

# Factors Associated with Poor Blood Pressure Control in Patients with Advanced Chronic Kidney Disease at the Borgou Departmental Teaching Hospital (Benin)

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## Abstract

**Background:** This study aimed to investigate factors associated with poor blood pressure control in patients with advanced chronic kidney disease (CKD) managed at the nephrology department of the departmental teaching hospital of Borgou (CHUD-B) in Benin in 2023. **Methods:** We conducted a longitudinal follow-up study involving patients with advanced CKD admitted to the nephrology department of CHUD-B from January 1, 2021, to September 30, 2023. The follow-up period was 12 months. Sampling was exhaustive. CKD was classified according to the KDIGO 2012 criteria, while hypertension and its progression were assessed based on the KDIGO 2021 criteria. Factors associated with poor blood pressure control were identified using logistic regression analysis, with statistical significance set at  $p < 0.05$ . **Results:** Among the 146 patients included, 106 (72.6%) had hypertension. Systolic-diastolic hypertension was most common (75.5%), and Grade 1 hypertension was predominant (38.7%). Patients were followed for at least six months; blood pressure targets were achieved in half of the hypertensive patients, mostly within six months. Angiotensin-converting enzyme inhibitors (ACEis) are the most prescribed antihypertensive drugs. In the multivariate analysis, potassium supplementation ( $p = 0.02$ ), poor treatment adherence ( $p = 0.012$ ), and missed follow-up appointments ( $p = 0.034$ ) were independently associated with poor blood pressure control. Conversely, the use of ACE inhibitors was significantly associated with better control ( $p = 0.043$ ). **Conclusion:** The prognosis of hypertension in advanced CKD depends on management. Adequate management is

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essential, as is the use of new-generation drugs.

## Keywords

Hypertension, CKD, Blood Pressure Control, Poor Prognosis, Benin

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## 1. Introduction

Hypertension affects more than 25% of the adult population worldwide, and its prevalence increases with age, making it the leading cause of cardiovascular mortality worldwide [1] [2]. Sub-Saharan Africa, including Benin, is not spared from this growing burden. According to the 2015 WHO STEPS survey, the national prevalence of hypertension in Benin was estimated at 25.9% [3], while a regional study conducted in Parakou in 2016 reported a much higher prevalence of 43.9% [4].

In parallel with the rising incidence of hypertension, chronic kidney disease (CKD) has emerged as a major global public health concern. It was estimated to affect over 843 million people worldwide in 2017 [5]. CKD and hypertension are closely intertwined: hypertension is both a major risk factor for CKD onset and a frequent complication as the disease progresses [6]. In Belgium, for instance, more than 250,000 individuals were living with CKD in 2007, with hypertension being a principal contributing factor [7].

In patients with CKD, hypertension is recognized as a traditional cardiovascular risk factor and can either precede or result from renal dysfunction [8] [9]. It remains a leading cause of CKD in Africa and other low-resource settings [10]. Despite advances in management and the proven benefits of achieving optimal blood pressure control, many patients with hypertension, including those with CKD, remain inadequately controlled [11] [12]. This issue is particularly pronounced in low- and middle-income countries, where access to specialized care and treatment adherence is often limited [11].

In Nigeria, Mamven *et al.* (2022) reported that 74.4% of CKD patients had uncontrolled hypertension [12]. Similarly, other African studies have found poor control rates ranging from 55% to 65% [11]. Multiple factors have been implicated in the poor control of blood pressure in CKD, including advanced age, polypharmacy, insulin resistance, systemic inflammation, oxidative stress, overactivation of the renin-angiotensin-aldosterone system (RAAS) and sympathetic nervous system (SNS), and proteinuria [13]-[15].

To date, no study has investigated the factors associated with poor blood pressure control among patients with advanced CKD in Benin. Given the bidirectional and synergistic relationship between hypertension and CKD, this study aimed to identify the determinants of poor blood pressure control in patients with advanced CKD managed at the Borgou Departmental Teaching Hospital (CHUD-B), Benin, from 2021 to 2023.

