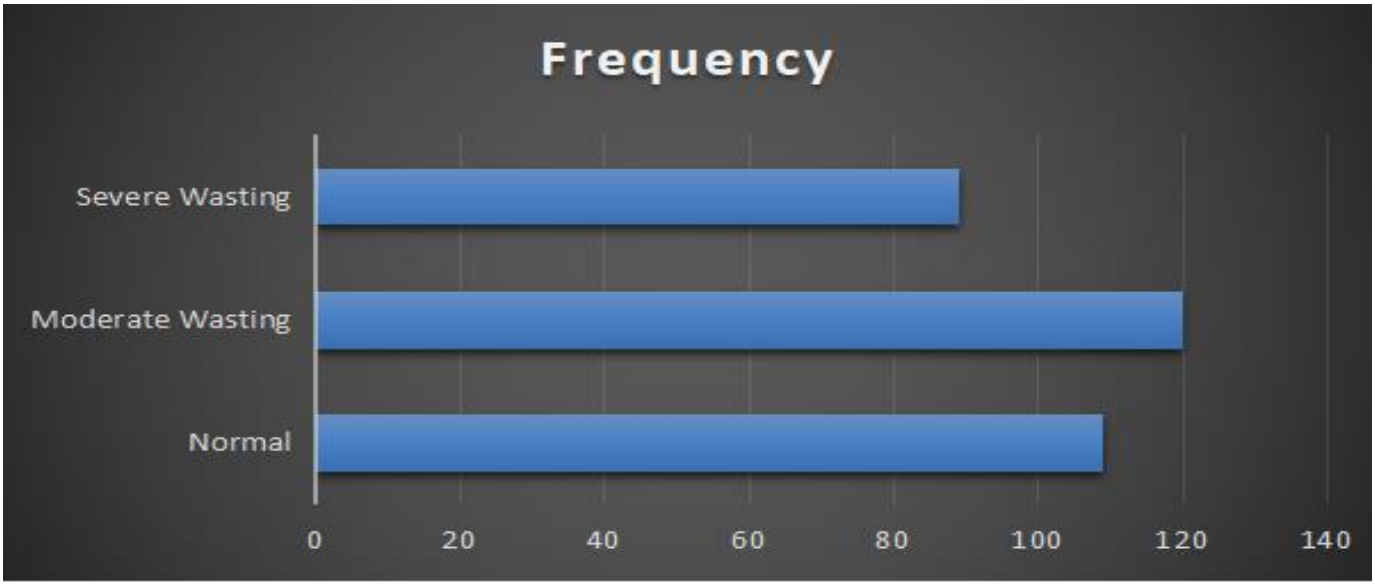
	Male	115	52.8
Residency	Addis Ababa	117	53.7
	Former SNNPR	17	7.8
	Oromia	54	24.8
	Amhara	21	9.6
	Bensham Gumz	1	.5
	Dire Dewa	3	1.4
	Harari	2	.9
	Somalia	3	1.4
Referral	Other Hospital	172	78.9
	Self	42	19.3
	Unknown	4	1.8

10.2. Nutritional Status

The data on the nutritional status of pediatric patients at TASH shows that 40.8% of the patients experienced severe wasting, while 9.2% had moderate wasting. In contrast, the majority of patients were categorized as normal (50.0). In terms of stunting, 29.8% of patients were classified as severely stunted, while 11.0% had moderate stunting. The remaining 59.2% were categorized as well-nourished

Table 2: Nutritional Status

Variable	Category	Frequency	Percent
Weight for length/height	Normal	109	50.0
	Moderate Wasting	120	9.2
	Severe Wasting	89	40.8
H/L for Age	Moderate Stunting	24	11.0
	Severe Stunting	65	29.8
	Well Nourished	129	59.2



10.3. VITAL SIGNS

The vital signs data of pediatric patients at admissions to TASH reveals that most had abnormal readings. Pulse rate was elevated in 94.5% of cases, and respiratory rate was elevated in 93.1%, while blood pressure was normal in only 17.9% of patients, with 76.6% of blood pressure records not recorded. Temperature was elevated in 51.8%, decreased in 14.2%, and normal in 33.5%, with very few records missing. When it comes to oxygen saturation, 88.1% of patients had decreased saturation levels at admissions.

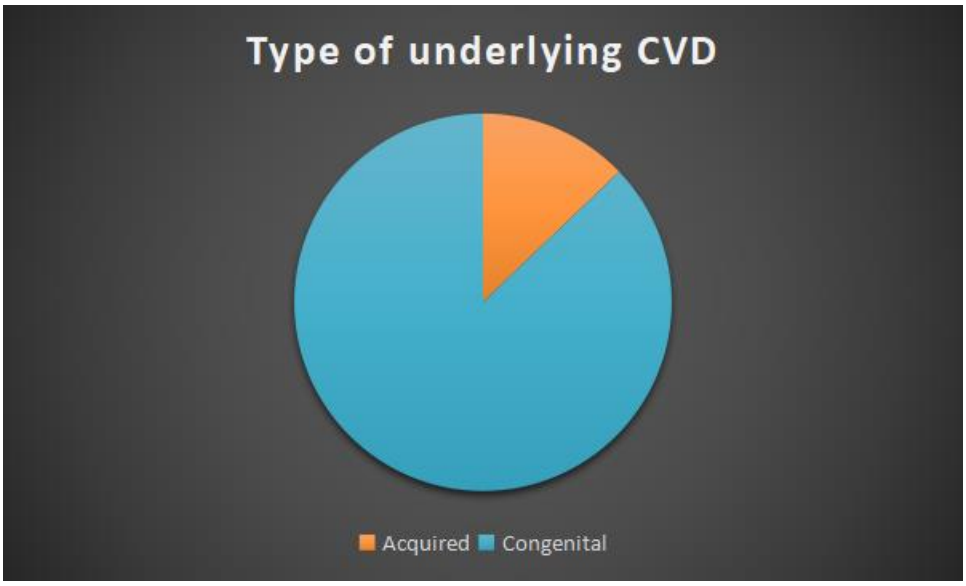
Variable	Category	Frequency	Percent
Pulse Rate	Decreased	6	2.8
	Elevated	206	94.5
	Normal	6	2.8
Respiratory Rate	Decreased	3	1.4
	Elevated	203	93.1
	Normal	12	5.5
Blood Pressure	Decreased	10	4.6
	Elevated	2	.9
	Normal	39	17.9
	Unknown	167	76.6
Temperature	Decreased	31	14.2
	Elevated	113	51.8
	Normal	73	33.5

