

# Prevalence and Characteristics of Hypertension among CKD Patients in Sudan: A Systematic Review and Meta-analysis

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## ABSTRACT

The rate of chronic kidney diseases (CKD) is increasing steadily in Sudan, and hypertension remains one of the most common coexisting conditions among the patients. In this meta-analysis, we aimed to answer the review question (what is the prevalence of hypertension among patients with advanced CKD in Sudan?). We applied a guidelines checklist for the literature search about the (PRISMA-P 2015). We searched Google Scholar, PubMed, Cochrane Library, Embase, and Medline electronic databases for all articles on CKD conducted in Sudan. Eventually, we identified 23 studies, and only eight were included in the final meta-analysis. Out of the eight articles, there is a total sample of 2682 patients who were presented and diagnosed with advanced stage CKD; among them, 864 were found to be hypertensive, and the overall pooled prevalent rate of hypertension was 32% (95% CI 25% to 39%) with 91% heterogeneity. The lowest rate of hypertension among patients diagnosed with CKD was falling in the range of (14%-21%). We assessed the heterogeneity among studies using the I<sup>2</sup>, T<sup>2</sup>, and Q statistics. The results showed a funnel plot with asymmetrical distribution for effect sizes. The literature and evidence-based data on CKD in Sudan are scarce. However, the eight studies reviewed revealed elevated odds of CKD among patients with hypertension. The burden of the increased rate of CKD associated with prevalent hypertension and DM is a call for authorities for urgent interventional response.

**KEYWORDS:** CKD; Dialysis; End-Stage Renal Disease; Hypertension; Renal Failure; Sudan.

## INTRODUCTION

A total number of 1.28 billion adults were identified to have hypertension, with a blood pressure of more than or equal to 140/90 mmHg. Low- and middle-income countries represented two-thirds of them<sup>1</sup>. This international rising prevalence of hypertension is owing to the aging of the population and increases in exposure to lifestyle risk factors including unhealthy diet and lack of physical activity. In addition to the high prevalence of hypertension in low and middle-income countries, the level of awareness, preventive measures, and control are also low. Epidemiological studies have shown several variations and heterogeneity in the prevalence of hypertension resulting from the difference in the rates of the coexisting risk factors, such as excess sodium and low potassium intake, unhealthy diet, obesity, and poor physical activity<sup>2,3</sup>. Chronic kidney disease (CKD) is when the kidneys fail to filter blood physiologically, accumulating excess fluid and waste. It has a high mortality and morbidity, causing a global health burden. CKD is a progressive health problem affecting

more than ten percent of the general population worldwide. It is more prevalent among patients with hypertension and diabetes, representing a significant burden on resources and economic revenues. Currently, CKD emerges as one of the global leading causes of mortality, showing an increase in associated deaths over the past twenty years<sup>4,5</sup>. CKD is associated with a wide range of different physiological disorders of abnormal renal function and progressive decline in glomerular filtration rate (GFR) reaching less than 60 mL/min/1.73 m<sup>2</sup> for three months, reaching a state of kidney damage, loss of function, and ultimately result in the need for renal replacement therapy (dialysis or transplantation). CKD comprises five scales of kidney damage ranging from mild kidney dysfunction to complete kidney failure; in a milder form, CKD is a normal eGFR of 90 mL/min/1.73 m<sup>2</sup> or greater with mild damage to the kidneys, while in the severe form of CKD, the eGFR is less than 15 mL/min/1.73 m<sup>2</sup> accompanied with severe renal damage to kidneys failure or nearly failure, and the only treatment options to survive include dialysis or a kidney transplant. Patients with stages 3 or 4 CKD are at much higher risk of progressing to either end-stage renal disease (ESRD) or death even before the development of ESRD<sup>6-8</sup>. CKD affects 8% to 16% of the population worldwide and is ranked the 16th leading cause of years of life lost worldwide<sup>9,10</sup>. Hypertension and diabetes are the traditional major risk factors for CKD. The rate of change in blood pressure (each 10 mmHg increase per year for

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systolic blood pressure per year) was found to have significant associations with CKD. The high burden of hypertension and diabetes in low- and middle-income countries is responsible for the increase in the rate of CKD. These complex clinical health problems require standard medical care involving aggressive monitoring for signs of disease progression and early referral to nephrologists for dialysis or renal transplant. However, it still carries a significant cause of reduced quality of life and premature mortality<sup>11,12</sup>.

