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Cardiovascular Complications in Patients with Chronic Kidney Disease at the Departmental Teaching Hospital of Borgou/Alibori (Benin)

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Abstract

Background: Background In patients with advanced chronic kidney disease, cardiovascular disease is known to be the leading cause of death.

Objective: To study cardiovascular complications in patients with chronic kidney disease (CKD) at CHUD B/A in 2023.

Methods: This was a descriptive, analytical, cross-sectional study with prospective data collection involving non-dialysis CKD patients seen in the nephrology, cardiology and internal medicine departments of CHUD B/A from 1 January 2023 to 31 August 2023. The dependent variable was the existence of at least one cardiovascular complication. Data were collected and analysed using R Studio 4.2.2 software. For comparisons, a p-value < 5% was considered statistically significant.

Results: 64 patients were included. The mean age of the patients was 58.3 ± 14.1 years, [extremes of 29 and 92 years]. The patients were predominantly male (60.9%) with a sex ratio of 1.6. Of the 64 patients with CKD, 51 (79.7%) had at least one cardiovascular complication. The most prevalent cardiovascular complication was LVH in 48 patients (75.0%), followed by heart failure (42.2%), uraemic pericarditis (28.2%) and hypertension (17.2%). In univariate analysis, the stage of CKD, hyperuraemia, anaemia, hypocalcaemia, hyperphosphaemia, positive CRP and lack of compliance with treatment were the factors statistically associated with cardiovascular complications in CKD patients ($p<0.05$). After adjustment, hyperuraemia was the potential factor associated with the presence of at least one cardiovascular complication (ORa= 62.92; IC95% = [3.12-1271.05]; p= 0.007).

Conclusion: Cardiovascular complications are common in patients with advanced chronic kidney disease, and many factors are associated with them.

Keywords: Chronic Renal Failure; Cardiovascular Complications; Benin

Introduction

A major public health problem, chronic kidney disease (CKD) is highly prevalent and is estimated to affect between 11% and 13% of the world's population [1]. CKD results either from the progression of chronic kidney disease (CKD) or from failure to recover from acute kidney injury. Starting with the major functions performed by the kidneys, these are organs whose proper functioning is essential to that of all the other organs in the human body. The heart and kidneys are inextricably linked, as demonstrated by

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the cardio-renal syndrome, in which dysfunction in one organ induces and promotes dysfunction in the other [2]. Chronic renal failure will cause a number of cardiovascular complications and vice versa.

The prevalence of cardiovascular disease (CVD) in CKD patients is up to nine times higher than in the general population [3]. This translates into increased morbidity and mortality in CKD patients [4]. Cardiovascular-associated mortality constitutes approximately forty to fifty percent of all deaths in advanced CKD (stage 4) and end-stage kidney disease (stage 5) patients. This compares to the twenty-six percent mortality observed in people with normal kidney function. This elevated danger spans beyond atherosclerosis-related issues like myocardial infarction and stroke; it also comprises coronary heart failure and fatal arrhythmias, specifically in advanced stages of CKD [5]. This constant reduction in the prevalence of CVD is thought to be linked to the fact that the majority of CKD patients die from CVD even before reaching the stage requiring supportive therapy [6]. In 2013, there were almost 2.2 million deaths in patients with reduced glomerular filtration rate (GFR), and almost half of these were of cardiovascular origin [7]. The high prevalence of CVD in stage 5 CKD patients suggests that the phenomena leading to these pathologies occur during the development of renal failure.

The increased prevalence of traditional cardiovascular risk factors (such as age, hypertension, diabetes and smoking) and the association with non-traditional risk factors specific to CKD, such as anaemia, uraemia and inflammation [8, 9] may explain the increased cardiovascular risk in CKD. These CKD-related factors contribute more to a fall in GFR [10].

In Benin, several hospital-based studies have reported a high prevalence of CKD [11]. It is necessary to identify cardiovascular complications in this population and the factors associated with them. Actions aimed at controlling or even reducing these factors would therefore be important for the management of CKD patients, with the aim of reducing the morbidity and mortality attributable to them[12]. This was the motivation for the present research, the aim of which was to study cardiovascular complications in patients with advanced stages of chronic kidney disease (CKD) at the Centre Hospitalier Universitaire Départemental Borgou/ Alibori (CHUD-B/A) in 2023.

