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Cardiovascular Affection in Chronic Kidney Disease in Children of Al Qalyubia Governorate

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Abstract
Background: Cardiovascular complications in children with chronic kidney disease (CKD) present significant clinical challenges. As kidney function declines, particularly in those with advanced stages or on maintenance dialysis, children become increasingly vulnerable to cardiovascular disease (CVD). These patients often have a higher burden of both traditional risk factors—such as hypertension and dyslipidemia and uremia-related factors, including fluid overload, mineral bone disease, and anemia. Early signs of cardiomyopathy and atherosclerosis, such as left ventricular dysfunction, are commonly observed in these young patients. **Aim:** This research seeks to explore the causes and impacts of cardiovascular disease in children living with chronic renal disease in Al Qalyubia Governorate. Understanding these factors is crucial for improving early detection, prevention, and management strategies for this vulnerable population. **Conclusion:** Cardiovascular disease is the leading cause of mortality in children with end-stage renal disease (ESRD). The pathophysiology of cardiovascular complications in CKD involves multiple factors, including hypertension, fluid imbalance, mineral metabolism disorders, and anemia. Early identification and proactive management of these risk factors, especially in the early stages of CKD, are critical to improving outcomes. Kidney transplantation remains the most effective long-term solution to avoid the complications associated with dialysis. However, even post-transplant, ongoing monitoring and management are essential, as cardiovascular risk persists. Careful control of modifiable risk factors, including blood pressure and lipid levels, is necessary to optimize long-term health and survival in these patients.

Keywords: Chronic Kidney Disease, Cardiovascular Disease, Children, Hypertension, Left Ventricular Hypertrophy, Cardiovascular Risk Factors, Pediatric Nephrology

1. Introduction:

The effects of chronic kidney disease (CKD) on development and other clinical symptoms in children are specific to childhood and the pediatric age. Not only so, but the etiology and CV issues, which are prevalent in pediatric chronic kidney disease (CKD), have an impact on the patient's health from infancy into adulthood. Even when it is unseen, we must not disregard its impact (1).

Children with advanced chronic kidney disease (CKD) are disproportionately at risk of death from cardiovascular disease (CVD). A plethora of studies assessing CV risk, disease processes, and early CVD markers in this population have been released as a result of these findings. Similar to adults, children with chronic kidney disease (CKD) are at high risk for cardiovascular disease due to traditional and uremia-related risk factors (2). Left ventricular dysfunction, increased carotid artery intima-media thickness, stiffness of the carotid arterial wall, and calcification of the coronary arteries are some of the early symptoms of cardiomyopathy and atherosclerosis that these children, especially those on maintenance dialysis, often display (3). The purpose of this research is to investigate the prevalence of cardiovascular problems and risk factors in children in Al Qalyubia Governorate who have chronic renal illness. It is crucial to identify and treat cardiovascular diseases in this susceptible population as soon as possible.

Chronic kidney disease in children

There is growing fear that a real "epidemic" may break out because to the increasing occurrence and prevalence of CKD, a major issue in world health. Irrespective of the cause, chronic kidney disease (CKD) is characterized by a steady decrease in kidney function over time. The kidney disease: Improving Global Outcomes (KDIGO) guidelines describe chronic kidney disease (CKD) as a health risk due to structural or functional renal abnormalities that have persisted for more than three months (4).

Chronic kidney disease (CKD) is a common and well-known health condition in adults. However, when it comes to children, the KDIGO criteria for diagnosing and staging CKD aren't fully applicable. Chronic kidney disease (CKD) in children is likely best viewed as a separate nomologic entity, despite the fact

that it has many pathologic and physiological parallels with CKD in adults (5).

Chronic kidney disease (CKD) has distinct clinical features in children, one of which is its impact on growth. The etiology and CV issues, which are prevalent in pediatric chronic kidney disease, have an impact on the patient's health from infancy into adulthood (5).