In Sudan, several health challenges influence the health care system, such as non-communicable diseases, including renal diseases, which were reported at increasing rates all over the Country, contributing to multimorbidity aggravated by multifactor of poverty, geopolitics, mismanagement, and armed conflicts<sup>13</sup>. The current prevalence of hypertension in Sudan is 27.6%, with predominantly male sex and increasing age<sup>14</sup>. When elevated blood pressure is left untreated, it will result in end-organ damage, renal failure, and increased morbidity and mortality. In Sudan, ESRF is progressively growing and becoming one of the significant health problems. Moreover, ESRF economically affects the most productive age group in the population, leading to a high unemployment rate among patients. Hypertension is found as the leading cause of ESRF, followed by diabetes mellitus and glomerulonephritis<sup>15</sup>.

**METHODOLOGY**

We searched electronic databases, including Google Scholar, Cochrane, PubMed, and Embase, with the search strategy shown in (Figure I), for all studies conducted in Sudan (Table I).

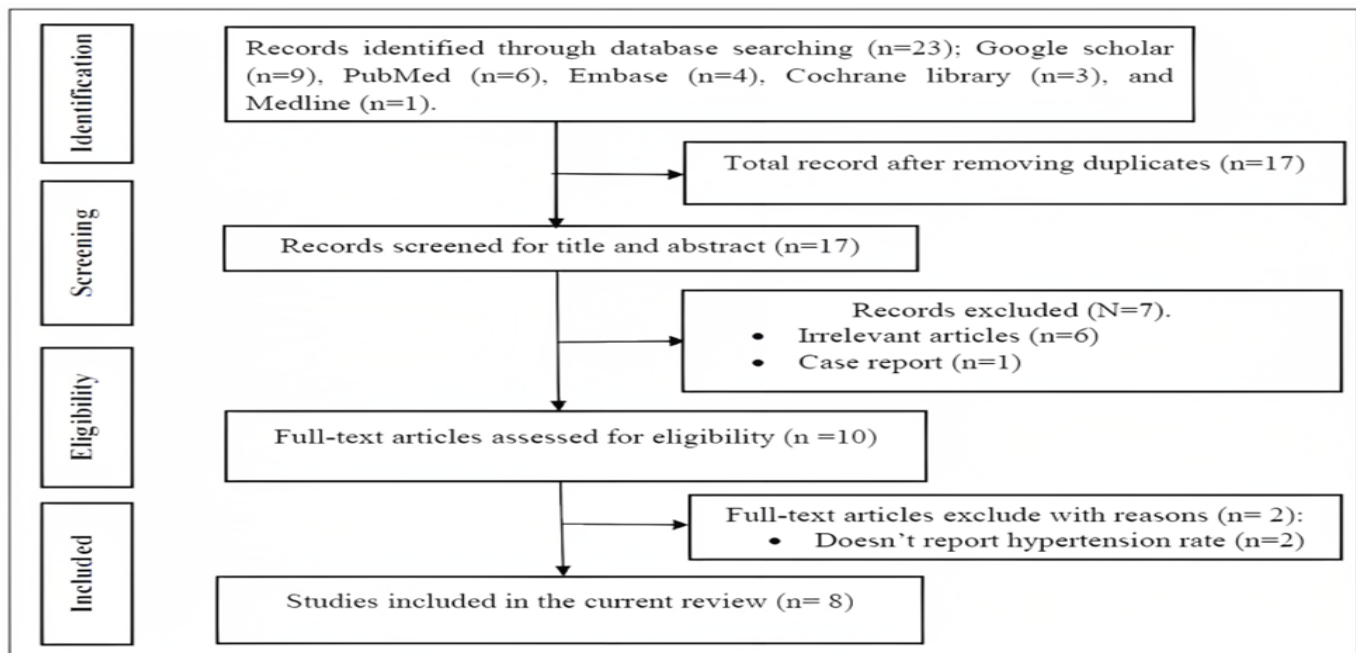
Our search strategy followed the Preferred Reporting