## 2. Methods

This was a prospective longitudinal follow-up study involving patients diagnosed with stage 3, 4, or 5 chronic kidney disease (CKD) who were admitted to the Nephrology Department of CHUD-B between January 1, 2021 and December 31, 2023. Data collection was carried out over a thirty-six (36) month period. All patients were reviewed at least once per month and followed for a minimum of 12 months.

The study population included all patients with a confirmed diagnosis of CKD stages 3, 4, or 5 who were regularly followed in the Nephrology Department of CHUD-B during the study period and who provided informed consent. Patients who were undergoing renal replacement therapy, those who did not complete the required diagnostic workup, were lost to follow-up, or had inconsistent monitoring were also excluded.

A non-probabilistic exhaustive sampling method was employed to include all eligible patients who met the inclusion criteria and presented for consultation during the data collection period.

### 2.1. Dependent Variable

The main outcome was the evolution of hypertension in CKD stage 3 - 5 patients. Outcomes were categorized as either favorable or unfavorable.

### 2.2. Outcome Definition

Hypertension was defined as a sustained elevation of blood pressure (BP)  $\geq 140$  mmHg systolic and/or diastolic  $\geq 90$  mmHg [5].

According to the 2021 Kidney Disease: Improving Global Outcomes (KDIGO) guidelines [8], poor blood pressure control was defined as a systolic BP remaining above 120 mmHg despite antihypertensive therapy.

CKD was classified according to the KDIGO 2012 criteria [9]. Advanced CKD staging was based on the estimated glomerular filtration rate (eGFR):

- Stage 3A: mild-to-moderate (eGFR 45 - 59 mL/min/1.73m<sup>2</sup>)
- Stage 3B: moderate-to-severe (eGFR 30 - 44)
- Stage 4: severe (eGFR 15 - 29)
- Stage 5: end-stage (eGFR <15)

### 2.3. Independent Variables

Independent variables included sociodemographic characteristics, lifestyle habits, clinical and paraclinical data, therapeutic regimens, and disease progression indicators.

### 2.4. Data Collection

Data were collected using a structured questionnaire. Clinical interviews and physical examinations were conducted by nephrologists and general practitioners. Renal ultrasounds were performed and interpreted by radiologists. Laboratory investigations were conducted at the Clinical Biology Laboratory of CHUD-B/A.

Blood pressure was measured via a SPENGLER® electronic sphygmomanometer with patients resting in the supine position for at least five minutes. Two to three measurements were taken, alternating between arms at three-minute intervals. The highest BP readings were used for analysis.

## 2.5. Data Analysis

The questionnaire was deployed on the KoBoToolbox platform (Version 1.30.1) and administered via mobile devices. The collected data were exported in Excel format from the KoBoToolbox server and analyzed using EpiInfo software, version 7.2.3.1.

Descriptive statistics were used to summarize the data. Categorical variables were presented as frequencies and proportions, and quantitative variables as means with standard deviations or medians with interquartile ranges, depending on their distribution. Comparative analysis of categorical variables was performed using Pearson's Chi-square test, with a significance level set at  $p < 0.05$ .

For the bivariate analysis, the Odds Ratio (OR) was calculated to assess associations between independent variables and blood pressure control outcomes. Variables with  $p$ -values  $< 0.2$  in the bivariate analysis were included in a multivariate logistic regression model, using a stepwise backward elimination approach. Adjusted Odds Ratios (aOR) with 95% confidence intervals (CI) were calculated to identify independent predictors and estimate the strength of the different associations.

## 2.6. Ethical Considerations

The study was conducted in accordance with ethical principles and good clinical practice guidelines. All the data collected were strictly used for the purposes of this research and remained confidential.

## 3. Results

### 3.1. Prevalence of Hypertension

During the study period, 307 patients were admitted to the nephrology department. Among them, 160 had advanced CKD (stages 3, 4, or 5). A total of 154 patients met the inclusion criteria; after eight patients were excluded, 146 were retained for analysis, resulting in a participation rate of 91.2%.

