IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 7 Ser. 11 (July. 2024), PP 15-22
www.iosrjournals.org

Pattern of Kidney Disease among Adult Hypertensive patients attending cardiac clinics in Dar es Salaam, Tanzania

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Abstract
Background*: Hypertension is a worldwide public health challenge. Over the years it has become one of the leading cause of kidney disease. This is due to closely interlinked pathophysiological states such that sustained hypertension impairs kidney function. Progressive decline in kidney function conversely leads to worsening hypertension. Early detection of indicators of kidney disease among hypertensive individuals and timely preventive intervention are the key strategies to prevent development of kidney disease among hypertensive patients.*
Objective*: The aim of this study was to determine the pattern of kidney disease among adult hypertensive patients in Dar es Salaam.*
Method*: A descriptive cross-sectional study was conducted. Questionnaires were applied for social-demographic data. Blood pressure, body weight and height were measured using standardized methods. Blood sample was collected to measure serum creatinine and estimated GFR using CKD EPI2021, while urine was collected for biochemical analysis, dipstick method and albumin creatinine ratio.*
Results*: A total of 400 hypertensive patients were enrolled in this study, 287 (72%) were females; 249(62%) had primary education, 232(58%) were unemployed, 240 (60%) had history of hypertension less than 10 years, 346(86.5%) had no history of alcohol consumption and 380(95%) had no history of cigarette smoking. Furthermore 240(60%) and 211(52.8%) had a blood pressure of ≥140 mmHg for systolic and ≥90 mmHg for diastolic respectively. BMI of ≥25kg/m^2 was found among 236(59%). Reduced eGFR (<60Ml/Min/1.73M ^{2}) and micro albuminuria were observed among 119 (30%) and 179(61.5%) respectively.*
Conclusion: *Acute Kidney Injury, Nephrotic Syndrome and End Stage Renal Disease were found to be the main kidney diseases among hypertensive patients, while higher systolic blood pressure, advanced age, long standing hypertension and unemployment being significant risk factors for decreased eGFR.*
Keywords: *Kidney disease, Hypertensive patients, Cardiac clinics*

Date of Submission: 18-07-2024 Date of Acceptance: 28-07-2024

I. Introduction

Hypertension is a global public health challenge. An estimated 1.28 billion adults aged 30-79 years globally have hypertension and most of them are reported from developing countries[1]. WHO reported the prevalence of hypertension among adult aged over 25 years being 27% and 18% in Africa and America respectively. In Tanzania, previous studies showed increasing prevalence of hypertension in different rural and urban populations: from 2-10% in 1960's to 13-79% in 2016, whereby alcohol, obesity and cigarette smoking were the most reported risk factors [6]. Studies in Arusha and Morogoro (regions of Tanzania) have documented that 25.7% and 45% of adults are hypertensive respectively, and odds of being hypertensive were increased with male gender, old age > 60 years, and obesity [7,8]. Study from Muhimbili National Hospital reported the prevalence of hypertensive emergency and hypertensive urgency being 68% and 32% [10] respectively.

Over the years hypertension has been reported to be one of the leading causes of kidney disease worldwide. For instance, disability adjusted life years (DALY) has shown a rising trend of numbers and rate of CKD due to hypertension from 1990 to 2019[14]. In Tanzania, a study done in Dodoma revealed that 43.8% of hypertensive patients had CKD[15]. In northwest of Tanzania it was reported that the prevalence of renal dysfunction among hypertensive patients was 53.9%. It was further reported that older age, female gender, obesity and high systolic blood pressure were the predictors of renal dysfunction.

Despite the fact that hypertension is an important cause of kidney disease, currently there is limited data explaining the pattern of kidney disease due to hypertension in Tanzania. Since, treating people with hypertension related kidney diseases imposes heavy financial burden on healthcare budgets worldwide[8,25,26,27,28] this study

emphasize on early kidney disease screening and comprehensive care at cardiac clinics as it will have beneficial impact on hypertension control and management of kidney disease.

II. Methods

Study design and setting

A descriptive cross-sectional study was conducted among hypertensive adult patients at cardiac clinics in Dar es Salaam over a period of six months.

Sampling technique

Multi-stage cluster sampling was employed in selecting cardiac clinics: Stage 1, listing of all cardiac clinics found in Dar-es-Salaam, where by one group comprised public cardiac clinics and the other group private cardiac clinics. Public hospitals were selected by simple random sampling. Stage 2, was formation of three sub-groups based on level of health care of public hospitals which included tertiary level, Regional Referral Hospitals and district hospitals levels. From these sub-groups, the regional referral hospitals level was selected by simple random sampling. Study participants were selected using simple random sampling from selected cardiac clinics.