Items for Systematic Review and Meta-Analysis for Protocols 2015 (PRISMA-P 2015). Due to the limited evidence-based data and scarce literature on this topic in Sudan, we used open inclusion-exclusion criteria. We included all studies on advanced CKD with renal failure conducted in the Country. Our method applied the random-effects model (REML) to estimate the pooled effect size with 95% CI. We additionally used Forest plots to visualize heterogeneity among the reviewed studies, reporting all the essential homogeneity tests: T<sup>2</sup>, Cochran's Q, H<sup>2</sup> and I<sup>2</sup> test (Figure III). At the same time, the publication bias was assessed by funnel plots and Egger's statistics (Figure IV).

**Table I: Summary of hypertension among patients with CKD in Sudan**

Author	Location	Year	Study design	Sample size
Amin Banaga et al.	Khartoum State	2014	Cross-sectional	1583 patients
E. M. Osman et al.	Khartoum State	1987	Cohort retrospective	61 patients
Mohamed Elhafiz et al.	All over Sudan	2009	Cross-sectional	224 patients
H Abu-Aisha et al.	Khartoum State	2009	Cross-sectional	30 patients
Mazin Shigidi et al.	Khartoum State	2018	Cohort retrospective	244 patients
Arabi, Khalafalla et al.	Gezira Region	2021	Cohort retrospective	240 patients
Alkhair Idris et al.	Khartoum State	2022	Cross-sectional	100 patients
Abdelsamee N. Elamin et al.	Khartoum State	2012	Cohort prospective	100 patients

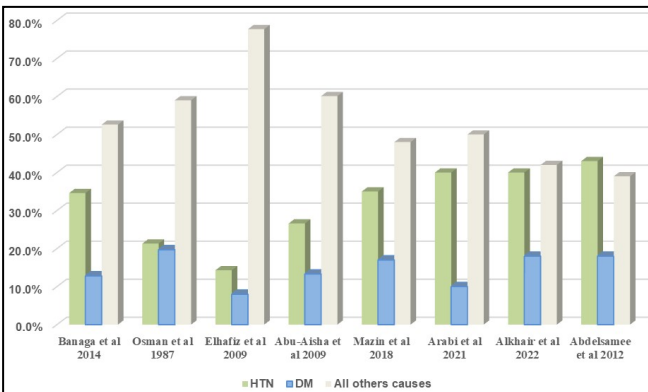
**Figure I: PRISMA flow diagram search strategy and included studies**