Among these 146 patients, 106 were diagnosed with hypertension, representing a prevalence of 72.6%.

### 3.2. Characteristics of Hypertension

Among these hypertensive patients, the most common pattern was systolic-diastolic hypertension, which was observed in 75.5% of the patients. Isolated systolic hypertension accounted for 18.9%, whereas isolated diastolic hypertension was noted in 5.6% of patients. In terms of the severity of hypertension, Grade 1 hypertension was the most common hypertension, present in 38.7% of cases, followed

by Grade 2 hypertension in 34.0% and Grade 3 hypertension in 27.3% of cases.

The mean arterial pressure among hypertensive patients was 161.2/100.3 mmHg (range: 120 - 230 mmHg). The mean systolic BP was (149.8 ± 28.1) mmHg, and the mean diastolic BP was (92.5 ± 19.4) mmHg.

### 3.3. Chronic Kidney Disease Characteristics

With respect to CKD staging, 16.0% of hypertensive patients were classified as stage 3, 25.6% as stage 4, and 58.4% as stage 5. In terms of etiology, chronic vascular nephropathy was the predominant cause, which was observed in 72.6% of cases. Diabetic nephropathy accounted for 19.8% of patients, and other forms of chronic glomerular nephropathy were identified in 28.3% of patients. Some patients present with overlapping etiologies.

### 3.4. Sociodemographic Characteristics

The mean age of the hypertensive patients was (54.9 ± 15.3) years, with ages ranging from 13 - 86 years. There was a marked male predominance (69.8%), corresponding to a sex ratio of 2.3. In terms of socioeconomic and occupational status, artisans and manual workers represented 20.5% of the sample, whereas housewives accounted for 19.8%. The majority (85.8%) belonged to a middle-income group.

### 3.5. Paraclinical Data

Blood tests revealed 92.4% hyperuraemia, 100% hypercreatininaemia, 38.6% hyponatremia, 19.8% hypokalaemia, 7.5% hyperkalaemia, 43.3% hypocalcaemia, and 33.9% hyperphosphatemia. Total hypercholesterolaemia, HDL hypercholesterolaemia, LDL hypercholesterolaemia, and hypertriglyceridaemia were found in 16%, 31.1%, 29.2% and 30.1%, respectively. ASAT and ALAT transaminases were elevated in 9.4% and 8.4% of patients, respectively. Haemoglobin levels below 10 g/dl were found in 56.6% of cases.

Urine dipstick tests revealed trace albuminuria in 12 patients (11.3%), moderate albuminuria in 40 (37.7%), severe albuminuria in 42 (39.6%), and very severe albuminuria in 12 (11.3%). The other parameters found were leukocyturia in 32 patients (33.9%), glucosuria in eight (7%), and haemoglobinuria in four (3.7%).

### 3.6. Therapeutic Characteristics

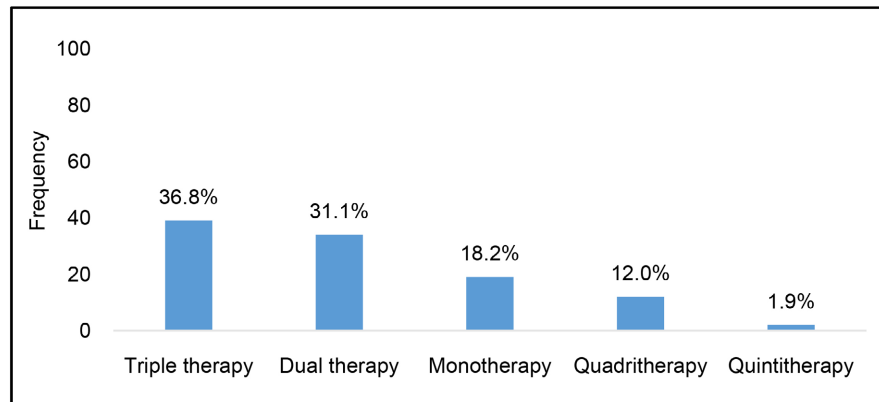
All patients received nonpharmacological management, which included dietary modifications such as salt and fat restriction, smoking cessation, self-medication avoidance, and excessive use of traditional remedies. With respect to pharmacological therapy, calcium channel blockers were the most frequently prescribed agents (26.9%), followed by diuretics (23%) and angiotensin-converting enzyme inhibitors (ACE inhibitors) (20.5%).