Data Collection

Questionnaires were administered for social demographic information while anthropometric parameters were obtained using standardized methods. Serum creatinine was measured and GFR estimated using CKD EPI 2021 equation .Urine was measured using dipstick analysis and Mindray BS 240 chemical analyzer.

Blood pressure was measured using aneroid sphygmomanometer (China made). Two consecutive readings were taken from each patients at 5 min interval and the average taken as mean BP. Hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg and diastolic blood pressure (DBP) ≥90 mmHg (WHO guidelines 2021). Weight (to the nearest 0.5 kg) and height (to the nearest 0.5cm) were measured using a standardized weighing scale (RGZ-160 from Changzhou China) and body mass index (BMI) calculated using the formula: Weight (kg)/height (m^2) (WHO recommendation of adult BMI).

Blood Test: Venous blood (3 ml) was taken from cubital vein into a test tube and allowed to stand undisturbed for 10 min. Then centrifuging at 2000 rpm for 15 min to remove clots. The resulting serum was transferred to a clean polypropylene tube. Serum creatinine was determined using Mindray BS- 240 clinical chemistry analyzer Guangdong China. Glomerular filtration rate calculation: CKD-EPI formula (2021 update) was used to calculate eGFR:

GFR = 141 * min (SC r/κ1)α * max(SC r/κ, 1)-1.209 * 0.993Age * 1.018 [if female] * 1.159 [if black]

Using National Kidney Foundation guideline (2013), kidney disease was taken to be present at eGFR < 60ml/min/1.73 m^2 and mild impairment of kidney function at eGFR ≥ 60ml/ml/1.73 m^2 and absent of kidney disease at eGFR>90ml/min/1.73m^2. Renal function was staged as follows: Stage 1(normal) = GFR>90; Stage 2 (mild to moderate renal impairment, GFR 60-89) and Stage 3-5 (kidney disease, GFR< 60ml/ml/1.73m^2.

Urine Test: Each study participant was given a sterile container to collect a urine sample and a dipstick urinalysis was done within ten minutes of sample collection using urine dipstick Multistix. Urinary dipstick was reported as: Negative to +1 classified as normal to mildly increased albuminuria, 2+ classified as severely increased albuminuria and 3+ to 4+ as nephrotic syndrome. Any patient with a urine dipstick negative for protein underwent further testing of urine for micro albuminuria using Mindray BS -240 clinical chemistry analyzer (Guangdong China). UACR was a method of choice to detect micro albuminuria and: an UACR of <30mg/g meant the normal albumin, an UACR of 30-300mg/g means the patient was having micro albuminuria while an ACR of >300mg/g means the patient was having macro albuminuria.

Pattern of kidney Disease: KDIGO guidelines was used to determine the proportion of patients with AKI. The criteria was based on a comparison with a known baseline SC r, to determine AKI. This baseline 'SCr' was obtained from previous patient medical records. For study participants whose previous serum creatinine were missed, an estimation of a reference baseline SCr was used. This is provided by KDIGO guideline where an estimated baseline is obtained through a back-calculation using the CKD -EPI equation and a glomerular filtration rate (GFR) of 75 mL/min/1.73 m^2. End Stage Renal Failure and nephrotic syndrome were diagnosed based on KIDGO criteria with estimated glomerular filtration rate.

DATA ANALYSIS

SPSS version 20 was used for data entry, cleaning and analysis. T-test and Chi-squared were used for categorical and continuous variables respectively. A p-value of <0.05 was statistically significant.

III. RESULTS

Socio-demographic Status of Study Participants

In this study, 400 study participants were enrolled with a response rate of 100%. Of these, 287(72%) were females. Of the study participants majority had primary education 249(62%), 232(58%) had no any employment. Majority of study participants 240 (60%) had history of hypertension for less than 10years. It was further observed that 54(13.5%) and 20(5%) had history of alcohol consumption and cigarette smoking respectively.

Table 1: Social demographic characteristics of hypertensive patients attending cardiac clinics in Dar es Salaam (N=400)

Variables	Categories	Frequency	Percentages (%)
Age groups (years)	18-39	24	6
	40-64	223	55
	65+	153	38.3
Gender	Male	113	28.2
	Female	287	71.8
Duration since diagnosis of Hypertension (months)	1-11	77	19.3
	12-119	240	60.0
	≥120	83	20.8
Occupation	Permanently Employed	13	3.3
	Non-Employed	232	58
	Self Employed	155	38.8
Level of education	Informal Education	**73**	**18**
	Primary	249	62
	Secondary	59	14.8
	College	15	3.8
	University	4	1
History of alcohol use		54	13.5
History of cigarettes smoking		20	5

Clinical related characteristics

Of 400 study participants, 240(60%) and 211(52.8%) had uncontrolled systolic and diastolic blood pressure respectively, while 204(51%) study participants had excess body weight (BMI≥25kg/m^2). Furthermore, 119(30%) study participants had reduced eGFR, while 179(61.5%) had micro albuminuria.