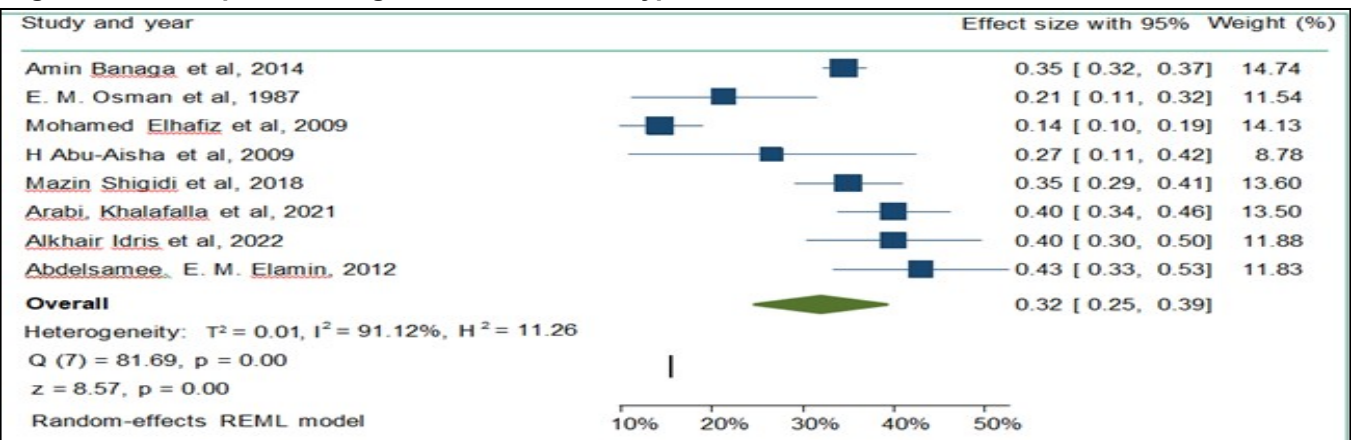
**RESULTS**

Out of the eight articles that meet the exact inclusion and exclusion criteria, 2(25%) were old studies conducted more than 30 years back, 2(25%) 10-15 years ago, and the remaining 4(50%) were conducted and published recently. Studies have a total sample of 2682 patients who were presented and diagnosed with CKD; among them, 864 were found to be hypertensive based on medical history and clinical examination. The overall pooled prevalent rate of hypertension was 32% (95% CI 25% to 39%) with 91% heterogeneity (**Figure III**). Other major causes of CKD, including glomerulonephritis, were grouped (**Figure II**). The lower rate of hypertension among patients diagnosed with CKD was falling in the range of (14% to 21%) reported in two old studies. In comparison, higher rates (35% to 43%) were reported in five recent studies, and the eighth study had an average rate of (27%). Heterogeneity among studies was assessed using the I2, T2, I<sup>2</sup> and Q statistics. The results showed a funnel plot with asymmetrical distribution for effect sizes. However, the regression-based Egger test showed non-significant publication bias with a p-value of 0.86. All the statistical analyses were conducted using Stata statistical software.

**Figure II: Common causes of advanced CKD in Sudan**

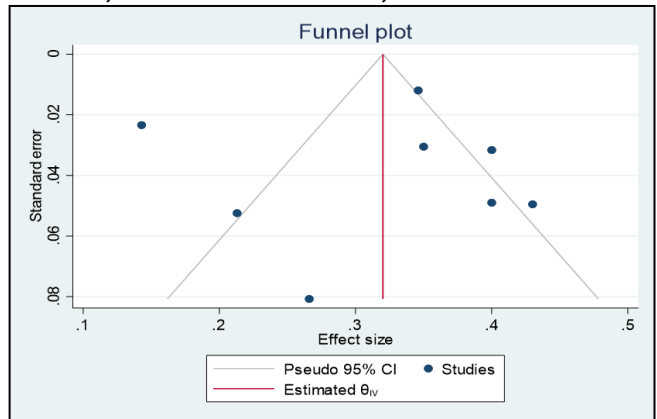


**Figure III: Forest plot showing the effect sizes of hypertension on CKD**



\* $T^2$ , Cochran's  $Q$ ,  $H^2$ , and  $I^2$  are the essential Forest plot tests that describe variation across studies.  $I^2$  value of 91% represents substantial heterogeneity

**Figure IV: Funnel plot publication bias for eight studies, estimated effect size, and 95% CI**



**DISCUSSION**

This study is a systematic review and meta-analysis conducted to identify the prevalence of hypertension and other common determinants among patients diagnosed with advanced CKD in Sudan. The reviewed and analyzed studies were obtained from a literature search using different electronic databases on all studies conducted in Sudan. Minimal data about the common risk factors leading to advanced CKD in Sudan were found. However, the available studies and accessible data have reported hypertension as the leading cause of CKD. Some studies conducted in Khartoum, the capital of Sudan, and others in the central region of the Country have reported only one-fifth of the total hypertensive patients in Sudan have controlled blood pressure and revealed that uncontrolled blood pressure was found to be the leading cause of ESRD in Sudan<sup>16</sup>. With the increased prevalence of CKD in Sudan, all reviewed studies indicated the presence of a high rate of hypertension among those patients. Some previous studies show a high magnitude of hypertension among patients with CKD reaching 43% (90% CI 33%

- 52%) reported in one study and 40% (90% CI 30% - 50%) in two studies<sup>17,18</sup>, with a pooled magnitude of 30% (95% CI 23% - 38%). These findings are higher than results reported in a large cohort retrospective study conducted on patients from Colorado registry in the United States in an extensive community-based registry of patients with CKD and hypertension, which reported an association of hypertension with the rapid decline of kidney function in a rate of (12.1%) in CKD patients<sup>19</sup>.

