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Original Article

Investigating the Biochemical Links in Hypertensive Chronic Kidney Disease

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Abstract

Chronic kidney disease (CKD) and hypertension are two medical conditions that are related to each other. This study aims to evaluate the relationship between CKD associated with hypertension and biochemical parameters such as kidney function (urea, creatinine, glomerular filtration rate), blood electrolytes (sodium, potassium, calcium) and random blood sugar levels.

The participants in this research were suffering from CKD and Hypertension. Creatinine, urea, and random blood sugar levels were measured using colorimetric methods, sodium, potassium, and calcium levels were measured using the Ion-Selective Electrode (ISE) method. Our study revealed significant associations between chronic kidney disease-associated hypertension and various biochemical parameters. According to the findings, hypertensive chronic kidney disease significantly affects kidney function. Controlling blood pressure and keeping a close eye on kidney function are advised to prevent the advancement of chronic kidney disease and enhance patient outcomes.

Key words

Chronic kidney disease (CKD), Kidney functions, estimated Glomerular filtration rate (eGFR), Clinical parameters, Hypertension.

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Introduction

Chronic Kidney Disease (CKD) refers to a condition where the kidneys are impaired and unable to effectively filter waste and toxins from the blood. Surplus fluid and waste may create more health concern in our body, and this issue threatens all over the world. With the development of kidney disease and irreversible destroying for our body. This condition may progress to kidney failure if left unmanaged, which needs kidney transplant or dialysis to survive (Kalantar-Zadeh et al., 2021). Recent evaluations play a crucial role in preventing kidney failure. The most effective method for assessing kidney function and diagnosing stages of kidney disease is regular monitoring of the estimated glomerular filtration rate (eGFR). The glomerular filtration rate (GFR) is determined based on factors such as gender, race, age, and blood creatinine levels (Shrestha, 2021) . The progressive decline in kidney function over time is a hallmark of CKD. Since high hypertension (HTN) can harm the kidneys' blood vessels and impair their function, it is thought to be one of the primary causes of chronic kidney disease. High blood pressure and chronic kidney disease have a bidirectional connection, where each condition can contribute to increased blood pressure levels and further decline in kidney function. (Suenaga et al., 2023).

In order to improve patient outcomes and stop the progression of chronic kidney disease, it is critical to identify and treat high blood pressure early. Blood creatinine and urea levels and GFR were measured to assess kidney function and gauge the degree to which chronic kidney disease affects kidney filtration. Electrolyte levels were measured to assess the body's electrolyte balance and gauge how much CKD affects calcium, potassium, and sodium levels

The study aims investigation of the connection between HTN and CKD and how it affects kidney function, assessing the impact of CKD on GFR, creatinine, and urea levels, examining how CKD affects the body's electrolyte levels, finding out how HTN and the development of CKD are related, and how this relationship affects kidney function and overall disease progression and patients outcomes.

It is anticipated that this study will advance knowledge of the connection between CKD and HTN and how these disorders affect kidney function, potentially leading to better diagnosis and care. This is particularly important because CKD progression is irreversible; therefore, early and accurate diagnosis is essential for patients to begin treatment promptly and take necessary steps to slow further kidney damage.

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Materials and Methods

1-Subjects

- Seventy individuals with hypertension and chronic kidney disease (CKD) were enrolled in the research. In addition, 35 healthy controls were matched by age and sex. The subjects were divided into:

Group I: control group included 35 normal healthy subjects.

Group II: Prerenal failure group included 30 patients with different stages of CKD (stages 3or 4) based on the estimated glomerular filtration rate (eGFR) level.

Group III: Renal failure group (stage 5) included 40 patients.

Hypertension was diagnosed by measuring blood pressure on two separate days; a diagnosis was confirmed if systolic readings were ≥140 mmHg and/or diastolic readings were ≥90 mmHg on both occasions. eGFR was calculated using the Modification of Diet in Renal Disease (MDRD) equation. This method employs a four-variable formula that includes sex, age, race, and serum creatinine levels. (Levey et al., 2005)

$$GFR = 175 \times (SCr)^{-1.154} \times (age)^{-0.203} \times (0.742 \text{ if female}) \times (1.212 \text{ if Black})$$

Where SCr = serum creatinine in mg/dL

The results of the chemical testing of the patients are in accordance with international health standards in terms of classifying people as kidney patients at the following different stages (Kalantar-Zadeh et al., 2021):