	Unknown	1	.5
Saturation	Decreased	192	88.1
	Normal	25	11.5
	Unknown	1	.5

10.4. Underlying cardiovascular diseases (CVD)

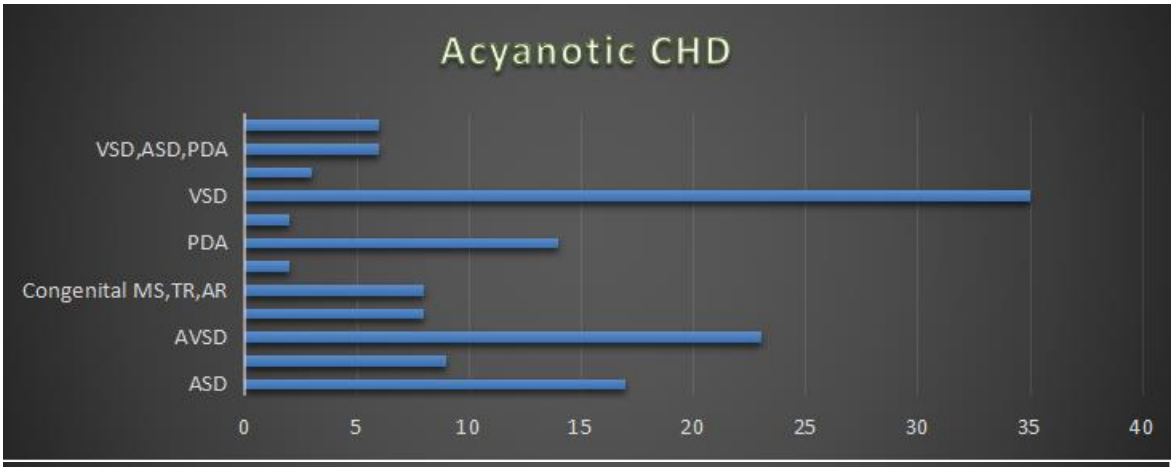
The data on the underlying cardiovascular diseases (CVD) in pediatric patients at TASH reveals that 87.2% of the cases were due to congenital heart defects (CHD), while 12.8% had acquired cardiovascular conditions. Among those with congenital heart defects, 62.4% had acyanotic heart defects, and 24.8% had cyanotic heart defects. Additionally, acquired heart diseases (AHD) were observed in a smaller proportion of patients, including RHD (Rheumatic Heart Disease) (8.3%), cardiac rhabdomyoma (0.5%), constrictive pericarditis (1.4%), dilated cardiomyopathy (DCMP) (1.8%), and infective endocarditis (IE) (1.8%). A combination of RHD and IE was present in 1.4% of the cases. A significant majority, 53.7%, of patients were diagnosed within the first week of illness, while 38.5% were diagnosed between 2 to 4 weeks after the onset of symptoms. Only a small percentage of patients, 4.6%, were diagnosed between 5 and 47 weeks, and just 3.2% were diagnosed after 48 weeks.

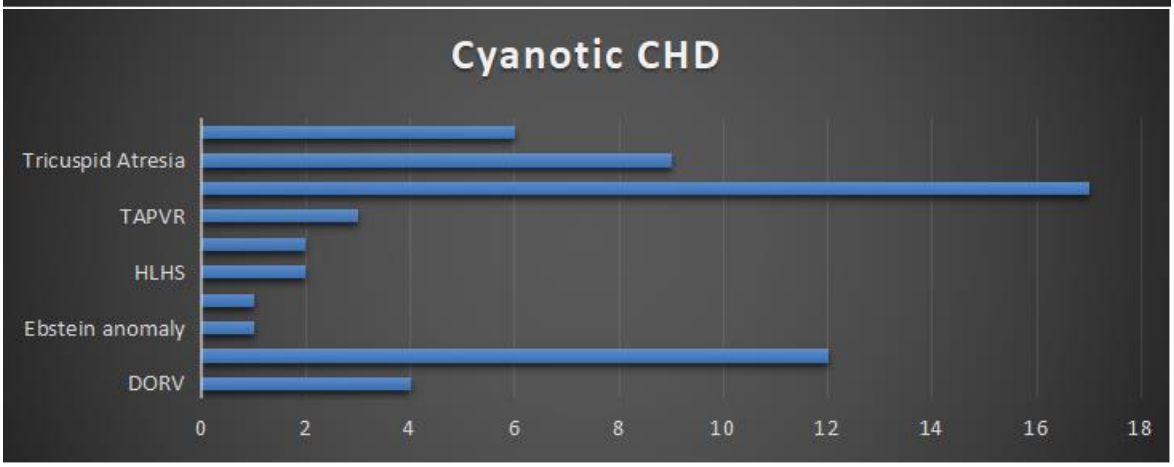
Variable	Category	Frequency	Percent
Type of underlying CVD	Acquired	28	12.8
	Congenital	190	87.2
CHD	Acyanotic	136	62.4
	Cyanotic	54	24.8
AHD	Cardiac Rhabdomyoma	1	.5
	Constrictive Pericarditis	3	1.4
	DCMP	4	1.8
	IE	4	1.8
	RHD	18	8.3
	RHD ,IE	3	1.4
Duration of illness before diagnosis	< 1 week	117	53.7
	2-4 weeks	84	38.5
	5-47 weeks	10	4.6
	> 48 weeks	7	3.2