Despite how crucial it is, this influence is often disregarded. The patient's and his family's mental health is also profoundly impacted by chronic kidney disease. Parents often shoulder a multitude of responsibilities typically associated with healthcare providers on top of parenting their children. Clinical and therapeutic advancements have led to an increase in the survival rate of young patients with chronic renal disease. Nevertheless, there is a cost to this: many adults will have challenges specific to CKD that started in infancy (5).

Causes of CKD

The causes of chronic kidney disease in adults differ greatly from those in children. The North American Pediatric Renal Transplant Cooperative Study (NAPRTCS) registry has been collecting data on the early stages of chronic kidney disease (CKD) in children in the US since 1994. The NAPRTCS Registry gathers data voluntarily from pediatric nephrology centers and includes almost 7,000 children younger than 21. The causes of chronic kidney disease (CKD) in children may be better understood using this resource (6).

New data from the NAPRTCS indicates that hereditary nephropathies (affecting 10% of cases) and congenital anomalies of the kidney and urinary tract (CAKUT) (affecting 48%) are the leading congenital causes. The incidence of glomerulonephritis was fourteen percent. The causes were dispersed differently as persons became older. Although glomerulonephritis was the leading cause in children older than 12 years old, CAKUT was more frequent in younger individuals. Chronic kidney disease (CKD) affects people of different races for various causes. The most common form of glomerular illness, focal segmental glomerulosclerosis, was three times more common among Black youths (35% vs. 19% vs. 6%) (6).

According to Bulu et al. (2015), the distribution of CKD causes in Europe is comparable in the Italian and Belgian registries as well. There may be a racial disparity in the prevalence of some kidney diseases, such as CAKUT (58–59%) and hereditary nephropathy (15–19%), while glomerulonephritis is less common (5-7%). Without national registries and surveys, it is difficult to determine what causes chronic kidney disease (CKD) in children in low- and middle-income countries. Chronic kidney disease (CKD) is mostly caused by CAKUT in Turkey and other Middle Eastern nations, with uropathies accounting for a significant portion of cases (17-30%) rather than hypo dysplasia and hereditary nephropathies (47-62%).

Although neuropathic bladder only affected around 4% of the population in Italy and Belgium, it remained a major contributor to chronic kidney disease in Turkey, affecting 15% of the population. It is possible that urologists were sluggish in making diagnoses and providing treatment based on these figures. In addition, the higher frequency of consanguineous marriages in the Middle East could explain why there are more inherited illnesses there than in Europe. A incidence of chronic glomerulonephritis ranging from 30 to over 60% has been observed in several studies conducted in sub-Saharan Africa, Latin America, Southeast Asia, and India (8). When it comes to chronic kidney disease (CKD), this is the main culprit.

Developing countries' kidneys are particularly vulnerable to bacterial, viral, and parasite infections, which may explain why glomerulonephritis rates are so high there. Another possible factor is the wide age range of patients admitted with advanced chronic kidney disease (CKD). According to the United States Renal Data System Registry (9, 10), congenital diseases (such as CAKUT and hereditary nephropathies) were the leading causes of end-stage renal disease (ESRD) among the youngest group of patients. Over time, more and more individuals with end-stage renal disease (ESRD) have acquired illnesses.

In Europe, Japan, Australia, and New Zealand, CAKUT is the leading cause of pediatric end-stage renal disease (ESRD), accounting for 34% to 43% of all cases (Table 1) (11).

Classification

CKD is categorized into five stages, according to the Glomerular filtration rate (GFR), and in three stages, according to the albuminuria **(12)**, as shown in

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GFR = Glomerular Filtration Rate.

Stages	GFR value ml/min/1.73m2	Classification
I	> 90	Normal or High
II	60-89	Slightly decreased
III A	45-59	Mild to moderately decreased
III B	30-44	Moderately to severely de-creased
IV	15-29	severely decreased
V	< 15	Kidney failure

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IV 15-29 severely decreased
V < 15 Kidney failure

Table below:

Table 1: CKD stages (13)
GFR = Glomerular Filtration Rate.