Methods

This was a descriptive cross-sectional study with an analytical aim which took place over a period of eight (08) months from January 1st to August 31, 2023 in the cardiology, internal medicine and nephrology departments of the Centre Hospitalier Universitaire Départemental Borgou Alibori (CHUD B/A). The study population consisted of all patients with chronic kidney disease stages 3, 4 and 5 13 admitted to the said departments during the study period. The study population consisted of all patients with chronic kidney disease stages 3, 4 and 5 13; admitted to the said departments during the study period. All patients aged 18 or over with stage 3, 4 or 5 chronic kidney disease admitted to the nephrology, internal medicine and cardiology departments and who had given their consent were included. Stage 5 CKD patients receiving renal replacement therapy or those who had not completed all necessary investigations were not included. Sampling was exhaustive. The dependent variable was the presence of at least one cardiovascular complication. The cardiovascular complications sought were: left ventricular hypertrophy, heart failure, arrhythmias, uraemic pericarditis, valvulopathy, arterial hypertension, coronary artery disease, stroke, peripheral arterial disease of the lower limbs and venous thromboembolic disease.

- Chronic kidney disease was selected according to the chronic kidney disease classification criteria (KDIGO) 13.
- CKD stages 3, 4 and 5 were selected for an entry glomerular filtration rate (GFR) of between 30 and 60, 15 and 30 and less than 15 ml/min/1.73m2 respectively. The Chronic Kidney Disease - Epidemiology Collaboration (CKD-EPI) equation was used as the basis for calculating GFR; Cardiovascular complications:
- Arterial hypertension: CKD patients are considered to have a cardiovascular complication such as arterial hypertension:

- if patient not known to be hypertensive prior to diagnosis of CKD stages 3-5 and
- the diagnosis of hypertension is made at the same time as or after the diagnosis of CKD
- whether or not the subject had an increase in blood pressure on the day of the survey

- Presence of left ventricular hypertrophy according to the following criteria:

- Either on ECG Sokolow Lyon index: SV1 + RV5 or RV6 ≥ 35mm and/or
- Cornell index: R(aVL) + SV3 ≥ 20 mm in women and ≥ 28mm in men. o Either on TTE LVMI > 115g/m2 (in men) or > 95 g/m2 (in women) 14,15.
- LVH is concentric if Relative Wall Thickness (RWT) > 0.42 or eccentric if RWT ≤ 0.4215.

- Presence of left and/or right heart failure syndrome;

- with cardiac ultrasound: systolic dysfunction (impaired LVEF)
- and/or diastolic dysfunction (increased ventricular filling pressures)

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- Assessment of the type of heart failure is based on the Simpson Biplan LVEF value.
- CI with preserved LVEF if : ≥ 50% o CI with moderately reduced LVEF if : [41% - 49%] o CI with reduced LVEF if ≤ 40%16.

➢ Coronary artery disease in the presence of ST segment or Q wave abnormalities on ECG

➢ Arrhythmias selected on the basis of an ECG showing one or other of these abnormalities:

- Atrial rhythm disorders: Atrial flutter, Atrial fibrillation, SSEV, Atrial tachycardia
- Junctional rhythm disorders: junctional extrasystole, junctional tachycardia o Ventricular rhythm disorders: ventricular fibrillation, ESV, ventricular tachycardia, torsade de pointe

➢ Uremic pericarditis retained in subjects with stage 5 CKD presenting :

- Clinical signs: chest pain exacerbated by deep inspiration, calmed by anteflexion, pericardial friction;
- Repolarisation anomalies in the Holtzman tetrad ; o Ultrasound sign: a pericardial effusion16

➢ Valvulopathy by the presence of one or other of these valve dysfunctions on ultrasound:

- Aortic stenosis: Presence of valvular calcifications on ultrasound + Vmax > 2.5m/s16.
- Aortic insufficiency17
- Mitral stenosis
- Mitral insufficiency
- Tricuspid narrowing
- Tricuspid insufficiency
- Valvular calcifications

➢ Cerebrovascular accident: in a patient already diagnosed with CKD, a sudden onset of focal neurological deficit. The nature of the stroke (ischaemic or haemorrhagic) was determined by means of a cerebral CT scan. In the absence of a cerebral CT scan, the nature of the stroke is said to be undetermined.