Most patients were managed with combination therapy: 36.7% received triple therapy, and 31.1% were on dual therapy. The most common combinations were

calcium channel blockers with angiotensin receptor blockers (33.3%), calcium channel blockers with ACE inhibitors (27.2%), and triple combinations of diuretics, ACE inhibitors, and calcium channel blockers (45%).

### 3.7. Follow-Up and Blood Pressure Control

All 106 hypertensive patients were followed for a minimum of six months. (**Figure 1**)



**Figure 1.** Distribution of anti-HTN treatment in patients with chronic renal failure and hypertension (N = 106).

Among them, target blood pressure was achieved in 53 patients. For the majority of these patients, control was attained within six months, representing 94.1% of those who achieved the target.

These patients were predominantly treated with calcium channel blockers (73.3%) and ACE inhibitors (66.6%) (**Table 1**). Additionally, all of them demonstrated good adherence to both pharmacological treatment and scheduled follow-up visits.

**Table 1.** Distribution of hypertensive patients with advanced chronic kidney disease according to the achievement of the blood pressure target in the nephrology department of CHUD/B from 2021 to 2023, based on antihypertensive treatment, therapeutic adherence, and appointment follow-up (January 1, 2021-September 30, 2023; N = 53).

	Target Achieved (N = 53)	Not Achieved (N = 53)
<b>Antihypertensives</b>		
ACE Inhibitor	90.5%	11.3%
ARB	5.6%	49.0%
Calcium Channel Blocker	79.2%	75.4%
Diuretic	69.8%	45.2%
Beta-blocker	20.7%	9.4%
Central	15.0%	20.7%
<b>Good Medication Adherence</b>	100%	24.5%
<b>Regular Follow-Up Attendance</b>	100%	24.5%

ACE: Angiotensin-Converting Enzyme; ARB: Angiotensin II Receptor Blockers.

### 3.8. Factors Associated with Poor BP Control

Multivariate analysis revealed that potassium supplementation ( $p = 0.02$ ), poor therapeutic adherence ( $p = 0.034$ ), and missed appointments ( $p = 0.012$ ) were independent risk factors for poor blood pressure control. Conversely, the use of ACE inhibitors was found to be a protective factor that was significantly associated with better hypertension outcomes ( $p = 0.043$ ) (Table 2).

**Table 2.** Factors associated with unfavorable outcomes of arterial hypertension in patients with advanced chronic kidney disease in the nephrology department of CHUD/B from 2021 to 2023.

	aOR	[95% CI]	p
<b>Potassium Supplementation</b>			
No	1	-	-
Yes	2.59	1.09 - 6.22	0.02
<b>Angiotensin-Converting Enzyme Inhibitor</b>			
No	1	-	-
Yes	0.007	0.001 - 0.858	0.043
<b>Appointment Adherence</b>			
Yes	1	-	-
No	1567.1	5.11 - 480 227.1	0.012
<b>Therapeutic Adherence</b>			
Yes	1	-	-
No	64.05	1.35 - 3025.35	0.034

## 4. Discussion

### 4.1. Bias and Limitations of the Study

The study was conducted in a single tertiary center, which may limit the generalizability of the findings. The use of an exhaustive, non-probabilistic sampling method may have introduced selection bias, as patients followed in specialized nephrology care may not reflect the broader CKD population.