Table 2: Categories of albuminuria (12)

Category	24-Hours Albuminuria mg/24 h	A/C Ratio Mg/g	Classification
A1	< 30	< 30	Normal to discrete
A2	30-300	30-300	Moderate
A3	> 300	> 300	Severe

A/C Ratio = Albumin/Creatinine Ratio in Isolated urine sample.

So, a patient is considered to be in CKD stage IIIB A2 if they have diabetic nephropathy, a GFR estimated to be 42 ml/min, and albuminuria of 200 mg/24 hours for more than three months. Keep in mind that the terms "microalbuminuria" and "macroalbuminuria" were formerly used to describe albuminuria levels ranging from 30-300 mg/g and 300 mg/g, respectively. In order to estimate the risk of renal dysfunction development, the degree of albuminuria should be included in the CKD classification. This is supported by table 3 below (14):

Table 3: Risk of renal outcomes according to the GFR and albuminuria (12)

		Albuminuria		
GFR		**< 30 mg/g**	**30-300 mg/g**	**> 300 mg/g**
Stage 1	**≥ 90**	**Low risk**	**Moderate risk**	High risk
Stage 2	**60-89**	**Low risk**	**Moderate risk**	High risk
Stage 3A	**45-59**	**Moderate risk**	**High risk**	Very high risk
Stage 3B	**30-44**	**High risk**	**Very high risk**	Very high risk
Stage 4	**15-29**	**Very high risk**	**Very high risk**	Very high risk
Stage 5	**< 15**	**Very high risk**	**Very high risk**	Very high risk

GFR in ml/min/1.73 m^2

The above-mentioned staging approach aids doctors in deciding how and how intensely to monitor patients with chronic kidney disease. By creating better risk prediction algorithms, we can improve the accuracy of risk assessments for individual patients. When estimating the prognosis, it is important to take into account not only the GFR and albuminuria, but also the kidney disease's etiology and other variables (such as age, sex, race, cholesterol levels, smoking, and plenty more) (15)

Epidemiology of CKD in children

If the glomerular filtration rate (GFR) remains below 60 mL/min/1.73 m2 of body surface area for more than three months or if there is evidence of structural or functional damage to the kidneys, then it is deemed kidney disease (CKD) according to the KDIGO criteria. Therefore, CKD is defined as a pattern of chronic renal failure in both adults and children, as opposed to a temporary change in renal function. Investigating the disease's epidemiology becomes more complicated as a result of this. Data on the illness's incidence and prevalence may be understated due to the fact that chronic kidney disease (CKD) is often asymptomatic, especially in its early stages (5). One reason for this is because prior to the KDIGO guidelines, there was no universally

accepted definition of chronic kidney disease (CKD) and no specific method for grading the severity of the condition (16).

For these reasons, most studies do not estimate CKD from the general population but rather from those with moderate to severe CKD or end-stage renal disease (16).

The inclusion of very small reference groups is another limitation of pediatric CKD registries. Regardless of these limitations, children in Europe have a chronic kidney disease (CKD) prevalence of 55-60 per million, with an estimated 11-12 per million for stages 3-5 (17). While precise data on the frequency or incidence of pre-terminal CKD is lacking in most Western nations, similar figures have been found in other countries' population-based registries. Some variations could emerge from studies comparing people of different ages. Over the 1980s and into the 1990s and 2000s, there was a slow but steady rise in the incidence of chronic kidney disease (CKD) among children. Due to the tremendous gains in both survival and treatment for chronic renal disease, the illness's prevalence has also grown substantially (18, 19).

Most epidemiological research on chronic kidney disease (CKD) in children have concentrated on children with end-stage renal disease (ESRD) who have required renal replacement therapy (RRT). Epidemiological studies conducted on adults have shown that ESRD is only the "tip of the iceberg" when it comes to chronic kidney disease (CKD). In fact, the number of patients in the early stages of the illness is expected to be at least 50 times larger than the number of individuals who reach ESRD (5).