Table 2: Distribution of clinical parameters for hypertensive patients attending cardiac clinics in Dar es Salaam (N=400)

Variables	Category	Frequency	Percentages (%)
Blood Pressure (mm/Hg)	Systolic BP>140	240	60
	Diastolic BP>90	211	52.8
BMI (kg/m^2)	Under weight(15-18.4)	32	8.0
	Normal weight (18.5-24.9)	164	41.0
	Over weight (25-29.9)	111	27.8
	Obesity (30+)	93	23.3
eGFR (ML/Min/1.73M ^{2})	0-14.9	11	2.8
	15-29.9	19	4.8
	30-44.9	34	8.5
	45-59.9	55	13.8
	60-89.9	182	45.5
	90+	99	24.8
Dip stick Urinalysis	Normal/mild increase albuminuria (negative)	291	72.8
	Severely increased albuminuria (2+)	96	24
	Albuminuria (3+)	13.	3.3
Urine ACR(Mg/L)	Normal albumin (0-29.9) albuminuria (negative to+1)	61	21
	Micro-albuminuria (30-300)	179	61.5
	Macro-albuminuria (>300)/ Nephrotic range	51	17.5

Distribution of eGFR and albuminuria in relation to age, gender, duration of hypertension and stages of hypertension

Advanced age >65years, long standing hypertension and higher systolic blood pressure were significantly associated with decline in eGFR. 75% of young age category in this study (18-39yrs) had an eGFR of ≥60 and only 25% had eGFR<60, while 57.5% of participants (older age ≥65yrs category had an eGFR of ≥60 and 42.5% of < 60eGFR with a p-value of 0.0 signifying that eGFR tends to decrease as age increases. Furthermore, long standing hypertension was found to be associated with low eGFR as 36.6% of participants with hypertension for more than 10years had low eGFR vs 25.8% of participants with < 10 years, the p-value was 0.038.In addition, increase in systolic blood pressure was statically associated with decline in eGFR(p-value 0.004). Albuminuria was associated with aging and it was statically significant with p-value of 0.034.

Table 3: Distribution of estimated glomerular filtration rate(eGFR) in relation to age, gender, duration of hypertension and stages of hypertension among hypertensive patients attending cardiac clinics in Dar es Salaam(N=400)

Variables		eGFR categories (Ml/min/1.73m ^{2})							
		0-14.9	15-29.9	30 - 44.9	45-59.9	60-89.9	90-160	Total	p-value
Age group (years)	18-39	2 (8.3%)	1 (4.2%)	1 (4.2%)	2 (8.3%)	6 (25%)	12 (50%)	24 (100%)	0.000
	40-64	3 (1.3%)	6 (2.7%)	17 (7.6%)	22 (9.9%)	102 (45.7%)	73 (32.7%)	223 (100%)	
	≥65	6 (3.9%)	12 (7.8%)	16 (10.5%)	31 (20.3%)	74 (48.4%)	14 (9.2%)	153 (100%)	
Gender	Male	2 (1.8%)	7 (6.2%)	13 (11.5%)	18 (15.9%)	55 (48.7%)	18 (15.9%)	113 (100%)	0.119
	Female	9 (3.1%)	12 (4.2%)	21 (7.3%)	37 (12.9%)	127 (44.350	81 (28.2%)	287 (100%)	
Duration since diagnosis of Hypertension (Months)	1-11	2 (2.6%)	4 (5%)	6 (7.8%)	8 (10.4%)	32 (41.6%)	25 (32.5%)	77	0.038
	12-119	6 (2.5%)	10 (4.2%)	21 (8.8%)	31 (12.9%)	113 (47%)	59 (24.6%))	240	
	120-160	3 (3.6%)	5 (6%)	7 (8%)	16 (19%)	37 (44.6)	15 (18%)	83	
Category of hypertension(mmHg)	Systolic hypertension								
	Grade 1(140-159)	4 (2%)	6 (3.5%)	15 (8.8%)	24 (14%)	78 (45.9%)	43 (25%)	170	
	Grade2(160-179)	5 (7.9%)	6 (9.5%)	7 (11%)	11 (17.5%)	26 (41%)	8 (12.7%)	63	
	Grade3(>180+)	0	0	0	2 (25%)	3 (37.5%)	3 (37.5%)	8	

Distribution of Albuminuria with eGFR stages among hypertensive patients attending cardiac clinics in Dar-es-Salaam (N=400)

Albumin creatinine ratio (ACR) and eGFR had a negative linear correlation in the present study which signifies that the higher the ACR the lower the eGFR as 21% of participants in ACR of 0-29.9 category had eGFR of <60ml/min/1.73m^2 compared to 53% of participants in ACR of> 300 category with eGFR of <60ml/min/1.73m^2.

Table 4: Distribution of albuminuria with eGFR among hypertensive patients attending cardiac clinics in Dar-es-Salaam (N=400)

ACR categories (Mg/g)	eGFR Category (ML/MIN/1.73)						Total	p-value
	0-14.9	15-29.9	30-44.9	45-59.9	60-89.9	90+		
0-29.9	0	2 (3.3%)	3 (4.9%)	8 (13.1%)	28 (45.9%)	20 (32.8%)	61	0.000
30-300	7 (2.4%)	8 (2.8%)	22 (7.6%)	42 (14.6%)	138 (47.9%)	71 (24.7%)	288	
>300	4 (7.8%)	9 (17.6%)	9 (17.6%)	5 (9.8%)	16 (31.4%)	8 (15.7%)	51	

Correlation between eGFR, Albuminuria with Social economic factors and BMI among hypertensive patients attending cardiac clinics in Dar-Es-Salaam (n=400)

Low social economic status was associated with low eGFR. 35% of study participants in non-employment category had eGFR< 60ml/min/1.73m^2 while 22% of study participants from self-employment category had the same eGFR value. This association was statistically significant as p-value was 0.001. Furthermore an increase in BMI was significantly associated with an increase in albuminuria (p-value 0.012).

Table 5: Distribution of eGFR, albuminuria with social -economic factors and BMI among hypertensive patients attending cardiac clinics in Dar-es-Salaam (N=400)

Social -economic factors		**eGFR Categories(ML/MIN/173M^2**						**Total**	**P-VALUE**
		0-14.9	15-29.9	30-44.9	45-59.9	60-89.9	90+		
History of alcohol use		2 (3.7%)	4 (7.4%)	6 (11.1%)	8 (14.8%	24 (44.4%)	10 (18.5%)	54	0.245
History of cigarette smoking		0	1 (5%)	2 (10%)	5 (25%)	9 (45%)	3 (15%)	20	0.306
Level of education	Informal Education	4 (5.5%)	3 (4.1%)	4 (5.5%)	11 (15.1%)	43 (58.9%)	8 (11%)	73	0.882
	Primary Education	5 (2.1%)	13 (5.2%)	22 (8.8%)	27 (10.8%)	109 (43.8%)	73 (29.3%)	249	
	Secondary	1 (1.7%)	2 (3.4%)	7 (11.9%))	14 (23.7)	22 (37.3%)	13 (22%)	59	
	College	0 (0.0%)	0 (0.0%)	1 (6.7%)	2 (13.3%)	7 (46.7%)	5 (33.3%)	15	
	University	1 (1.2%)	1 (25%)	0 (0.0%)	1 (25%)	1 (25%)	0 (0.0%)	4	
Occupation	Permanent employment	0 (0%)	1 (7.7%)	2 (15.4%)	1 (7.7%)	6 (46.2%)	3 (23%)	13 0.001	0.001
	Self employment	2 (1.3%)	4 (2.6%)	10 (6.5%)	17 (11%)	73 (47.1%)	49 (31.6%)	155	
	Non - employment	9 (3.9%)	14 (6%)	22 (9.5%)	37 (15.9%)	103 (44.4%)	47 (20.3%)	232	

Variable	**Category**	**BMI(Kg/M$^{2)}$**				**p-value**
		Under weight(<18.5)	Normal weight(18.5-24.9)	Overweight (25-29.9)	Obese (>30)	
ACR(Mg/g)	0-29.9	6(9.8%)	31(50.8%)	14(22.9%)	10(16.4%)	0.012
	30-300	18(6%)	106(36.8%)	92(31.9%)	72(25%)	
	>300+	8(15.7%)	27(52.9%)	5(9.8%)	11(21.6%)	

IV. Discussion

Clinical pattern of renal disease among adult hypertensive patients was explored in this study. The pattern was dominated by AKI 89(22.3%), nephrotic syndrome 12.8% and end stage renal failure 2.8%.These findings were in contrast with what were found in Cameron and Ghana whereby the clinical pattern of renal diseases was dominated by advanced CKD with the prevalence of 61.8% and 70.8% respectively[30,31].