10.5.Clinical data

The data on both acyanotic and cyanotic heart conditions in pediatric patients at TASH shows a broad spectrum of heart defects. Among those with specific conditions, VSD was the most common, affecting 16.1%, followed by AVSD at 10.6%, ASD (Atrial Septal Defect) (7.8%), and PDA (6.4%). Combinations like VSD, ASD (1.4%) and VSD, ASD, PDA (2.8%). Less frequent conditions included COA and Congenital MS, TR, AR each affecting 3.7%, and MVP and PS each seen in 0.9%. In contrast, 73.9% of patients had cyanotic heart defects, with TOF being the most common (7.8%), followed by DTGA (5.5%). Other notable conditions included Tricuspid Atresia (4.1%), DORV (1.8%), and TAPVR (1.4%). Less common cyanotic conditions,including Ebstein anomaly, Heterotaxy syndrome, HLHS, PA, and Truncus Arteriosus, wereeach observed in small percentages.





Variable	Category	Frequency	Percent
Acyanotic CHD	ASD	17	7.8
	ASD,PDA	9	4.1
	AVSD	23	10.6
	COA	8	3.7
	Congenital MS,TR,AR	8	3.7
	MVP	2	.9
	PDA	14	6.4
	PS	2	.9
	VSD	35	16.1
	VSD,ASD	3	1.4
	VSD,ASD,PDA	6	2.8
	VSD,PDA	6	2.8
Cyanotic CHD	DORV	4	1.8
	DTGA	12	5.5
	Ebstein anomaly	1	.5
	Hetrotroxy syndrome	1	.5
	HLHS	2	.9

	PA	2	.9
	TAPVR	3	1.4
	TOF	17	7.8
	Tricuspid Atresia	9	4.1
	Truncus Arteriosus	6	2.8

10.6.Comorbid Conditions and congenital anomalies

The data on comorbid conditions among pediatric patients at TASH shows that a significant majority of patients, 95.9%, had one or more comorbidities. Only 4.1% of patients had no identified comorbidities. The most prevalent comorbidity was sepsis, affecting 61.5% of patients, followed by respiratory infections (17.4%) and neurological issues (5.5%). Other common conditions included renal failure (4.1%) and metabolic disorders (3.7%). A smaller proportion of patients had rarer comorbidities, such as anemia, asplenia, asthma, AV malformation, hematologic disorders, malignancy, and a combination of renal failure and sepsis, each affecting 0.5% of patients. The data on congenital anomalies in pediatric patients at TASH reveals that 34.9% of the patients had some form of congenital anomaly, while the remaining 65.1% did not have any identified congenital defects. Among those with congenital anomalies, Down syndrome was the most common, affecting 18.3% of patients. Other notable anomalies included TEF-EA (Tracheoesophageal Fistula and Esophageal Atresia) (5.0%) and Edward syndrome (1.8%). A smaller proportion of patients had anomalies such as ARM (Anorectal Malformation), Noonan syndrome, and VACTREL, each accounting for 1.4%. Less common anomalies like diaphragmatic hernia, Digeorge syndrome, inguinal hernia, obstructive hydrocephalus, omphalocele, Patau syndrome, Pierre Robin Sequence, club foot, scoliosis, and umbilical hernia were each seen in 0.5% of patients.

Variable	Category	Frequency	Percent
Comorbid Conditions	Yes	218	95,9
	No comorbid	9	4.1
Types of comorbid	Sepsis	134	61.5
	Respiratory Infection	38	17.4
	Neurological Issues	12	5.5
	Renal Failure	9	4.1
	Metabolic Disorders	8	3.7
	Anemia	1	0.5
	Asplenia,	1	0.5
	Asthma	1	0.5
	AV malformation	1	0.5
	Hematologic	1	0.5
	Malignancy	1	0.5
	Renal failure, Sepsis	1	0.5
	RVI	1	0.5