➢ Venous thrombo-embolic diseases

- Lower limb venous thrombosis selected on the basis of the WELLS clinical probability score (simplified) for DVT for a high clinical probability (score ≥ 2) 18.
- Pulmonary embolism retained in a patient with :
- Clinical signs: sudden or progressive onset of dyspnoea, lateral thoracic pain, haemoptysis, and/or
- o On ECG, sinus tachycardia, S1Q3 appearance, BBD and/or
- On ultrasound: signs of overload of the right cavities or acute pulmonary heart disease (dilatation of the VD, paradoxical septum, hypokinesia of the VD, increased pulmonary pressures).
- With a Wells clinical probability score (simplified) of strong PE ≥ 217 .
- Obliterative arterial disease of the lower limbs, retained on the basis of an SPI (ankle SBP/humeral SBP) < 0.9018.

➢ Independent sociodemographic, lifestyle, clinical, paraclinical and therapeutic variables were studied.

Data were collected using a pre-tested interview guide. The interview and physical examination were carried out by the nephrologists and general practitioners. Electrocardiograms and cardiac ultrasounds were performed and interpreted by the cardiologist. Biological tests were carried out in the clinical biology laboratory of the CHUD B/A.

Brachial blood pressure was measured using a SPENGLER® electronic sphygmomanometer in the unclothed subject at rest (supine) for at least five minutes. We took three measurements, each three minutes apart (alternating between the right and left arms). The average of the second and third measurements was used for the analysis.

To calculate the limb-specific SPI, blood pressure measurements were taken at the ankles of each pelvic limb. At each right and left ankle, systolic blood pressure (SBP) was measured. The limb-specific SBP was calculated by dividing the highest SBP in that pelvic limb by the homolateral brachial SBP.

Electrocardiogram

This was a 12-lead resting ECG, collected at a paper speed of 25 mm/s, at a gain of 10 mm/mV (or 5 mm/mV) using a MEDITECH EKG312T device commissioned on 12 November 2022.

Cardiac Doppler ultrasound

This involved transthoracic cardiac echography performed by the cardiologist using a MINDRAY DC 60 machine commissioned on 19 February 2022.

Statistical analysis

The data was entered and analysed. The questionnaire was drawn up online on the koboToolbox platform. The form was then digitised on a smartphone using the kobocollect application. The data was extracted and analysed using R Studio 4.2.2 software. Quantitative variables were described as mean ± standard deviation or median with interquartile range, depending on the normality of the distribution.

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Qualitative variables were described in terms of frequency or proportion. Associated factors were identified using the chi-square test or Fischer's exact test as appropriate. A p value < 5% was considered significant. The strength and direction of stability of the associations between variables were estimated using Odds ratios (OR) with their 95% confidence intervals, obtained using a logistic regression model. A multivariate analysis (with adjusted Odds-ratio) was used to highlight the associations between the different variables.

The study was approved by the Technical Medical Committee of the Departmental University Hospital of Borgou/Alibori in Parakou (Benin). It also received the approval of the Local Ethics Committee for Biomedical Research of the University of Parakou (CLERB-UP). The anonymity and confidentiality of the data collected complied with the ethical principles applicable to medical research on human subjects contained in the Declaration of the World Medical Association of Helsinki19.

Results

During the study period, 79 CKD patients were identified and 15 were excluded because their complementary examinations were not complete. A total of 64 patients were included, giving a participation rate of 81.0%. The flow chart for patient inclusion is shown in Figure 1.