Despite the progressive increase in the rates of hypertension associated with CKD in Sudan, surprisingly, the odds of hypertensive patients developing CKD reported in one old study in Khartoum, Sudan, revealed patients with advanced CKD had hypertension (19%). The study's findings at that time were reported as low incidence compared with findings within African studies<sup>20</sup>. In Sudan, the limited availability and accessibility of primary health care might hide a large number of hypertensive patients with a risk of developing end-organ damage, in addition to the low awareness about hypertension in the community, and all these factors carry together a fatal risk. Accordingly, one of the studies in Sudan reported a higher rate of more than (40%) of patients diagnosed with advanced CKD being hypertensive. In addition to the high prevalence of hypertension among people diagnosed with CKD, the study revealed only a small number of patients aware of their elevated blood pressure status; few of them were on antihypertensive medication, and none of them had controlled blood pressure<sup>21</sup>. Evidence from most of the reviewed studies identified hypertension and diabetes as the leading determinants of CKD, except two studies by Elsharif ME 2011<sup>16</sup> and Osman EM 1987<sup>20</sup> reported glomerulonephritis as the first determinant. At the same time, Shigidi M 2021<sup>22</sup> reported patients with CKD were referred late and mostly with long-standing hypertension who had adhered poorly to therapy and did not follow up regularly. These late referrals are shown to be associated with reduced survival on dialysis and less chance of having a kidney transplant. In support of our results, a similar finding in the region revealed that hypertension and diabetes are the main determinants significantly associated with CKD<sup>5</sup>.

In Sudan, hypertension is rated as the significant non-communicable preventable disease that causes ESRD, resulting in a considerable burden on the population. The Country has witnessed the expansion of renal services in the last decade in the capital and regional hospitals. Yet, the deficit in health services and the demand for transplantation services is even higher. Advanced CKD is becoming a major national health problem that carries a significant socioeconomic cost at both individual levels and the government health system<sup>23</sup>. Hussain AA 1999<sup>24</sup> claim that hypertension was found to be one of the significant causes of morbidity and mortality and detected stage 2 and stage 3 target organ involvement, particularly albuminuria, occurred in

about one-third of the patients. Although hypertension has long been recognized as a significant risk factor for kidney diseases, besides a multitude of new pharmacological agents in Sudan, a substantial proportion of hypertensive patient's blood pressure remains uncontrolled. However, lifestyle changes and medication adherence remain primary preventive measures in controlling HTN. Moreover, novel approaches are needed to help motivate patients diagnosed with hypertension and apply their knowledge regarding therapeutic lifestyle changes (TLC)<sup>25,26</sup>. Overall, we have observed a strong association between hypertension and advanced CKD, and our findings have significant implications for public health.

## CONCLUSION

The results of this study showed that high blood pressure carries a great risk for high morbidity and mortality as a silent killer and a cause of advanced CKD. An extensive database study is recommended to better understand this complex public health problem. The increasing number of affected individuals with high blood pressure and its implications in advanced CKD should prompt national efforts for proper preventive measures and management.

## LIMITATION

One of the significant limitations of our review was the small number of studies included in the meta-analysis; another major limitation is the large variability among the eight studies, mainly in the variant number of their sample sizes. Furthermore, the review in seven studies consists solely of observational cross-sectional and retrospective designs, subjecting the review to all the limitations of this type of design. Furthermore, excluding studies published in non-English languages might have impacted the richness of the data analyzed in the review, increasing the risk of publication bias.

**Conflict of Interest:** The authors have no conflict of interest to declare

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**Data Sharing Statement:** The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publically.

## AUTHOR CONTRIBUTION

Ahmed GY: Original draft preparation, writing, review, editing, methodology, data curation, validation and formal analysis

Osman AA: Methodology, data curation

Ali AA: Methodology

Basheer AA: Methodology

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