10.7. Congenital Anomalies

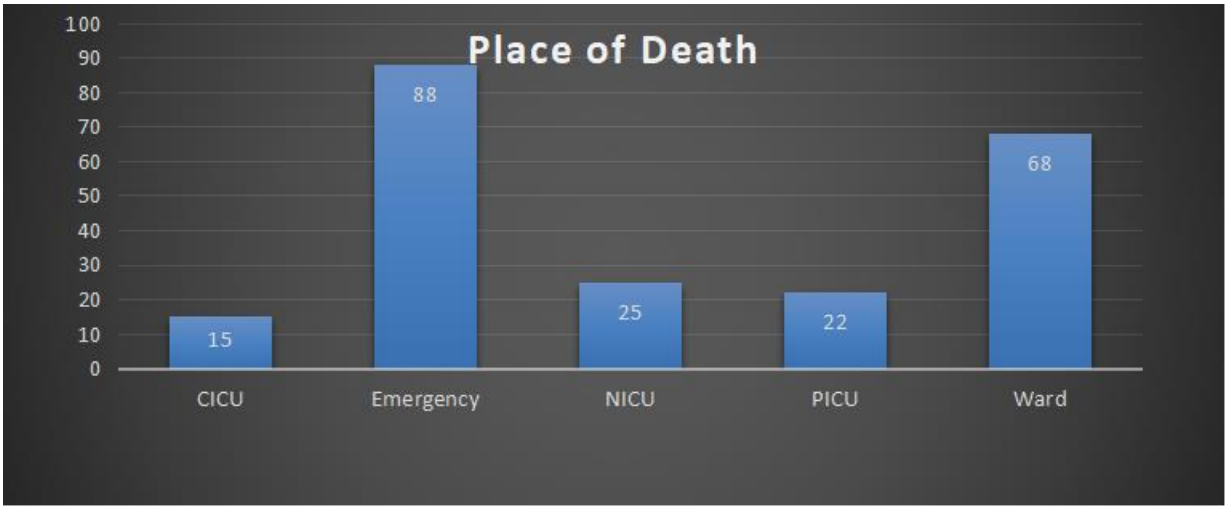
Variable	Category	Frequency	Percent
Congenital Anomalies	No	142	65.1
	Yes	76	34.9
Types Congenital Anomalies	Down syndrome	40	18.3
	TEF-EA	11	5.0
	Edward syndrome	4	1.8
	ARM	3	1.4
	Noonan syndrome	3	1.4
	VACTREL	3	1.4
	Diaphragmatic Hernia	2	0.9
	Digeorge syndrome	2	0.9
	Inguinal hernia	1	0.5
	Obstructive Hydrocephalus	1	0.5
	Omphalocele	1	0.5
	Patau syndrome	1	0.5
	Pierr Robin Sequence	1	0.5
	Club foot	1	0.5
	Scoliosis	1	0.5
	Umblical hernia	1	0.5

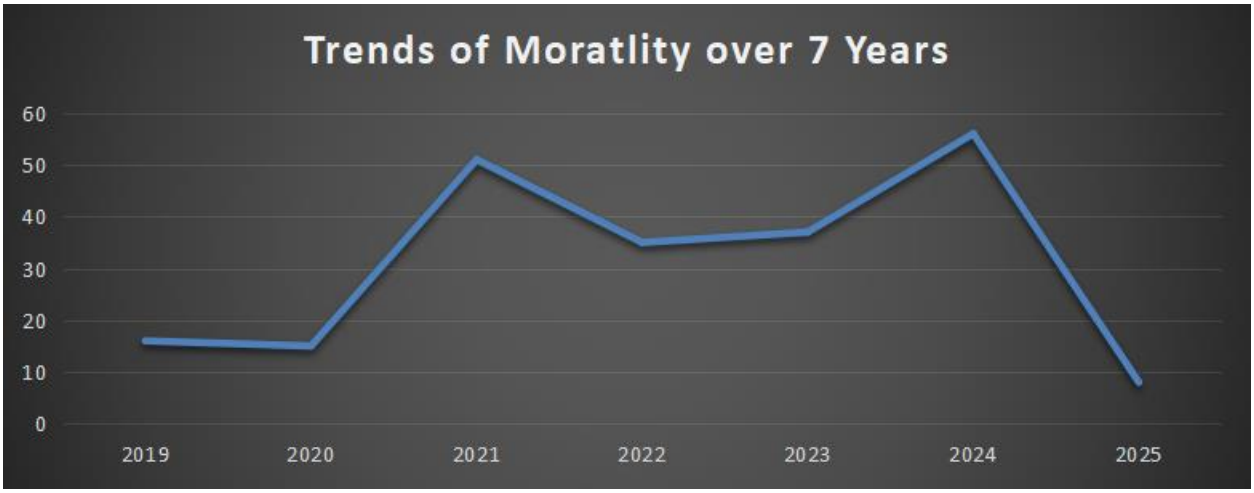
10.8. Mortality Data

The highest number of deaths occurred in 2024, with 25.7% of patients passing away that year, followed by 2021 (23.4%) and 2023 (17.0%). In terms of the time of death, 67.9% of deaths occurred during the night, while 32.1% happened during the day. Regarding the location of death, 40.4% of patients died in the emergency department, while 31.2% passed away in the ward. Other locations included the CICU (6.9%), NICU (11.5%), and PICU (10.1%).

The data also revealed that the majority of patients had previous admissions, with 79.8% of patients being admitted at least once before their death. Of those, 65.1% had 2 previous admissions, and 19.3% had 1 admission. The most common place of previous admission was the ward, with 29.8% of patients having been admitted there. NICU (Neonatal Intensive Care Unit) was the second most frequent location, with 22.5% of patients having stayed there before. Other

admissions included emergency (17.4%), ward and emergency (12.8%), and combinations like ward, emergency, and NICU (2.8%). Less common combinations of previous admissions included ward, emergency, PICU (0.5%), and ward, emergency, PICU, NICU (1.4%). In terms of the duration of hospital stay before death, 39.0% of patients died 2-6 days after admission, 20.6% died 7-14 days later, and 14.7% died within 1 day of admission.