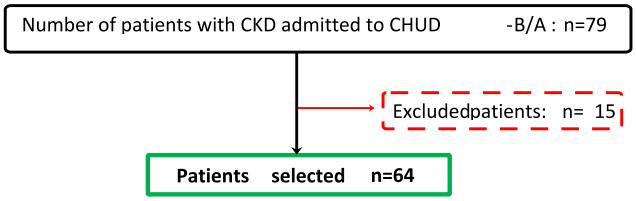

Figure 1: Flow chart showing changes in the number of participants in the study of cardiovascular complications in CKD patients at CHUD B/A in 2023.

General characteristics of the sample

Socio-demographic characteristics of patients

The mean age of patients was 58.33 ± 14.07 years [range 29 to 92 years]. Male predominance was 60.9%, with a sex ratio of 1.6. Civil servants and housewives accounted for 34.4% and 31.3% respectively. Participants with primary and secondary education were 26.6% and 28.1% respectively. Of the 64 participants, 75.0% lived in urban areas and 71.9% were married.

Characteristics linked to associated pathologies and lifestyle

Hypertensives, diabetics, former cerebrovascular accident victims and viral hepatitis Bou C virus carriers were found in 73.4%, 23.4%, 21.0% and 3.1% respectively. Of the 64 participants, 42.2% were not physically active, 45.3% were overweight, 20.3% regularly drank alcohol, 14.1% smoked, 15.6% did not regularly eat fruit and vegetables, 25.0% used herbal medicine excessively and 43.3% self medicated with non-steroidal anti-inflammatory drugs and/or painkillers.

Clinical characteristics of patients

Age of chronic kidney disease stages 3-5

The mean duration of CKD in our patients was 9.83 ± 19.5 months [extremes 0 and 120 months]. CKD was diagnosed in less than one month, one to ten months and more than 20 months in 25.0%, 53.1% and 15.6% respectively.

Anatomo-clinical diagnosis of chronic kidney disease

Hypertensive nephropathy (73.4%), diabetic nephropathy (18.7%), other chronic glomerulonephritis (7.8%), obstructive uropathy (6.3%) and chronic tubulointerstitial nephropathy (1.6%) were the anatomo-clinical disorders.

Stages of chronic kidney disease

With regard to the stage of the CKD, 25.0% and 51.6% were in stages 4 and 5 respectively (Figure 2).

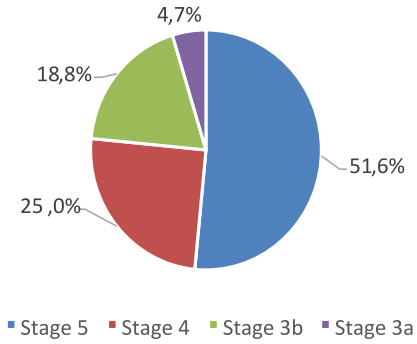

Figure 2: Distribution of patients by stage of CKD at CHUD B/A in 2023 (N= 64)

Biological characteristics of CKD patients

Haemoglobin levels below 11g/dL, hypocalcaemia, hyperphosphaemia and hyperuricaemia were found in 57.8%, 42.2%, 48.4% and 42.2% respectively. Hypoprotidemia (25.0%), positive C Reactive Protein (32.8%), total hypercholesterolemia (14.1%), HDL hypocholesterolemia (35.9%) and hypertriglyceridemia (12.5%) were found.

Therapeutic characteristics

Of the 64 participants, 48 (75.0%) were taking dietary hygiene measures. Drug treatments included calcium channel blockers (70.3%), conversion enzyme inhibitors (40.6%), angiotensin II receptor antagonists (29.7%), iron (34.4%), calcium carbonate and vitamin D (25.0%), thiazides (25.0%), platelet anti-aggregants (25.0%), allopurinol (23.4%), loop diuretics (18.8%) and beta-blockers (10.9%) were used. Statins, ascorbic acid, antialdosterone and erythropoietin were

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used by 9.4%, 7.8%, 3.1% and 1.6% of patients respectively. In the sample, 41 patients (64.1%) were compliant.

Overall frequency of cardiovascular complications

Of 64 patients with stage 3-5 CKD, 51 (79.7%) had at least one cardiovascular complication.

Variation in cardiovascular complications depending on the stage of CKD

As CKD progresses towards the end stage, cardiovascular complications become more prevalent, as shown in Figure 3.