This line of thinking might be used in the pediatric population, where chronic kidney disease (CKD) is still mostly undiscovered. Notably, the hefty cost of radiation therapy for children is more reasonable in North America, Europe, and Japan, where the treatment is performed in large quantities (80%). Therefore, the actual impact of chronic kidney disease (CKD) on children in developing countries is not well understood, especially in areas where RRT is either not financed or is not supported (20).

males are more likely to have chronic kidney disease (CKD) than women are because to the greater prevalence of CAKUT in males. Finally, racial identification is an additional factor that influences the epidemiology of chronic kidney disease (CKD). Chronic kidney disease (CKD) is two to three times more common in children of African American heritage in North America than in children of Caucasian descent, and this disparity holds true across genders. Among the juvenile populations in Australia and New Zealand, the risk of end-stage renal disease (ESRD) is higher among children from indigenous communities such the Maori and Aborigines (21).

Cardiovascular disease in Children

In industrialized countries, CVDs account for a disproportionate share of healthcare costs and deaths. Atherosclerosis develops in response to several risk factors, and various studies have shown that it may be detected in children at an early stage. Vascular alterations, the earliest symptoms of atherosclerotic disease, often appear in a child's first decade of life. Some of the conditions that might increase the likelihood of this happening include hypertension, metabolic abnormalities, and chronic inflammation. Nevertheless, defects in the structure or function of the heart may also induce CVD in children (22, 23).

Results from the Muscatine and Bogalusa Heart Studies, among others, point to a connection between conventional CV risk factors introduced to infants and the onset of subclinical atherosclerosis in adulthood. Raised cIMT, reduced carotid elasticity, and dysfunctional endothelial cells in adulthood are all outcomes of high apolipoprotein and cholesterol levels in childhood (24).

According to a recent meta-analysis, screening adolescents with CV risk factors starting in the late teens to identify subclinical atherosclerosis is a good idea since elevated cIMT is a predictor of the development of atherosclerosis in adults in children aged 9 and above (24).

Observational and epidemiological research show that atherosclerosis starts in childhood and is strongly correlated with the quantity, severity, and cumulative impact of risk factors introduced to a kid throughout infancy. There is a correlation between these parameters and the severity and degree of atherosclerosis. Inadequate physical activity and a diet deficient in fruits and vegetables have also been associated with accelerated vascular inflammation development and increased cIMT throughout adulthood (24).

Because of this, it is essential for pediatricians to recognize atherosclerosis as a prevalent childhood condition and begin preventing it in children as early as possible, for the benefit of both the general population and individuals at high risk of cardiovascular disease (25).

Cardiovascular risk in children

- **Dyslipidemia**

Several studies have shown that atherosclerosis first appears in children, specifically as fatty streaks, which are lesions inside the arteries containing lipid-filled

macrophages, the precursors of atheromatous plaque (26). These studies include the Pathobiological Determinants of Atherosclerosis in Youth Study and the Bogalusa Heart Study.

Low density lipoprotein cholesterol (LDL-C) is the most important element in the development of atherosclerotic plaques, which increases the risk of cardiovascular disease. Atherosclerotic plaques, caused by calcium accumulation in the coronary arteries, are more likely to form in adolescents whose blood LDL-C levels are consistently high. Adults may be at a higher risk of developing ischemic heart disease because to changes that may occur in the coronary arteries. After that, aiming for low serum LDL-C levels from infancy onwards is the core approach for reducing CV occurrences (27).

There is no more significant cardiovascular risk factor than hypercholesterolemia when it comes to the onset of coronary heart disease. Familial hypercholesterolemia (FH) is the most common form of this condition, which is mostly caused by genetics. A hereditary disorder that occurs in families, FH affects cholesterol metabolism (28).

The heterozygous variety, characterized by very high LDL-C levels, affects 1 in 250 individuals. If there is a history of elevated LDL-C levels or early cardiovascular disease in first- or second-degree relatives, together with the presence of LDL-C values of 160 mg/dL (4.0 mmol/L), the diagnosis may be suspected. A positive genetic test for an anomaly that raises LDL-C levels may confirm the notion (22).