- **Stage 1:** eGFR ≥ 90 mL/min/1.73 m² (normal or high kidney function with signs of kidney damage)
- **Stage 2:** eGFR between 60–89 mL/min/1.73 m² (mild decrease in kidney function)
- **Stage 3:** eGFR between 30–59 mL/min/1.73 m² (moderate decrease in kidney function)
- **Stage 4:** eGFR between 15–29 mL/min/1.73 m² (severe decrease in kidney function)
- **Stage 5:** eGFR < 15 mL/min/1.73 m² (kidney failure or end-stage renal disease)

- Participants with the following criteria were excluded from the study: Pregnant females, any cases suffering from CKD due to: Polycystic kidney disease, obstructive uropathy or autoimmune diseases like systemic lupus erythematosus, rheumatoid arthritis and individuals with a history of drug addiction / NSAIDs. Additional exclusion criteria were active urinary tract infection and thyroid disorders.

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- Prior to participating in the trial, each individual provided written informed consent.
- All participants underwent physical examinations and routine blood biochemical analyses following an overnight fast.

2-Sampling

A 5 mL sample of venous blood was drawn from each patient to perform biochemical investigations. The blood for the biochemical tests was lifted at room temperature for 30 min, clotting for 10-min then centrifugation at 3000 g to separate the serum.

3-Clinical and laboratory examinations:

- Assessment of Kidney functions:(Serum creatinine and urea were determined using Enzymatic colorimetric method)
  a-Serum urea was measured using BIO-MED kit (Chaney, et al, 1962)
  b-Serum creatinine using the kit of (GPL Reagents Barcelona, Spain)(Kaplan et al., 1984b)
- Assessment of random blood glucose.(Kaplan et al., 1984a)
- Serum sodium, potassium, and calcium levels were measured using an ion-selective electrode (ISE) method with the RAPIDLab 348EX analyzer (Siemens Healthcare Diagnostics Manufacturing Ltd, UK).(Fonseca et al., 2016)

4- Analysis of statistics

Stats Direct statistical software, version 2.8 for Microsoft Windows (Stats Direct Ltd., Cheshire, UK), was used to calculate the sample size. IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA), was used on an IBM computer to analyze the data. The three groups were compared using the ANOVA test, and quantitative data were presented as mean ± standard error.

Results

1-The participants' ages

The ages of the patients and the control group did not differ significantly.

According to Figure 1, the three groups' average ages were as follows: control group (52.48571), prerenal group (54.83333), and renal group (53.325).

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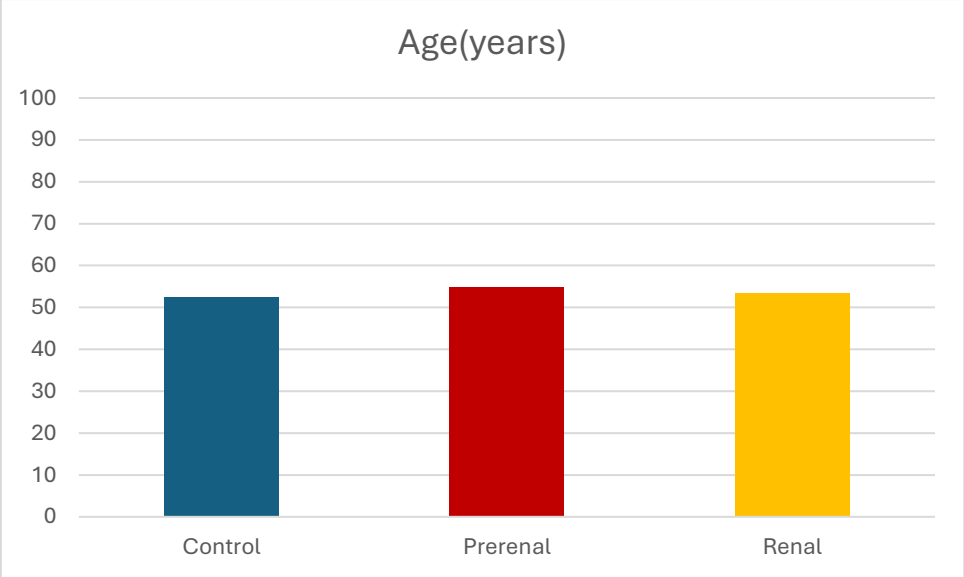

Figure1: Clarification of the average lifespan for the groups under study.