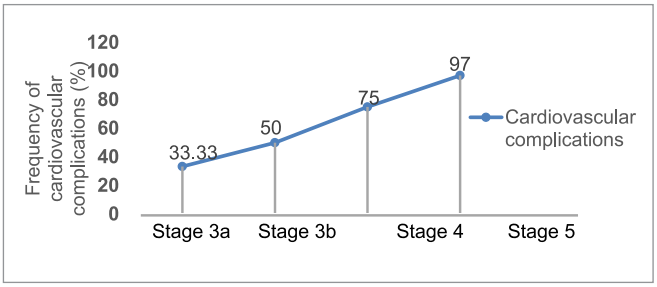

Figure 3: Prevalence of cardiovascular complications by stage of CKD in patient admitted to CHUD B/A in 2023 (N= 64)

Description of cardiovascular complications in CKD patients

Of the 64 patients, 75.0% had left ventricular hypertrophy, 42.86% had heart failure, 22.2% had uremic pericarditis and 17.2% had hypertension. The figure 4 shows the various complications founds.

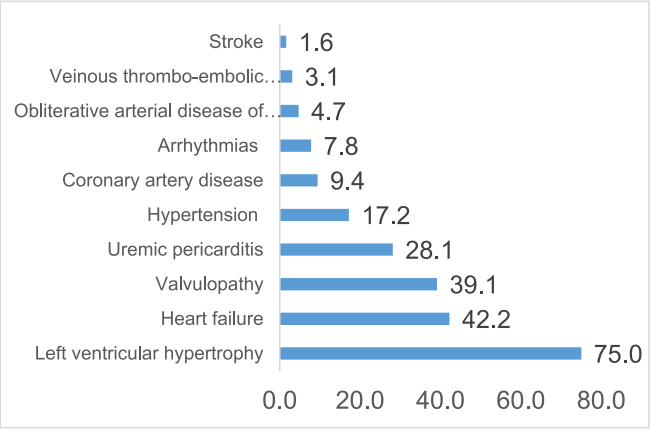

Figure 4: Distribution of CKD patients according to cardiovascular complications at CHUD B/A in 2023 (N= 64)

Left ventricle hypertrophy

Of the 48 patients with LVH, concentric and eccentric forms were found in 35 (72.9%) and 13 (27.1%) respectively.

Heart failure

Of the 27 participants with heart failure, left ventricular ejection fraction was reduced in 18.5%, hypertensive heart disease in 96.3% and decompensated heart failure in 74.1% (Table 1).

Table 1: distribution of CKD patients with heart failure at CHUD B/A in 2023 (N=27)

		Frequency	Porportions
Type according to left ventricular hypertrophy			
	Preserved	13	48.2
	Moderately	9	33.3
	Reduced	5	18.5
Etiology of heart disease			
	Hypertensive	26	96.3
	Ischemic	6	22.2
	Expanded	6	22.2
Status of heart disease			
	Compensated	7	25.9
	Decompensated	40	74.1

Of the 20 patients with cardiac decompensation, 19 (95.0%) had global cardiac decompensation and one patient had left-sided cardiac decompensation.

Valvulopathy

Of the 25 patients with valve disease, the most common was mitral insufficiency (84%), which was grade 2 in 56.0% of cases (Table 2).

Table 2: Distribution of CKD patients according to type of valvulopathy on transthoracic cardiac echocardiography at CHUD B/A in 2023 (N=25)

	N=25	%	Severity					
			Grade 1		Grade 2		Grade 3	
			n	%	n	%	n	%
Types of heart valve disease								
Mitral insufficiency	**21**	84,0	6	24,0	14	**56**,0	1	4,0
Aortic insufficiency	12	48,0	5	20,0	7	28,0	0	0,0
Tricuspid insufficiency	5	20,0	3	12,0	2	8,0	0	0,0

Uremic pericarditis

Among the 18 cases of uraemic pericarditis, 13 patients (72.2%) had a small pericardial effusion, and 5 patients (27.8%) had a medium-sized effusion.