Heart failure and other cardiac complications are more common in children with dyslipidemias as the condition advances. It is critical to recognize LVH and decreased heart function early so that the correct therapy may be started for children with dyslipidemias. It is important to test all children as they develop, not just the ones who are at risk. Children with dyslipidemia should have non-invasive cardiac morphology and cIMT for risk assessment in the prevention of future cardiovascular disease (27).

It is recommended by the American Academy of Pediatrics to check a child's cholesterol (total, LDL-C and high-density lipoprotein cholesterol HDL-C) and triglyceride (TG) levels in the blood at the age of 10 and again at the age of 19. It is possible to achieve the early detection of hypercholesterolemia and the start of targeted treatment in this way. Behavioral intervention, such as dietary and lifestyle modifications, is the mainstay of therapy for early-stage diseases. After nonpharmacological therapy have failed and the condition has progressed to the point where blood cholesterol levels are high, pharmaceutical treatment with statins may be initiated (29).

Clinical investigations have shown that statins may be safely used by children and adolescents with FH. Thus, statin therapy should start with low dosages in children aged 8 to 10 who have the heterozygous form of FH. Among the many long-term advantages is a reduced incidence of atherosclerotic CVD in a 40-year follow-up (30).

Table (4) Recommendations for screening dyslipidemia (31)

Children older than 2 years + 1 or more of the followings:
1. First-grade relatives (men < 55 years and women < 65 years) with previous MACEs.
2. Parents with hypercholesterolemia (Total cholesterol 240 mg/dL).
3. Parental/grandparental family history not known + 2 or more other risk factors for CAD (including hypertension, cigarette smoking, low HDL choles-terol, obesity, physical inactivity, and diabetes mellitus).

- **Hypertension**

A key predictor of CVD in adults is hypertension in childhood. Adolescents and children under the age of 18 have an estimated prevalence of 3–5% for arterial hypertension; this rises to 10–11% in 18–year-olds, a rate comparable to that of young adults. Table 5 shows that the annual incidence of hypertension in adults with normal blood pressure is 1.4%, which is similar to the occurrence in teenagers with prehypertension prior to screening (32, 33).

Table (5) Definitions of elevated BP and HTN in children and adults. (34)

Adults and children ≥ 13 years of age	
Elevated blood pressure	Systolic BP ≥ 120 and diastolic BP ’80 mm Hg
Stage I hypertension	Systolic BP ≥ 130 and diastolic BP ≥ 80 mm Hg
Stage II hypertension	Systolic BP ≥ 140 and diastolic BP ≥ 90 mm Hg
Children ’13 years of age	

Elevated blood pressure	Systolic and/or diastolic ≥ 90th percentile for age, sex and height
Stage I hypertension	Systolic and/or diastolic ≥ 95th percentile for age, sex and height
Stage II hypertension	Systolic and/or diastolic ≥ 95th percentile + 12 mm Hg

In children as young as three years old, screening for hypertension (HTN) or raised blood pressure (BP) should begin; a diagnosis is made when BP remains elevated after three visits (Figure 3). It is recommended to diagnose primary hypertension (HTN) instead of doing a thorough assessment for secondary causes in children and adolescents aged 6 years and above who have a positive family history of the disease, are overweight or obese, and/or do not have a history of physical examination abnormalities that would indicate a secondary HTN (22).

The leading causes of secondary hypertension in younger children are disorders of the kidneys and the blood vessels that supply them. Aortic coarctation is a cardiac condition that often manifests with hypertension and a right arm blood pressure that is 20 mm Hg higher than the lower extremity blood pressure. Additional factors that might lead to secondary hypertension include endocrinology, environmental factors, neurofibromatosis, and pharmaceutical interactions (Figure 1) (35).