Variable	Category	Frequency	Percent
Year of Death	2019	16	7.3
	2020	15	6.9
	2021	51	23.4
	2022	35	16.1
	2023	37	17.0
	2024	56	25.7
	2025	8	3.7
Time of Death	Night	148	67.9

	Day	70	32.1
Place of Death	CICU	15	6.9
	Emergency	88	40.4
	NICU	25	11.5
	PICU	22	10.1
	Ward	68	31.2
Hospital Stay	<1 day	32	14.7
	2-6 days	85	39.0
	7-14 days	45	20.6
	14-28 days	24	11.0
	28-40 days	9	4.1
	40-60 days	7	3.2
	>61 days	16	7.3
Previous Admissions	Yes	176	80.3
	No	42	19.7
Frequency of Previous admissions	1 day	106	60.2
	2 days	36	20.5
	>3 days	34	19.3

10.9. Hospital course

The data from TASH on medical treatment for pediatric patients shows that 69.7% of patients received medical therapy, while 30.3% did not. A large number of patients (34.4%) were given a combination of Furosemide and Spironolactone, and another 34.4% didn't receive any medication. Other common treatments included Furosemide alone (6.9%) and a mix of Furosemide, ACE-Inhibitors/ARBs, and Spironolactone (1.4%). Some patients had small combinations of Beta-Blockers/Calcium Channel Blockers with Steroids, or Furosemide with ACE-Inhibitors/ARBs, Benzanthine Penicillin, and Aspirin, each making up 0.5%. Other medications, like Digoxin, Warfarin, and Heparin, were each used for 0.5% of patients.

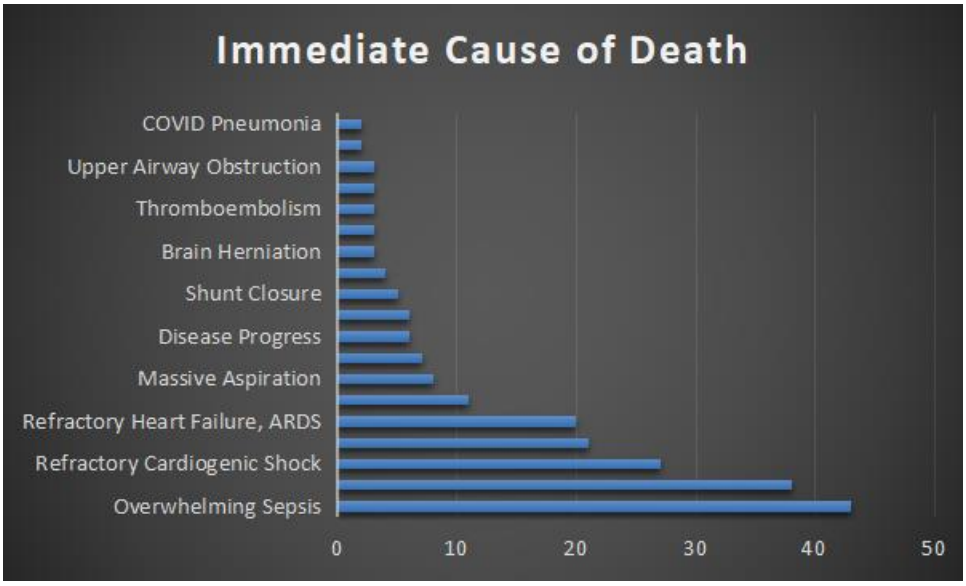
As for surgery, 95% of patients didn't have surgery, while 5% did. ECG results showed that 6% of patients had arrhythmias, 60.6% had normal ECGs, and 33.5% didn't have an ECG. In terms of ejection fraction, 83.5% of patients had a normal result, 1.8% had mild reductions, 5.5% had severe reductions, and 8.7% didn't have it specified. Chest X-rays (CXR) showed that 73.9% had abnormal results, with 60.6% showing cardiomegaly, along with other problems like pulmonary edema and pleural effusion. A smaller group (17%) had normal CXR results, and 9.2% didn't have a CXR. Finally, for CT scans of the brain, chest, or great vessels, 91.7% of patients didn't have a CT scan, while 8.3% did.

Variable	Category	Frequency	Percent
Medical Therapy	No	66	30.3
	Yes	152	69.7
Surgical Therapy	No	207	95
	Yes	11	5.0
ECG	Arrhythmia	13	6.0
	No Arrhythmia	132	60.6
	Not done	73	33.5
Ejection Fraction	Increased	1	.5
	Mildly Reduced	4	1.8
	Normal	182	83.5
	Not specified	19	8.7
	Severely Reduced	12	5.5
CXR	Abnormal	161	73.9
	Normal	37	17.0
	Not done	20	9.2
CXR abnormalities	Cardiomegaly	132	60.6
	Cardiomegaly, Boot-Shaped Heart	10	4.6
	Cardiomegaly, Egg-On-A-String Appearance	1	.5
	Cardiomegaly, Massive Pleural &Pericardial Effusion	1	.5
	Cardiomegaly, Pulmonary edema	10	4.6
	Cardiomegaly, Pulmonary edema; Opacity	2	.9
	Pleural effusion	2	.9
	Pulmonary edema	2	.9
CT of the brain,chest or Great Vessels	No	200	91.7
	Yes	18	8.3

10.10.Cause of Mortality

The data on the immediate causes of death for pediatric patients at TASH reveals a variety of conditions contributing to mortality. The most common causes were overwhelming sepsis (19.7%) and refractory septic shock (17.0%), followed by refractory cardiogenic shock (12.4%) and refractory heart failure with ARDS (9.2%). Other notable causes included sudden cardiac

arrest (3.7%), massive aspiration (3.2%), and type I respiratory failure (5.9%). Less frequent causes included pulmonary hemorrhage (1.8%), ischemic stroke, thromboembolism, pulmonary thromboembolism (PTE) (1.4%), and intracranial bleeding (1.4%). In rare instances, conditions such as multiorgan failure, arrhythmia, and tension pneumothorax with massive aspiration contributed to mortality, each accounting for 0.5% of deaths.