Other cardiovascular complications

Other complications included arterial hypertension (17.2%), arrhythmias (7.8%), venous thromboembolism (3.1%) and stroke (1.6%). (Table 3)

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Table 3: Distribution of CKD patients seen at CHUD B/A in 2023 according to other cardiovascular complications (N=64)

	Frequency	Porportions
Arterial Hypertension	11	17.2
Systolo-diastolic	8	12.5
Systolic	2	3.1
Diastolic	1	1.6
Arrhythmias	5	7.8
Ventricular extrasystoles	4	6.3
Atrial extrasystoles	1	1.6
Venous thromboembolic diseases	2	3.1
Deep vein thrombosis	2	3.1
Pulmonary embolism	1	1.6
Ischemic stroke	1	1.6

Identifying factors associated with cardiovascular complications

!In bivariate analysis, the stages of CKD ((p = 0.014), hyperuraemia ((p = 0.001), haemoglobin less than 11g/dl, positive CRP ((p = 0.006), hypocalcaemia (p =0.028), hyperphosphaemia ((p = 0.008), non-compliance with treatment (p = 0.002) were statically associated with the occurrence of cardiovascular complications. (Table 4).

In the multivariate model adjusted for excess weight, hyperuraemia was the potential factor associated with the presence of at least one cardiovascular complication. Indeed, CKD patients with hyperuraemia were 62.92 times more likely to have at least one cardiovascular complication than those with normal uraemia (ORa= 62.92; CI95% = [3.12-1271.05]; p= 0.007). (Table 5)

Table 4: Factors associated with cardiovascular complications in CHUD B/A in 2023

N	Cardiovascular complications	%	OR [IC]$_{95\%}$	*p*
Stages of chronic kidney disease				***< 0,014***
3a	31	33,3	1	
3b	126	50,0	2,00[0,14-28,42]	
4	1612	75,0	6,00[0,42-85,25]	
5	3332	97,0	64,00[2,83-1446,88]	
Hyperuremia				***0,001***
Yes	6051	85,0	-	
No	40	0,0	1	
Haemoglobin level < 11g/dl				***0,001***
Yes	3735	94,6	1,60[1,16-2,20]	
No	2716	59,3	1	
CRP positive				***0,006***
Yes	2121	100,0	1,43[1,18-1,75]	
No	4330	69,8	1	
Hypocalcaemia				***0,028***
Yes	2725	92,6	1,31[1,04-1,66]	
No	3726	70,3	1	
Hyperphosphatemia				***0,008***
Yes	3129	93,5	1,40[1,08-1,82]	
No	3322	66,7	1	
Therapeutic compliance				***0,002***
Yes	4128	68,3	1	
No	2323	100,0	1,46[1,19-1,80]	

Table 5: Results of the multivariate model of factors associated with the existence of at least one cardiovascular complication in CKD patients admitted to CHUD B/A in 2023.

	Univariate		Multivariate	
	OR[IC]$_{95\%}$	*p*	ORa[IC]$_{95\%}$	*p*
Excess weight		*0,578*		*0,206*
Yes	1,42[0,41-4,94]		2,86[0,60-10,99]	
No	1			
Hyperuremia		***0,001***		***0,007***
Yes	-		62,92[3,12-1271,05]	
No	1	0,0		

Discussion

Limitations of the study

The cross-sectional nature of our study made it difficult to distinguish between the presence of cardiovascular pathology unrelated to CKD and what should be termed cardiovascular complications in CKD patients. A longitudinal study of CKD patients with none of the cardiovascular complications of interest at baseline would have been more appropriate. However, this difficulty was overcome thanks to the good operationalisation of the variables in our study. The lack of financial support for this study was a constraint. We had to reduce the biological variables to be explored because this represented a significant cost for the patient. Despite this, our study took into account most of the biological parameters of interest explored by other similar studies.