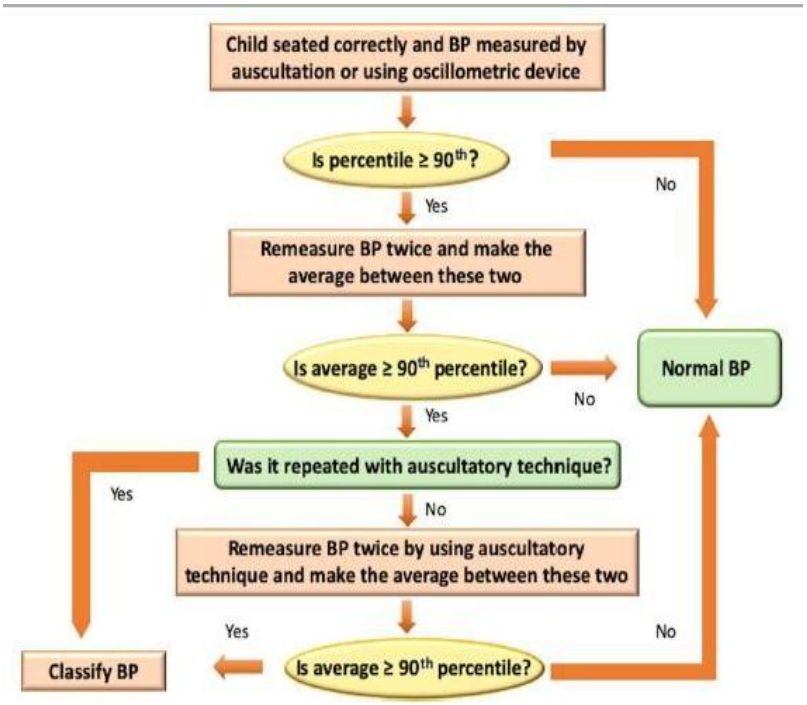

Fig. (1) BP measurement algorithm (24)

- **Congenital heart diseases**

Adults with structural or functional abnormalities of the heart are at increased risk for atherosclerosis and other CVDs, including heart failure, myocardial infarction, stroke, transient ischemic attacks (TIAs), aortic aneurysms, and peripheral vascular disorders, according to the available research. The majority of congenital heart defects associated with an increased risk of premature CV disease in adulthood include anomalies of the coronary arteries, cyanotic congenital heart defects (such as Eisenmenger syndrome), and obstructive lesions of the left ventricle and aorta. Additionally, LVD is an independent risk factor for CV events in adults and is known to occur with severe aortic stenosis (24).

In addition, acquired heart disease, namely ischemic heart disease, is the main killer of individuals with mild to moderate congenital heart defects (CHD). Life expectancy is lower for those with severe congenital heart disease compared to the general population since most of their deaths are caused by underlying heart disorders and any acquired CVD. Therefore, the variation is determined by the degree of the underlying congenital defect. Hypertension

and hyperlipidemia are also more prevalent in those with mild to moderate coronary heart disease (36).

Individuals with cyanogenic congenital heart disease also tend to have coronary arteries with lower CIMT values and no plaque. This strongly suggests that these patients will not develop atherosclerosis in adulthood. Cardiovascular disease risk factors should be regularly evaluated by long-term follow-up in patients with non-severe coronary heart disease (36).

Multiple studies indicated that adult individuals with cyanogenic congenital heart disease had identical lipid profiles, cardiovascular risk scores, and frequencies of subclinical carotid and coronary atherosclerosis as the general population. It is possible that the lower risk of atherosclerosis seen in people with coronary heart disease (CHD) is due to hypoxemia, which leads to an increase in the synthesis of anti-atherogenic chemicals such nitric oxide, hyperbilirubinemia, and thrombocytopenia (37).

Congenital coronary anomalies

Atherosclerosis may occur at a young age in certain people due to congenital heart defects, such as congenital coronary abnormalities. It is well recognized that main preventive strategies, including managing one's nutrition, engaging in aerobic physical exercise, and quitting smoking, are the most effective ways to minimize CV risk in people. On the other hand, hyperlipidemia screening and treatment, diabetes mellitus, and hypertension all play crucial roles (22).