Immediate Cause of Death	Frequency	Percent
Overwhelming Sepsis	43	19.7
Refractory Septic Shock	38	17.5
Refractory Cardiogenic Shock	27	12.4
Type 1 Respiratory Failure	21	9.6
Refractory Heart Failure, ARDS	20	9.2
Sudden Cardiac Arrest	11	5.1
Massive Aspiration	8	3.7
Arrhythmia	7	3.2
Disease Progress	6	2.7
Refractory Hyper cyanotic Spell	6	2.7
Shunt Closure	5	2.3
Pulmonary Hemorrhage	4	1.8
Brain Herniation	3	1.4
Pulmonary Edema	3	1.4
Thromboembolism	3	1.4
Intracranial Bleeding (ICH)	3	1.4
Upper Airway Obstruction	3	1.4

Massive Pericardial Effusion with Tamponade Effect	2	0.9
COVID Pneumonia	2	0.9

11.Discussion

11.1 Cardiovascular death associations with demographic factors

A significant portion of patients were diagnosed at very young ages, with many being identified during the neonatal and infancy periods. The highest mortality rate was observed in the infancy age group, followed by neonates, which aligns with the findings of the Philadelphia study, where more than half of the cases were under one year old. Both studies also noted a slight male predominance among the affected patients. However, research conducted in our country showed a different trend, with the study population primarily consisting of children over the age of 5, who accounted for 57.4% of the total population.

Geographically, most patients were from Addis Ababa, followed by Oromia and then Amhara. This is consistent with a study conducted in Pennsylvania, USA, where the majority of deaths occurred in urban settings, accounting for 49.2%.

A majority of the patients were came with referral from other hospital, while a smaller portion self-referred.

The majority of patients were categorized as having normal nutritional status but a significant portion of the patients experienced severe wasting and stunting, with a smaller group having moderate wasting and stunting.

11.2 Vital signs

The vital signs data of pediatric patients admitted to TASH showed that the majority had abnormal readings. Most patients had an elevated pulse rate and respiratory rate, while blood pressure records was not documented the majority patients. Temperature readings were frequently elevated, though some patients had decreased or normal temperatures. Oxygen saturation levels were decreased in most patients at admission.

11.3 Underlying cardiovascular diseases

Most patients were diagnosed within the first week of illness, while a smaller number were diagnosed weeks or even months after symptom onset.

The data on underlying cardiovascular diseases (CVD) in pediatric patients at TASH reveals that the majority of cases were due to congenital heart defects (CHD), with a large number having

acyanotic CHD and a smaller proportion presenting with acquired cardiovascular conditions. This aligns with the findings of the Karachi study, at the Aga Khan University Hospital in Karachi, Pakistan, where nearly three-quarters of infants had CHD, particularly shunt lesions. However, the study conducted in Hawassa, Ethiopia, showed a different pattern, with rheumatic valvular heart disease (RHD) contributing to 52% of children with structural heart disease.

The spectrum of heart defects observed was diverse, with ventricular septal defect (VSD) being the most prevalent acyanotic condition, followed by atrioventricular septal defect (AVSD), atrial septal defect (ASD), and patent ductus arteriosus (PDA). Combinations of these defects were also frequently noted. Similarly, a study conducted at the Aga Khan University Hospital in Karachi, Pakistan, found that acyanotic heart disease accounted for 85% of cases, with atrial septal defect, ventricular septal defect (VSD), and combinations such as VSD with atrial septal defect, VSD with patent ductus arteriosus, or VSD with coarctation being the most common presentations.

Cyanotic heart defects were dominated by tetralogy of Fallot (TOF) and dextro-transposition of the great arteries (DTGA), with other conditions such as tricuspid atresia, double outlet right ventricle (DORV), and total anomalous pulmonary venous return (TAPVR) appearing less frequently. Rare cyanotic conditions, including Ebstein anomaly, heterotaxy syndrome, hypoplastic left heart syndrome (HLHS), pulmonary atresia, and truncus arteriosus, were also noted in small numbers. This aligns with a study conducted Hawassa, Ethiopia found that Multiple CHDs comprising ASD with VSD, VSD with PDA, VSD and PS with D-TGA etc contributed to 18(28%) of CHDs. Others including tricuspid atresia accounted for 7(10.9%) of CHD

Acquired heart diseases (AHD) were observed in a smaller number of patients, in most patients it is rheumatic heart disease (RHD) by , dilated cardiomyopathy (DCMP) and infective endocarditis (IE). cardiac rhabdomyoma, constrictive pericarditis)

The vast majority of patients had one or more comorbidities, with only a small proportion having no identified comorbidities. The most common comorbidity was sepsis, followed by respiratory infections and neurological issues. This mirrors the findings of a study conducted in Hawassa, Ethiopia, where pneumonia (42.9%) was the most common comorbid condition associated with heart failure. Similarly, a study at the Aga Khan University Hospital in Karachi, Pakistan, found that 74% of patients were admitted with a diagnosis of pneumonia or sepsis.

A significant portion of patients had some form of congenital defect, with Down syndrome being the most prevalent. Other notable anomalies included tracheoesophageal fistula and esophageal atresia (TEF-EA) and Edward syndrome.

11.4 Mortality Data

The highest number of deaths occurred in 2024, followed by 2021 and 2023. The CVS mortality showed peaks in 2021 and 2024.The 2021 peak could be attributed to COVID epidemics and associated CVS services disruptions. Children with CVS problems are noted to have increased COVID related deaths (22). The peak noted in 2024 may be due to increased CVS interventions

and overall CVS admission rates. Further explorative qualitative studies may needed to uncover the trends.