Comments and comparison of results

Overall frequency of cardiovascular complications

Our study involved 64 CKD patients and found an overall frequency of cardiovascular complications (CCV) estimated at 79.7%. Halle et al in Cameroon on 83 CKD patients found a frequency of 69.8%20. Lascasas et al in Portugal, on 416 patients with CKD, found a prevalence of 62% [21]. Diakité et al in Guinea, on 378 CKD patients, found a frequency of 22.2% for CVD [22]. There are several possible reasons for the higher incidence of CVD in our study. On the one hand, our study was more exhaustive, looking for at least ten groups

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of CVD, and concerned patients in the advanced stages of CKD. Secondly, differences in sample size and methodology could explain these differences in frequency.

Description of cardiovascular complications

Left ventricular hypertrophy

LVH was the most prevalent cardiovascular complication in our study. Many studies of cardiovascular complications in CKD patients report a high prevalence of LVH [14,20,22,23]. As in our study, in these various studies, LVH is the leading cardiovascular complication in CKD patients. The frequency of LVH in our study was 75%, which is in line with the literature, which reports a frequency of up to 60-75% in patients at the pre-dialysis stage14. However, our frequency appears to be higher than that reported by Halle et al [21], Diakité et al [22], and Kara et al [14], who reported 48.2%, 58.3% and 59.8% respectively. Our study found a higher prevalence of concentric LVH (72.9%) than eccentric LVH (27.1%). This could be explained by the fact that most cases of CKD in our study were newly diagnosed (78.0% of patients had been diagnosed with CKD less than 10 months previously). In CKD, there is an initial concentric LVH due to an increase in systemic arterial resistance. Continued left ventricular overload will lead to cardiomyocyte death and the development of eccentric LVH [24].

Heart failure

In our study, the overall prevalence of heart failure was 42.2%. Congestive heart failure represented 31.2% of our sample. This is similar to the 39% found by Lascasas et al in Portugal [21]. As anaemia is a major factor in decompensation, its high prevalence in our study (57.8%) may explain the frequency of cardiac decompensation.

Valvulopathy

The prevalence of valvulopathy (all valvulopathies combined) in our study was 39.1%. Our frequency is much lower than the 80% found by Ezziani et al in Morocco following a study of haemodialysis CKD patients [25]. This high prevalence in the Ezziani et al study may be explained by the fact that valvulopathy is a more prevalent complication in dialysis patients5. Contrary to what has been reported in the literature, no cases of calcific aortic stenosis (CAS) were identified in our study. This could be due, on the one hand, to our small sample size but, on the other hand, to the fact that this literature found a high prevalence of CAD, which is more degenerative in origin, and related to older Caucasian populations [5]. Mitral valve leakage was the most frequent valvular disease in CKD patients in our study at 32.8%.

Uremic pericarditis

The incidence of uraemic pericarditis (UP) in our study was 28.1%. Our results corroborate data from the literature, which reports a prevalence of between 3% and 41%26. Babua et al in Uganda reported 21.7% for PU [27]. However, our frequency is much higher than the 5.5% reported by Diakité et al [22], or the 7% found by Lazreg et al in Morocco [28]. It should be noted that in our study, all CKD patients were systematically subjected to cardiac ultrasound. This made it possible to detect cases that were clinically pauciously symptomatic but in whom effusions were found on ultrasound. Furthermore, PU is essentially a complication of CKD [29]. The high frequency of PU in our study could be explained by the fact that more than half of the patients (51.6%) were in the end stage of CKD. Bentata et al in Morocco [30] found 16 cases of PU over a period of 28 months; Lazreg et al28 found 9 cases of PU over a period of 8 months; in our study we identified 18 cases over a period of 7 months. The present study, with its prospective data collection, had the advantage of better measurement of the data, which probably explains the large number of cases over a shorter period. However, none of our patients had yet been initiated on RRT. It is well known that initiation or intensification of dialysis reduces the prevalence of PU in CKD patients [26,30].

Arrhythmias

In our study, the prevalence of arrhythmia was 7.8%. The diagnosis of rhythm disorders in our study was based on an electrocardiographic recording of less than 30 seconds. The frequency of arrhythmias in our study would certainly be underestimated. In fact, Bonato et al in Brazil carried out a study in CKD patients in which they explored ventricular and supraventricular arrhythmias by electrocardiographic monitoring over 24 hours and found a much higher prevalence of 35% [31].