According to this study, 75% of the hypertensive patients had a decreased glomerular filtration rate (eGFR<90ML/Min/1.73M ^{3}), with at least 30% recording <60ML/Min/1.73M^3. This finding was similar to a study done in Cameroon [2, 36 ,] but varied with the study done in Mwanza which reported 5% of participants having decreased glomerular filtration rate [2, 26].

Micro-albuminuria was recorded in 61.5% of the adult hypertensive patients in the current study, which was lower compared to that reported at Muhimbili National Hospital in Tanzania (82.8%) [28] and higher than that reported in Mwanza and Cameroon (23.3% and 15% respectively)[26,36]. The variation might be due to difference study setting and methods employed in the diagnosis of micro-albuminuria and eGFR.

Furthermore, higher systolic blood pressure was significantly associated with decline in eGFR (p-value=0.004) among adult hypertensive patients. This finding was in line with studies conducted in Northen Tanzania, Ghana, Cameroon and Norway ([26,36,38,39,]). However, a study done in Ethiopia showed that diastolic BP greater than 90mmHg was most likely associated with development of kidney diseases[40]. In addition, higher systolic and diastolic blood pressures were associated with increase in albuminuria. This is due to effect of uncontrolled hypertension which cause blood vessels within the kidney to be narrowed, weaken or harden and as a result are not able supply enough blood to the kidney and this impairment leads to glomerular hypertension and an increase proteinuria.

Advanced age was significantly associated with decline in eGFR (p-value =0.000) and higher albuminuria (ACR) (P-value= 0.034) among adult hypertensive patients in this study. This finding was similar to findings reported from Mwanza, Dar es Salaam, Ethiopia and Northern Cameroon ([26, 28, 36]).

Long standing hypertension was significantly associated with decline in eGFR among adult hypertensive patients(p-value=0.038) as study participants with duration of hypertension for more than ten years had higher percentage of decline in eGFR (37%) compared to those whose duration of hypertension is less than ten years (28%). This concurs findings from Ethiopia[37]. The explanation to this is due to the fact that over time; hypertension damages blood vessels throughout the kidney and reduce the blood supply to the kidney and this leads to renal vascular nephropathy which slowly leads to the decrease of glomerular filtration rate.

An increase in albuminuria was significantly associated with decline in eGFR (P=0.000) among adult hypertensive patients. This finding was in line with study done by Levey AS et al and Melsom T,[38,39].

Low social-economic status was associated with decline in eGFR and increased albuminuria among adult hypertensive patients as 35% of study participants with lower level of occupation (unemployed) and education had eGFR <60ml/min/1.73m^2 compared to those with higher level of occupation 31% and education which was statically significant(p-value 0.001).This result was similar to study done in Netherland and Northen Tanzania/Kilimanjaro[40,41]. This might be due to the fact that people with low education levels are unaware of behaviors and factors that contribute to hypertension while unemployment causes access to quality care /treatment difficulties.

Increase in body mass index was significantly associated with an increase in albuminuria (ACR) (p-value=0.012). This finding was similar to what was found in Mwanza and China [26,55,56]. This is due to the fact that obesity is associated with increased fat-free mass with vasodilatation of the afferent arteriole, resulting in increased renal plasma flow, eGFR and filtration fraction and in addition increased intra-glomerular pressure drives glomerular filtration barrier injury[47,48, 56].

V. Conclusion

Acute Kidney Injury, Nephrotic Syndrome and End Stage Renal Disease are the main kidney diseases among hypertensive patients, with higher systolic blood pressure, advanced age, long standing hypertension and unemployment being significant risk factors for decreased eGFR.

Ethical issues: The ethical clearance and permission to conduct this study were issued by Hubert Kairuki Memorial University (HKMU) and Medical officer in charge of Amana, Mwananyamala and Temeke hospitals respectively. Consent were obtained from study participants.

Availability of data and materials: The data sets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: Data collection and analysis were funded by TPDF & Kairuki Hospital.

Authors' contributions: All authors contributed equally in conception, research development and study design. Absalom Maiseri contributed in data collection and entry. Warles Charles Lwabukuna & Yassin Mgonda were instrumental in statistical analysis.

All authors read and gave final approval for the manuscript's submission and publication.

Acknowledgement: I would like to thank TPDF, HKMU & KH managements for their support during this study. I would like to appreciate all the participants who took part in this study.

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