Most deaths took place during the night, with a smaller proportion occurring during the day. The emergency department was the most common location of death, followed by the ward, while smaller numbers of deaths occurred in the CICU, NICU, and PICU.

The majority of patients had previous admissions, with most having been admitted at least once or twice before their death. The ward and NICU were the most frequent locations of previous admissions, followed by the emergency department and combinations of these units. In terms of hospital stay duration before death, a significant proportion of patients died within 2-6 days of admission, while others died within 1 day or 7-14 days.

The immediate causes of death were varied, with overwhelming sepsis and refractory septic shock with multi organ dysfunction being the most common, followed by refractory cardiogenic shock and refractory heart failure. Other causes included sudden cardiac arrest, massive aspiration, and type I respiratory failure. Less frequent causes of death included pulmonary hemorrhage, ischemic stroke, thromboembolism, pulmonary thromboembolism, and intracranial bleeding. Rare conditions such as multi-organ failure, arrhythmia, and tension pneumothorax with massive aspiration were also noted. These findings highlight the significant role of acute complications and infections in driving mortality among pediatric patients with cardiovascular conditions.

11.5 Diagnostic findings

Many patients had normal ECG results, while a smaller number had arrhythmias, and others did not undergo an ECG. Ejection fraction results were normal in most cases, with mild or severe reductions observed in a few instances. Chest X-rays (CXR) were abnormal in a large number of patients, with cardiomegaly being the most common finding, often accompanied by pulmonary edema or pleural effusion. A smaller group had normal CXR results, and a few did not undergo the procedure. Finally, CT scans of the brain, chest, or great vessels were rarely performed, with most patients not having a CT scan and only a small number undergoing the procedure.

11.6 Treatment

A large majority of patients were treated with medical therapy, while a smaller group did not receive treatment. The most frequently used treatment was a combination of Furosemide and Spironolactone, given to a significant number of patients. Similar to the study conducted in Hawassa, Ethiopia, various combinations of diuretics, angiotensin-converting enzyme inhibitors, β-blockers, and digoxin were used in the management of heart failure

Regarding surgery, the vast majority of patients did not undergo any surgical procedures, with only a small percentage receiving surgical intervention. This aligns with the findings of the study conducted at The Aga Khan University Hospital in Pakistan, where most of the CHD patients awaiting surgery

Multivariate Linear regression

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.190	3.356		3.036	.003
	Sex:	-.072	.398	-.008	-.181	.856
	Place of Residency	-.061	.153	-.019	-.398	.691
	Source of Referral:	-.063	.491	-.006	-.128	.898
	Weight-for-Height	-.038	.229	-.008	-.164	.870
	Type of Underlying Cardiovascular Illness	.048	.552	.004	.087	.931
	Place of Admission	-.026	.183	-.007	-.140	.889
	Secondary Comorbid Conditions	-.492	1.036	-.021	-.475	.635
	Congenital Anomalies	-.141	.484	-.015	-.291	.771
	Ejection Fraction Value	.107	.187	.029	.574	.567
	Presence of arrhythmia	.787	.427	.096	1.845	.021
	Chest X-Ray	-.270	.439	-.030	-.616	.539
	Medications	.110	.525	.011	.210	.834
	Surgical or Device Intervention for Cardiovascular Disease	-2.419	.959	-.115	-2.523	.049
	Hospital stay in days	-.006	.014	-.019	-.436	.663
	Age at death	-.505	.340	-.114	-1.484	.139
	Age at diagnosis	.456	.292	.108	1.559	.121
	frequency of previous AD	-0.822	0.530	0.105	-1.551	0.122
	Duration of illness before DX	.188	.304	.030	.617	.538
	Year of Death	2.212	.123	.779	17.982	.000
	Time of death	-.341	.443	-.034	-.770	.442
a. Dependent Variable: Trends of CVS death						

- The Presence of Arrhythmia and intervention predicted trends of CVS mortality. Surgical or device intervention was inversely related to the trends of CVS mortality. This concurs an established evidence of a positive relation with the definitive CVS health care access and improved health outcomes (16).

- The presence of arrhythmia on ECG showed positive relationship with trends in CVS mortality. Arrhythmias are often the complications of untreated CVS diseases and are often fatal(15)

12.Conclusion

- A significant portion of patients were diagnosed at neonatal and infancy periods.
- The most common cause of CVD were due to congenital heart defects (CHD), with a large number having acyanotic CHD
- The vast majority of patients had one or more comorbidities
- The most common comorbidity was sepsis, followed by respiratory infections
- Most deaths took place during the night
- The most common cause of immediate cause of death is Overwhelming sepsis and refractory septic shock with multiorgan dysfunction
- Age, previous admission, duration of illness before diagnosis, and place of residency were significantly associated with outcomes

13.Strengths and Limitations of the study

13.1Strengths of the study

- This is the first study conducted in this particular setting.
- The research was carried out at the largest pediatric cardiac center in the country, serving a vast catchment area.
- The study highlights critical areas of improvement, such as early diagnosis, timely referrals, prompt surgical interventions and chart keeping.
- It emphasizes the need for larger, multicenter studies to accurately assess the full extent of pediatric cardiovascular mortality and offers guidance for future interventions.

13.2 Limitations of the study

- A significant number of patient charts could not be retrieved, as they were lost from the central medical records archive.
- The study is based in a single center and hospital.
- Deaths occurring at home were not included in the study

14.Recommendations

Expansion of definitive for surgical or device related interventions is recommended to avert the CVS mortality trends.