Kawasaki disease

In affluent countries, acquired pediatric heart disease is most often caused by acute systemic vasculitis, which is also called Kawasaki sickness. Because it affects the coronary arteries, it might trigger the development of coronary aneurysms in severe cases. The incidence has been on the rise recently, with 30 instances per 100,000 youths in the United States. The reason for it is unclear (38).

Coronary artery aneurysms (CAAs) form in 20-25% of untreated youth. It is not known if the accelerated atherosclerosis process is linked to future coronary issues, however these people do have an elevated risk for CV disorders. Although there is mixed data in the literature, particularly for low-risk individuals, CAA is characterized by arterial stiffness, endothelial dysfunction, and high cIMT (24, 39).

Childhood cancer

The proportion of people surviving childhood cancer is improving, thanks to the greater availability of innovative therapy, even if the late morbidity and mortality rates are still high. In comparison to age-matched control individuals, cardiovascular disease mortality is eight to 10 times higher among childhood cancer survivors (CCS) (40).

The Childhood Cancer Survivor Study found that compared to their siblings, children who survived cancer had three times the risk of developing cerebrovascular accidents, ten times the risk of developing coronary artery disease (CAD), and fifteen times the risk of developing congestive heart failure (41).

The CCS group had higher insulin resistance, lower carotid compliance and distensibility, and higher arterial stiffness compared to their siblings, as well as higher fat mass and lower lean mass (41).

Their elevated CV risk is due to a number of reasons, one of the most important of which is their history of anti-tumoral treatment. Patients who had radiation therapy (1550 cm2 whole body, chest, or abdomen) had a 2.5-fold increased risk of having congestive heart failure, myocardial infarction, pericardial disease, and valve abnormalities compared to CCS who did not get radiation treatment (24).

Following a hematopoietic stem cell transplant, the patient is at a two- to threefold higher risk of cardiovascular disease (CVD) mortality, complications such as cardiomyopathy, congestive heart failure, cerebrovascular accident, coronary artery disease (CAD), and rhythm issues. When brain tumors harm the pituitary and hypothalamus glands, it may lead to a variety of endocrine disorders, including radiation treatment and brain surgery. Metabolic syndrome symptoms might be exacerbated by disorders such as growth hormone deficiency (36).

Central hypothyroidism develops in 20% to 30% of patients undergoing CRT (> 30 Gy), and long-term central hypogonadism affects 3% to 9% of individuals (42).

Hypertension (high blood pressure due to an increase in the resistance of the blood arteries to blood flow), diabetes, dyslipidemia, and thyroid cancer are all potential causes of primary hypothyroidism. Other tumors may also cause radiation to the neck and mantle. Out of all patients treated with more than 30 Gy of CRT, 3-6% have adrenal insufficiency, a side effect that may be brought on by high-dose steroid treatment (42).

Renal insufficiency is another prevalent comorbidity that may develop as a consequence of some chemotherapy medications, including isocyanide and methotrexate, in addition to hypertension (HTN). One drawback of the current

guidelines for treating CV risk in CCS is the lack of large-scale prospective studies. However, there are a handful of suggestions that may be quite useful for physicians while they are in the field. The Children's Oncology Group suggests screening CCS patients every two years with fasting lipid profiles and fasting glucose or glycated hemoglobin (43).

Lifestyle measures such as keeping a healthy weight, eating a heart-healthy diet, getting adequate exercise, and avoiding secondhand smoking should also be vigorously advocated in treatment of CV risk factors, which should be personalized to each patient's history of cancer treatment (43).

Public health

Cardiovascular diseases (CVDs) accounted for 633,842 deaths in 2015 (or one in four fatalities) in the US, placing them among the top two killers. In 2015, 595,930 people lost their lives to cancer, with heart disease coming in second. According to the World Health Organization, cardiovascular disease (CVD) was the top killer in 2015, killing an estimated 17.7 million people. After diabetes and Alzheimer's disease, cardiovascular disease (CVD) has the highest projected yearly indirect expenses at $237 billion, with an expected increase to $368 billion by 2035 (44, 45).

The general population still has a significant risk of heart disease—50% by age 45—despite advances in detection and treatment over the last several decades. The age-adjusted rate of acute death from MI has decreased, yet this remains the case. Although there are gender variations, the frequency increases dramatically with age; for instance, men often have a higher prevalence at younger ages. As women enter menopause, the incidence difference gradually closes (44, 46).

Cardiovascular affection in CKD in children

Around 10,000 children in the United States are on dialysis, and over 1,000 have kidney transplants every year. The overall mortality pressure (BP) reading below the 50th percentile for the patient's age, sex, and height while managing proteinuria in children, unless doing so induces symptoms of hypotension. These patients should be treated with angiotensin receptor blockers or angiotensin-converting enzyme inhibitors (ACEi) regardless of the level of proteinuria (24).

When a child is just diagnosed with chronic kidney disease (CKD), it is prudent to check their lipid profile. All children with chronic renal illness should have their fasting lipid levels evaluated annually. However, you should wait until you are at least 18 years old

rate in children is lower than that of children treated with long-term dialysis (30 times) and young kidney transplant recipients (10 times), despite the fact that survival rates for individuals with early onset chronic kidney disease (CKD) have improved over the past few decades. Cardiovascular disease (CVD) is the leading cause of death from end-stage renal disease (ESRD) in children. Several risk factors do contribute to these people developing vascular and cardiac dysfunction at an earlier age (22, 47).

At the early stages of chronic kidney disease (CKD), hypertension (HTN) is the main cause of cardiovascular disease (CVD). However, after dialysis is started, anaemia, fluid overload, and mineral bone deterioration become the main concerns. Sudden cardiac death, arrhythmias, valvular heart disease, cardiomyopathy, and stage 5 chronic renal disease in children have been linked to each other (48).

The cardiovascular system goes through a lot of changes in the early stages of chronic renal disease (49), all in an attempt to adapt to the biochemical and haemodynamic abnormalities that are distinctive of the illness (Figure 4).

Furthermore, recent studies have linked FGF23 to a decrease in GFR and myocyte hypertrophy, leading to the possibility that it plays a role in LVH. The mortality rate for young women with CKD was greater than that of young men (50, 51).

When estimating LVH from estimated lean body mass, there were no differences between the sexes. However, when comparing 681 children with chronic kidney disease (CKD) to their height, researchers discovered that girls had a higher proportion of LVH when indexing left ventricular mass (LVM) to height (51).

When it comes to controlling the most common risk factors for cardiovascular disease (CVD), KDIGO might be useful for children with chronic kidney disease (CKD). It is crucial to consistently maintain a blood before beginning to take statins or ezetimibe. Children with hypertriglyceridemia and chronic kidney disease (CKD) are encouraged to adopt a healthier way of life (49).

Cardiovascular disease (CVD) and its problems are most often caused by dialysis; thus, it is recommended to undertake transplantation promptly to avoid these issues. However, transplantation should not be considered a last resort as CV risk persists after kidney transplantation (24).

It is crucial to closely monitor and manage complications such as inflammation, abnormal mineral metabolism, dyslipidemia, and

hypertension in patients who may need long-term dialysis (22).

5. Conclusion

Cardiovascular disease is the leading cause of death in children with end-stage renal disease (ESRD). Cardiovascular complications may occur in children with chronic renal illness for a variety of reasons, including hypertension, fluid overload, mineral bone disease, anemia, and others. Particularly in the early phases of chronic kidney disease, it is crucial to detect and manage these risk factors without delay. A kidney transplant is the greatest way to avoid dialysis's long-term side effects. Patients will still need frequent monitoring and management because to the fact that cardiovascular risk persists even after a donation. Consistent monitoring and management of these patients' modifiable risk factors, including as lipid profiles and blood pressure, is essential.

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