Other atherosclerotic complications

- **Hypertension**

In our study, the prevalence of arterial hypertension defined as a complication of chronic renal failure was 17.2%. Many studies report a higher prevalence of hypertension in patients with CKD. This could be explained by the more structured methodology of our study, which enabled us to distinguish between the concepts of the culprit kidney (this study), the victim kidney (where it is the TAH that leads to renal dysfunction) and the control kidney (where the kidneys are neither the cause of the TAH nor the victims of the TAH).

- **Obliterative arteriopathy of the lower limbs**

Its prevalence was low in our study (4.7%), contrary to what is reported in the literature [21,32,33]. This could be explained by our diagnostic method based on IPS which, using only a standard electronic blood pressure monitor not coupled to the Doppler, is not very sensitive in CKD patients with hypervolaemia and oedema of the lower limbs.

- **Cerebrovascular accident**

The incidence of stroke as a cardiovascular complication

in CKD was 1.6% in our study. This low prevalence, contrary to what is reported in the literature [21,22], could be explained by several reasons, in particular our methodology (see operational definition of stroke as a cardiovascular complication in CKD; the framework of the study did not take into account the neurology department, which receives almost all cases of stroke at CHUD B/A).

Factors associated with the existence of at least one cardiovascular complication

In univariate analysis, as in this study, the stage of CKD was also found by Halle et al 20 to be a factor statistically associated with the existence of cardiovascular complications in CKD patients (p=0.022). Progressive decline in renal function is associated with a significantly increased risk of cardiovascular events, such that CKD itself is now considered an independent risk factor for CVD [34,35]. This study identified other non-traditional factors such as hyperuraemia, anaemia, abnormalities in phosphocalcium metabolism (hypocalcaemia, hyperphosphaemia) and positive CRP as factors associated with the presence of at least one cardiovascular complication ($p<0.05$), thus corroborating the data in the literature5. In addition to these factors, non-compliance with treatment was also statistically associated with the occurrence of cardiovascular complications. However, traditional factors such as age, sex, history of hypertension, excess weight and dyslipidaemia were not significantly associated with the presence of complications. In the multivariate model adjusted for excess weight, hyperuraemia was the potential factor statistically associated with the presence of at least one cardiovascular complication in CKD patients (OR= 62.92; 95% CI = [3.121271.05]; p= 0.007). Hyperuraemia is a complication of CKD. The accumulation of uraemic toxins is correlated with a rapid progression of cardiovascular diseases such as congestive heart failure and vascular calcifications in patients with CKD [36].

Conclusion

The prevalence of cardiovascular complications in patients with chronic kidney disease is high. These complications are dominated by left ventricular hypertrophy and heart failure. Several factors are associated with these complications. Adequate control of these factors will be important in reducing the mortality attributable to them in patients with advanced stages of CKD.

Abbreviations

CKD chronic kidney disease

CVD cardiovascular disease

CVEs cardiovascular events

LVH left ventricular hypertrophy

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Author contributions

SA, SMD, GVVG, EE, GZ and JV developed the research protocol. GVVG, A V, EE, NH, AM, JG collected the data under the supervision of SA, JVI and LHC The data were analysed by SA, JV, AV, AM and JG. The 1st version of the article was written by SA, GZ and LHC . All co-authors contributed to the finalisation of the article..

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Availability of data and materials

The data that support the fndings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Technical Medical Committee of the Departmental University Hospital of Borgou/Alibori in Parakou (Benin). It also received the approval of the Local Ethics Committee for Biomedical Research of the University of Parakou (CLERB-UP). The anonymity and confidentiality of the data collected complied with the ethical principles applicable to medical research on human subjects contained in the Declaration of the World Medical Association of Helsinki .

Consent for publication

All authors of the above mentioned manuscript give consent for publication and they confirm that the results presented in this paper have not been published previously in whole or in part, except in abstract form..

Competing interests

These are the results of a study of cardiovascular complications in patients with chronic kidney disease at the departmental university hospital of Borgou/Alibori (Benin). The authors declare that they have no links of interest.

The authors declare that they have no competing interests.

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