The cross-sectional design does not allow for causal inference between the identified factors and poor blood pressure control. In addition, the absence of funding and limited technical resources restricted access to some complementary tests, leading to a reduced sample size. These factors may have limited the identification of additional associations.

Despite these limitations, the study provides relevant data on blood pressure control among advanced CKD patients in a low-resource setting.

### 4.2. Prevalence of Hypertension

In our study, 72.6% of the 106 patients had arterial hypertension. This finding is

consistent with previous reports. For instance, Ahoui *et al.* found a prevalence of 68.8% in Parakou, Benin, in 2019 [16]. Bouricha *et al.* reported 79.9% in Algeria in 2018 [17] while Sinomono *et al.* in Congo found a frequency of 67.6% [18]. Similarly, in Côte d'Ivoire, Tia *et al.* reported in 2020 that 69% of patients with advanced CKD also had hypertension [19], corroborating our findings.

In contrast, Degoga *et al.* in Mali reported a lower prevalence of 61% in 2020 [20]. This discrepancy may be attributed to the differences in study design, as Degoga *et al.* focused specifically on patients aged 65 years and older, whereas our study included patients of all ages.

### 4.3. Blood Pressure Control and Evolution

Among the 106 patients diagnosed with advanced hypertension and CKD, blood pressure target was achieved after six months in 50 people, corresponding to 94.1%. These results are in line with those of Hyeok-Hee *et al.* in South Korea in 2022, who reported a substantial proportion, estimated at over 10%, of patients achieving their blood pressure target [21].

Despite this, the majority of our patients had poor control even using a less stringent target than that recommended in some international guidelines [5] [8]. This suggests that most patients remain at high risk of developing hypertension-related morbidity and mortality. Hypertension is a major risk factor for the progression of CKD to end-stage kidney disease (ESKD) and the development of cardiovascular diseases. Previous studies have established the beneficial effects of lowering blood pressure in CKD patients on their cardiovascular and renal outcomes as well as overall mortality [12] [15].

In our cohort, patients who achieved their blood pressure goal were predominantly treated with calcium channel blockers and ACE inhibitors. This was not the case for patients whose blood pressure target was not achieved. This supports evidence from the literature recommending renin-angiotensin system (RAS) blockers—particularly ACE inhibitors—combined with calcium channel blockers and diuretics as first-line therapy in CKD patients [8].

### 4.4. Factors Associated with Poor Blood Pressure Control

In our study, potassium supplementation was identified as a significant risk factor for poor blood pressure control ( $p = 0.02$ ). High dietary potassium intake may lead to elevated serum potassium levels, which could, in turn, affect blood pressure regulation. In China, Lu *et al.* (2013) reported that elevated serum potassium levels may increase the risk of hypertension, independent of renal function [13]. Conversely, Filippini *et al.* (2016) in Italy reported that moderate long-term potassium supplementation may lower blood pressure in hypertensive individuals, especially those with high sodium intake and not on antihypertensive treatment [14]. Given that our patients were receiving pharmacological therapy and dietary counseling, these discrepancies could reflect contextual and population differences.

According to our series of studies, the administration of ACE inhibitors was a protective factor against the worsening of hypertension in patients with advanced chronic kidney disease. This aligns with current recommendations, which emphasize the role of RAS blockers in managing hypertension in patients with advanced CKD [8].

Finally, other factors may influence the unfavourable evolution, such as insulin resistance, systemic inflammation, excessive oxidative stress, and excessive activation of the RAAS and sympathetic nervous systems (SNS) [6]. Unfortunately, we were unable to determine these factors in our study due to a lack of technical facilities.

## 5. Conclusion

Hypertension and advanced chronic kidney disease (CKD) are two pathophysiological entities that are intrinsically linked—each potentially aggravating the other. In patients with advanced CKD, hypertension is often difficult to control and frequently follows an unfavorable course. Achieving adequate blood pressure control in this population requires regular monitoring, strict adherence to therapy, and appropriate pharmacological management.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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