Actively screening and optimal treatment which includes medications, ablation, or implantable devices is recommended

-Raise awareness among both the community and physicians about the importance of early diagnosis.

-Improve access to specialized pediatric cardiac care.
-Implement targeted interventions aimed at reducing preventable deaths.
-Promote appropriate clinical practices to effectively address pediatric cardiovascular mortality. -
-Digitalize patient charts within the central medical records archive to improve accessibility and

15.Acknowledgment
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Annex:-Data collection Questionnaire

Section I: Socio-Demographic Data

1. Code Number:
2. Medical Record Number (MRN):
3. Age of Child (Years):
   i) Current Age: _____
   ii) Age at Diagnosis: _____
4. Sex:
   i. Male
   ii. Female
5. Place of Residency (Region):
   A. Addis Ababa
   B. Oromia
   C. Amhara
   D. Former SNNPR
   E. Other: _____
6. Source of Referral:
   i. Self
   ii. Other Hospital
   iii. Unknown Referral Status
7. Anthropometry:
   Weight (kg): _____
   Height: _____
   Mid-Upper Arm Circumference (MUAC): _____
   Weight-for-Height (WFH): _____
   Height-for-Age (HFA): _____
   Body Mass Index (BMI): _____
   BMI/Age: _____
8. Nutritional Status (HFA):
   i. Well Nourished
   ii. Moderate Stunting
   iii. Severe Stunting
9. Weight-for-Height (WFH):
   i. Normal
   ii. Moderate Wasting
   iii. Severe Wasting

Section II: Clinical Data

1. Duration of Illness Before Diagnosis (Days):
2. Previous Admissions:
   i. No

ii. Yes

If yes, specify:

- Frequency: _____
- Place:
  - Ward
  - Emergency
  - PICU
  - CICU

3. Date of Death (if applicable):
4. Type of Underlying Cardiovascular Illness:

i. Congenital Heart Disease
ii. Rheumatic Heart Disease
iii. Myocarditis
iv. Cardiomyopathy
v. Arrhythmias
vi. Other (please specify): _____

5. Section III: Current Admission

1. Vital Signs:
   - Pulse Rate (PR):
     i. Normal
     ii. Elevated
     iii. Decreased for Age
   - Respiratory Rate (RR):
     i. Normal
     ii. Elevated
     iii. Decreased for Age
   - Temperature (T):
     i. Normal
     ii. Elevated
     iii. Decreased for Age
   - Oxygen Saturation (SaO2):
     i. Normal
     ii. Elevated
     iii. Decreased for Age
   - Blood Pressure (BP):
     i. Normal
     ii. Elevated
     iii. Decreased for Age
2. Place of Admission:
   - Ward
   - Emergency
   - PICU
   - CICU
3. Secondary (Co-morbid) Conditions (if any):
   - Respiratory Infection

- Renal Failure
- Sepsis
- Neurological Issues
- Metabolic Disorders
- Congenital Anomalies:
  i. Tracheoesophageal Fistula (TEF)
  ii. Diaphragmatic Hernia
  iii. Anorectal Malformations
  iv. Other (please specify): _____
- Other (please specify): _____

4. Investigations:
   - ECHO:
     i. Yes
     ii. No
       - If yes, type of lesion:
         A. Acquired B. Congenital
       - If acquired:
         i. Rheumatic Heart Disease (RHD)
         ii. Myocarditis
         iii. Dilated Cardiomyopathy (DCMP)
         iv. Other (please specify): _____
       - If congenital:
         i. Cyanotic ii. Acyanotic
       - If cyanotic:
         i. Tetralogy of Fallot (TOF)
         ii. D-Transposition of the Great Arteries (DTGA)
         iii. Tricuspid Atresia
         iv. Double Outlet Right Ventricle (DORV)
         v. Other (please specify): _____
       - If acyanotic:
         i. Ventricular Septal Defect (VSD)
         ii. Coarctation of the Aorta (COA)
         iii. Atrial Septal Defect (ASD)
         iv. Left Ventricular Outflow Tract Obstruction (LVOTO)
         v. Hypertrophic Cardiomyopathy (HCMP)
         vi. Restrictive Cardiomyopathy (RCMP)
         vii. Other (please specify): _____
       - Ejection Fraction (EF) Value:
         i. Normal for Age
         ii. Mildly Reduced for Age
         iii. Severely Reduced for Age
   - ECG:
     i. Arrhythmia Present ii. No Arrhythmia
       - If yes, specify: _____
   - Chest X-Ray (CXR):
     i. Normal ii. Abnormal

        - If abnormal:
          i. Cardiomegaly
          ii. Boot-Shaped Heart
          iii. Egg-On-A-String Appearance
          iv. Other (please specify): _____
    - CT of the Brain, Chest, or Great Vessels:
      i. Yes ii. No
        - If yes, specify findings: _____
5. Treatment Received:
    - Medications:
      i. Yes ii. No
        - If yes, list medications:
          i. Furosemide
          ii. Spironolactone
          iii. ACE-Inhibitors/ARBs
          iv. Beta-Blockers/Calcium Channel Blockers
          v. Other (please specify): _____
    - Surgical or Device Intervention for Cardiovascular Disease:
      i. Yes
      ii. No
        - If yes, specify: _____
    - Other Treatments (please specify):

Section IV: Mortality Data

1. Hospital Stay (Days):
2. Age at Death (Years):
3. Time of Death:
   a. Day
   b. Night
4. Immediate Cause of Death:
5. Death Document Source:
   i. HMIS
   ii. Death Certificate
   iii. Other (please specify): _____
6. Contributing Cause of Death:
7. Underlying Cause of Death: