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Assessment of Chronic Kidney Diseases among individuals with Hypertension in Al-Ahssa region, Saudi Arabia

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ABSTRACT

Introduction

Hypertension, affecting 1.28 billion adults globally, is linked to chronic kidney disease (CKD). Saudi Arabian studies demonstrate hypertension's association with decreased glomerular filtration rate (GFR) and CKD development. However, generalizability limitations prompt a new cross-sectional study in Al-Ahssa, Saudi Arabia, to investigate the hypertension-CKD correlation and its implications for renal health.

Methods

The study employed a cross-sectional design conducted in Alahsa, Saudi Arabia, from August 2023 to January 2024. The study population comprised 377 patients, determined using the Raosoft formula for sample size calculation. Data was analyzed using SPSS software.

Results

Our study included 139 participants. Study reveals notable findings across various laboratory test results. Mean values and standard deviations are provided for creatinine (0.794 mg/dL ± 0.228), uric acid (5.64 mg/dL ± 1.41), HbA1c (5.55% ± 0.533), and LDL (126 mg/dL ± 42.1). Regarding gender differences, with males exhibiting higher creatinine (0.882 ± 0.2) and uric acid (6.08 ± 1.41) levels compared to females, and age-related effects, notably in individuals over 50, displaying higher creatinine (0.8 ± 0.24) and uric acid (5.524 ± 1.44) levels. Smoking status appeared to influence LDL levels, with smokers exhibiting higher levels (104.6 ± 27.8) than non-smokers (127.053 ± 42.4). Correlation analysis reveals a significant positive correlation between Creatinine and Uric Acid ($r = 0.452$, $p < .001$).

Conclusion

Study revealed significant gender disparities in creatinine and uric acid levels, with males exhibiting higher mean levels compared to females. Correlation analysis highlighted a significant positive relationship between creatinine and uric acid levels.

Keywords

Blood pressure, renal impairment, epidemiology, middle east, medical records

Introduction :

Hypertension is defined as blood pressure that equals or is higher than 140/90 mmgh when measured on two different occasions. According to recent report by the World Health Organization's, an estimated 1.28 billion adults aged 30 to 79 years old have hypertension worldwide, with the majority (two-thirds) living in low- and middle-income countries {1}.Chronic kidney disease (CKD) is one of the long-term complications of untreated hypertension, resulting in significantly increased morbidity and mortality {2}. CKD is diagnosed by the presence of either kidney damage or glomerular filtration rate (GFR) < 60 mL/min/1.73 m^2 for three months or more, regardless of the cause. The presence of albuminuria, determined as an albumin-to-creatinine ratio >30 mg/g in two of three spot urine specimens, is a reliable indicator of kidney impairment in many renal disorders {3}.

A cross-sectional study conducted by Anupama et al. to explore the association of HTN with CKD revealed that 4.8% of patients with HTN had eGFR < 60 mL/min. Furthermore, HTN was a potent independent predictor of end-stage renal disease {4}. Surprisingly, it was found that children with CKD who have hypertension are at greater risk of developing subclinical cardiovascular diseases. Reports from 1980 to 2010, showed that 28.4% of the end-stage CKD cases in the US were attributed to HTN{5}. A study investigated the relationship between serum uric acid (SUA) and chronic kidney disease in patients with hypertension, showed that SUA is strongly correlated with CKD in hypertensive patients even after elimination of other risk factors **{**2}.

Similarly, a study performed in Saudi Arabia found that patients with hypertension had significant decreases in GFR compared to individuals without hypertension. Additionally, several studies have detected a strong correlation between the rate of GFR decrease and the development of CKD in individuals with hypertension over years {7}. Moreover, a study conducted in Saudi Arabia with 299 participants found that hypertension was the cause of 64.3% of the patients with CKD.{8} Another study carried out in Riyadh, Saudi Arabia, demonstrated that 33 out of 78 (42%) cases of end-stage renal failure were caused by hypertension. However, This study was not a random selection of hypertensive patients; participants were solicited to sign up for the research. In addition , almost 80% of the patients in the study were females. Therefore, the study findings cannot be generalized to the whole population {9}. For this reason, a cross-sectional study will be conducted to determine the relationship between chronic kidney diseases among individuals with hypertension in the Al-Ahssa region, Saudi Arabia. This cross-sectional study aims to determine the correlation between hypertensive patient and their kidney function.

Aim:

This study aims to assess the correlation of chronic kidney disease among individuals with hypertension

Objectives:

- To select patients who are diagnosed with hypertension or who use anti-hypertensive medications, collect patient's demographics and characteristics .
- To perform kidney function tests including estimated glomerular filtration rate (eGFR), albumin to creatinine ratio (ACR), and urinalysis
- To correlate tests findings and outcomes of kidney function in patients with hypertension

Hypothesis

The long-term effect of hypertension is directly related to chronic kidney disease, which may leads to the deterioration of kidney function and eventual renal failure **4**

Methodology:

6.1 Study design:

A cross-sectional study that will conduct in 2023-2024 in Alahsa, Saudi Arabia aims to assess the correlation of chronic kidney disease among individuals with hypertension.

6.2 Study area and duration

Al-Hassa region in Saudi Arabia from August 2023–January 2024

6.3 Study population:

The population of this study are individuals with hypertension who received medical care in hospitals and specialized medical centers in Alahsa. The study will target both genders aged 18 years and older who have been diagnosed with hypertension.

The sample size consists of 377 patients from Alahsa which calculating by Raosoft formula.

6.4 Inclusion criteria:

1. Patient has a documented diagnosis of hypertension.
2. Patient has undergone diagnostic testing for CKD.

3. The medical record of the patient is available for the study.
4. Patient is aged 18 years or above.

6.5 Exclusion criteria:

1. Patients with missing or incomplete medical records
2. Patients with a history of kidney transplant before the diagnosis of hypertension
3. Patients suffering from kidney disease due to other causes such as autoimmune disorders.
4. Diabetic patients.
5. Patients aged less than 18 years old.

The demographic profile of the study population, as depicted in Table 1, reveals a mean age of 53.5 years with a standard deviation of 12.1, indicating moderate variability in age within the sample. Gender distribution shows a slight preponderance of males, constituting 55.4% of the participants, while females make up 44.6%. Age group distribution demonstrates that 43.2% of the individuals are aged 50 or younger, with the remaining 56.8% being older than 50. Additionally, a small proportion (3.6%) of participants report being smokers, while the vast majority (96.4%) are non-smokers. These demographic characteristics provide important context for interpreting study outcomes and may influence the generalizability of findings to broader populations.

Results

Table 1. demographic data

	Mean	Standard deviation
Age	53.5	12.1
Gender (n/%)	Male	77 (55.4%)
	Female	62 (44.6%)
Age group (n/%)	<=50	60 (43.2%)
	>50	79 (56.8%)
Smoker (n/%)	Yes	5 (3.6%)
	No	134 (96.4%)

Table 2 presents the mean and standard deviation values for several laboratory test results, namely Creatinine, Uric Acid, HbA1c, and LDL. These parameters are commonly used in clinical settings to assess various aspects of health.

Creatinine, a waste product of muscle metabolism, is measured to evaluate kidney function. The mean value of 0.794 mg/dL with a standard deviation of 0.228 suggests variability within the population being studied, which may indicate diverse renal health statuses.

Uric Acid, a byproduct of purine metabolism, is often measured to assess kidney function and diagnose conditions such as gout. The mean value of 5.64 mg/dL with a standard deviation of 1.41 indicates variability in uric acid levels among individuals, potentially reflecting differences in diet, metabolism, or underlying health conditions.

HbA1c, or glycated hemoglobin, is a marker used to monitor long-term blood sugar control in individuals with diabetes. The mean value of 5.55% with a standard deviation of 0.533 suggests variability in glycemic control among the population under study, highlighting the importance of individualized treatment approaches.

LDL (Low-Density Lipoprotein) cholesterol is a key factor in assessing cardiovascular risk. The mean value of 126 mg/dL with a standard deviation of 42.1 suggests variability in LDL levels among individuals, which may indicate differences in dietary habits, genetics, or response to lipid-lowering therapies.

Table 2. lab test results

	Mean	Standard deviation
Creatinine	0.794	0.228
Uric Acid	5.64	1.41
HbA1c	5.55	0.533
LDL	126	42.1

Lab Test results among Demographic data

Table 3 presents a comprehensive overview of laboratory test results across different demographic categories. Gender differences are evident, with males displaying higher levels of Creatinine (0.882 ± 0.2) and Uric Acid (6.08 ± 1.41) compared to females (Creatinine: 0.684 ± 0.21, Uric Acid: 5.12 ± 1.23), while no significant gender-based variations are observed in HbA1c (Males: 5.48 ± 0.53, Females: 5.63 ± 0.52) and LDL (Males: 126 ± 42.7, Females: 127 ± 41.7) levels. Age-related effects are apparent, particularly among individuals aged over 50, showing higher levels of Creatinine (<=50: 0.785 ± 0.22, >50: 0.8 ± 0.24) and Uric Acid (<=50: 5.793 ± 1.37, >50: 5.524 ± 1.44), indicating potential age-related changes in these parameters. Smoking status appears to influence LDL levels (Yes: 104.6 ± 27.8, No: 127.053 ± 42.4), with smokers exhibiting notably higher levels compared to non-smokers, suggesting a relationship between smoking and LDL levels. These findings underscore the intricate relationship between demographic factors and laboratory test results, emphasizing the need for comprehensive analyses considering multiple variables to better understand these associations in clinical settings.

Table 3. Lab Test results among Demographic data

	Gender		Age group		Smoker	
	Male	Female	<=50	>50	yes	no
Creatinine	0.882±0.2	0.684±0.21	0.785±0.22	0.8±0.24	0.8±0.1	0.793±0.23
Uric Acid	6.08±1.41	5.12±1.23	5.793±1.37	5.524±1.44	5.28±1.29	5.656±1.42
HbA1c	5.48±0.53	5.63±0.52	5.487±0.49	5.596±0.56	5.69±0.55	5.544±0.53
LDL	126±42.7	127±41.7	124.041±43	127.853±41.6	104.6±27.8	127.053±42.4

Relationship between lab test results

Table 4 provides correlation coefficients (Pearson's r) and associated p-values for the relationships between Creatinine, Uric Acid, HbA1c, and LDL levels. It reveals a significant positive correlation between Creatinine and Uric Acid (r = 0.452, p < .001), suggesting a moderate linear relationship. However, the correlations between Uric Acid and both HbA1c (r = -0.136, p = 0.124) and LDL (r = 0.089, p = 0.307) are not statistically significant. Conversely, there is a statistically significant but weak negative correlation between HbA1c and Uric Acid (r = -0.136, p = 0.124). The relationships between HbA1c and LDL, as well as LDL and Creatinine, are not statistically significant (p > 0.05). These findings indicate that while Creatinine and Uric Acid levels are positively associated, the correlations between Uric Acid and other tested variables, as well as HbA1c and LDL, are not robust, suggesting the need for further investigation into potential underlying factors influencing these biomarkers.

Table 4. relationships between lab test results

		Creatinine		**Uric Acid**		**HbA1c**	
Uric Acid	Pearson's r	0.452	***	—			
	p-value	< .001		—			
HbA1c	Pearson's r	-0.014		-0.136		—	
	p-value	0.873		0.124		—	
LDL	Pearson's r	-0.041		0.089		-0.110	
	p-value	0.636		0.307		0.215	

Demographic data and lab test results

Table 5 summarizes the findings of a T-test analysis examining the association between age groups (categorized as <=50 and >50) and biomarkers including Creatinine, Uric Acid, HbA1c, and LDL. T-test statistics and corresponding p-values are provided for each biomarker. Results indicate that there are no statistically significant differences between the two age groups for Creatinine (T=-0.383, p=0.702), Uric Acid (T=1.109, p=0.269), HbA1c (T=-1.160, p=0.248), and LDL (T=-0.521, p=0.603).

Age group*	**T test**	**p-value**
Creatinine	-0.383	0.702
Uric Acid	1.109	0.269
HbA1c	-1.160	0.248
LDL	-0.521	0.603

***Age group (<=50, >50)**

Table 6 presents the results of T-tests examining gender differences in four biomarkers: Creatinine, Uric Acid, HbA1c, and LDL levels. Statistically significant gender disparities were observed in Creatinine and Uric Acid levels ($p < .001$), with males displaying higher mean levels compared to females, consistent with existing literature. Conversely, no significant gender discrepancies were found in HbA1c ($p = 0.101$) or LDL ($p = 0.839$) levels.

Gender	**T test**	**df**	**p**	**In favor of**
Creatinine	5.629	137	< .001	Male
Uric Acid	4.233	134	< .001	Male
HbA1c	-1.650	130	0.101	Non-sig
LDL	-0.204	134	0.839	Non-sig

Table 7 presents statistical comparisons of various biomarkers between smokers and non-smokers. Analysis reveals that for Creatinine levels, Uric Acid levels, HbA1c levels, and LDL levels, there are no significant differences observed between the two groups, as indicated by the p-values of 0.949, 0.559, 0.550, and 0.243 respectively.

Smoker	**Statistic**	**df**	**p**
Creatinine	0.0645	137	0.949
Uric Acid	-0.5851	134	0.559
HbA1c	0.5991	130	0.550
LDL	-1.1728	134	0.243

Discussion

The present study conducted in the Al-Ahssa region of Saudi Arabia aimed to explore the relationship between chronic kidney disease (CKD) and hypertension. Hypertension is a well-known risk factor for CKD, as prolonged high blood pressure can damage the small blood vessels in the kidneys, leading to impaired kidney function over time [10]. Therefore, understanding the correlation between hypertension and CKD is paramount for effective management and prevention of kidney-related complications in hypertensive individuals.

CKD represents a significant public health concern globally, with its prevalence not fully characterized in many countries. A study conducted in northern Portugal with adult users of healthcare units aimed to estimate the CKD prevalence and staging in an unselected population. The study found that the overall prevalence of CKD was 9.8%, with a higher prevalence in females (5.5%) than in males (4.2%). This real-world-based study is the first to characterize CKD prevalence in a large, unselected Portuguese population, providing a near estimate of the true CKD prevalence [11].

The relationship between hypertension and CKD is well-established, with hypertension being both a cause and a consequence of CKD. A study by Jha et al. in 2016 found that poorly controlled hypertension is associated with much of the high burden of CKD, highlighting the need for improved blood pressure control in CKD patients to mitigate the risk of disease progression [12].

The mean values of laboratory tests such as creatinine, uric acid, HbA1c, and LDL cholesterol serve as important indicators of kidney function and overall health status among individuals with hypertension. Elevated levels of creatinine in our study participants, may suggest decreased kidney function, as the kidneys may be less efficient at filtering waste from the blood. Similarly, uric acid levels are often elevated in individuals with kidney dysfunction, as the kidneys play a crucial role in excreting uric acid from the body. Therefore, monitoring these biomarkers can provide valuable insights into the health of the kidneys and the progression of CKD among hypertensive individuals.

Uric acid levels have been studied for their association with renal dysfunction. Li et al. in 2017 conducted a systematic review and meta-analysis to determine the effectiveness of uric acid-lowering therapy on renal function in CKD patients. The study suggested that such therapy tends to show superior preservation of eGFR compared to patients without the therapy, but further studies are needed to verify the reno-protective effects [13].

The demographic analysis reveals notable variations in laboratory test results based on gender and age. Males exhibited higher levels of creatinine and uric acid compared to females. The Global Burden of Disease Study 2016 utilized a Bayesian-regression analytic tool, DisMod-MR 2.1, to analyze gender disparities in CKD prevalence among 195 countries. The study revealed that the global number of individuals with impaired kidney function reached 752.7 million, including 417.0 million females and 335.7 million males. The study highlighted significant gender disparities in CKD prevalence, with a complex nature of these disparities that must be interpreted cautiously [14].

In the United States, current estimates indicate that CKD is more common in people aged 65 years or older (34%) than in younger age groups, and slightly more common in women (14%) than men (12%). These statistics underscore the need for targeted interventions and healthcare strategies to manage and prevent CKD, especially in older populations and among women [15].

Additionally, age-related effects were evident, with individuals over the age of 50 showing higher levels of creatinine and uric acid. This age-related decline in kidney function underscores the importance of regular monitoring and early intervention to prevent the progression of CKD in older individuals [16].

The correlation analysis provides insights into the interplay between different biomarkers and their potential implications for kidney health. The significant positive correlation between creatinine and uric acid levels suggests a potential relationship between renal function and uric acid metabolism, highlighting the intricate nature of kidney disease. However, the lack of significant correlations between uric acid and other biomarkers such as HbA1c and LDL cholesterol indicates the multifactorial etiology of CKD, which may involve various metabolic pathways and risk factors.

The correlation between creatinine and uric acid levels has been investigated in relation to CKD. Silva et al. in 2021 studied the association of uric acid and the uric acid to creatinine ratio with CKD in hypertensive patients. The study found that elevated levels of isolated serum uric acid were associated with CKD and a lower eGFR, but the uric acid to creatinine ratio was not associated with CKD [17].

Additionally, the absence of significant differences in laboratory test results between age groups, gender, and smoking status suggests that hypertension may be the primary driver of kidney dysfunction in this population. This underscores the importance of effective management of hypertension to prevent or delay the onset of CKD and its associated complications. Management of hypertension in CKD patients is crucial for preventing disease progression. Whelton et al. in 2018 provided guidelines for the prevention, detection,

evaluation, and management of high blood pressure in adults, which include recommendations specifically for patients with CKD. These guidelines aim to improve the quality of care and outcomes for individuals with hypertension and CKD [18]. However, further research is needed to elucidate the underlying mechanisms driving the observed associations and to develop targeted strategies for CKD prevention and management in this setting.

Clinical Implications and Future Research

The clinical implications of this study are significant for healthcare providers involved in the management of hypertension and CKD. The findings emphasize the importance of routine assessment of kidney function in hypertensive patients, as evidenced by the variations in laboratory test results observed in this study [19, 20]. Healthcare practitioners should consider incorporating kidney function tests, such as creatinine and uric acid measurements, into regular check-ups for hypertensive individuals to detect early signs of kidney dysfunction and intervene promptly to prevent disease progression. The demographic variations identified in this study highlight the need for personalized management strategies tailored to specific patient populations. For instance, older individuals and males may require closer monitoring of kidney function due to their higher susceptibility to CKD. The lack of significant differences in laboratory test results based on smoking status suggests that smoking cessation interventions may not directly impact kidney function in hypertensive individuals. However, further research is needed to explore the long-term effects of smoking cessation on kidney health in this population.

In terms of future research directions, longitudinal studies are warranted to elucidate the causal relationship between hypertension and CKD development among individuals in the Al-Ahssa region. Long-term follow-up of hypertensive patients with regular kidney function assessments can provide valuable insights into the progression of CKD and the effectiveness of various treatment strategies in preventing renal complications [21]. Moreover, exploring additional biomarkers and risk factors associated with CKD, such as genetic predisposition and dietary habits, can further enhance our understanding of the pathophysiology of kidney disease in hypertensive populations. Additionally, interventions aimed at addressing modifiable risk factors, such as hypertension control and lifestyle modifications, should be evaluated in clinical trials to assess their impact on kidney function and overall cardiovascular health outcomes in this population. By addressing these research gaps, healthcare providers can develop evidence-based interventions to improve the management and outcomes of hypertension-associated CKD in the Al-Ahssa region and beyond.

Limitations

The study has several limitations that should be acknowledged. Tha cross-sectional design limits its ability to establish causality between hypertension and chronic kidney disease (CKD). The reliance on laboratory test results may not fully capture the complexity of kidney function and its interaction with other clinical variables. Factors such as dietary habits, medication adherence, and comorbidities were not extensively explored but could significantly influence kidney health in hypertensive individuals. Sample size and recruitment strategy may introduce selection bias, limiting the generalizability of the findings to the broader population in the Al-Ahssa region. The study's focus on a specific geographic region may not fully represent the diversity of the Saudi Arabian population, warranting caution in extrapolating the results to other regions or ethnic groups. Despite these limitations, this study provides a valuable foundation for future research aimed at better understanding the relationship between hypertension and CKD and developing targeted interventions to improve kidney health outcomes in hypertensive populations.

Conclusion

Study revealed significant gender disparities in Creatinine and Uric Acid levels, with males exhibiting higher mean levels compared to females, while no significant differences were observed based on age groups or smoking status. Correlation analysis highlighted a significant positive relationship between Creatinine and Uric Acid levels, emphasizing their relevance in assessing kidney function. However, no significant correlations were found between Uric Acid and HbA1c or LDL levels. These findings underscore the importance of regular kidney function assessments and personalized management strategies for individuals with hypertension, particularly among older age groups and males who may be at higher risk of CKD.

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