2- Blood Pressure levels (BP)

Hypertension level was observed in the participants in the study that suffered from CKD to be above normal range, where systolic/ diastolic BP for control, prerenal, and renal groups were 120/80,130/90, and 140/91mmHg respectively as shown in figure 2.

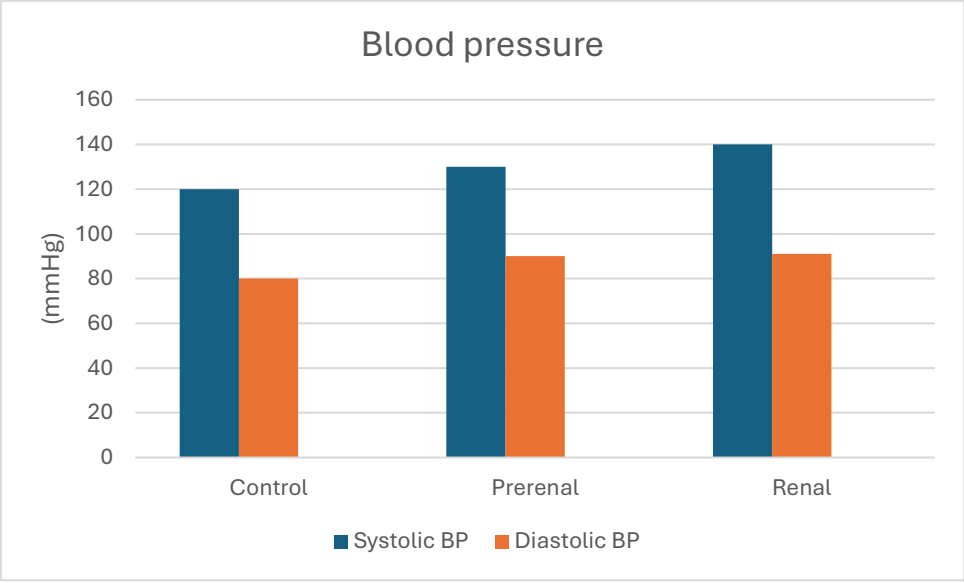

Figure 2: Examination of blood pressure levels.

3-Blood glucose levels

Blood glucose levels indicate a marked difference in control, conditions with different stages of kidney disease and the renal failure group. Glucose levels decrease in patients with renal failure but within the normal range which may be less than 140mgs/dl as shown in figure3.

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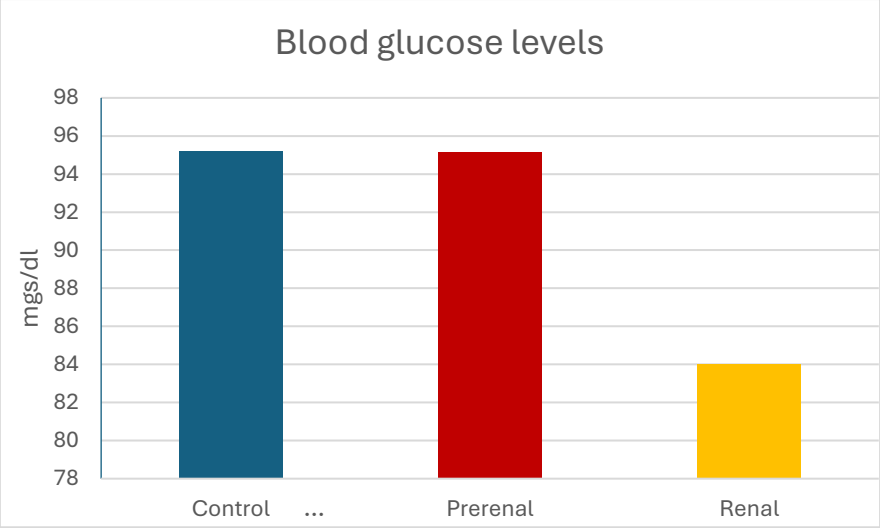

Figure 3: Examination of Glucose levels.

4-Hemoglobin levels

There were some changes in hemoglobin scores that were lower than normal in renal conditions.as shown in figure 4.

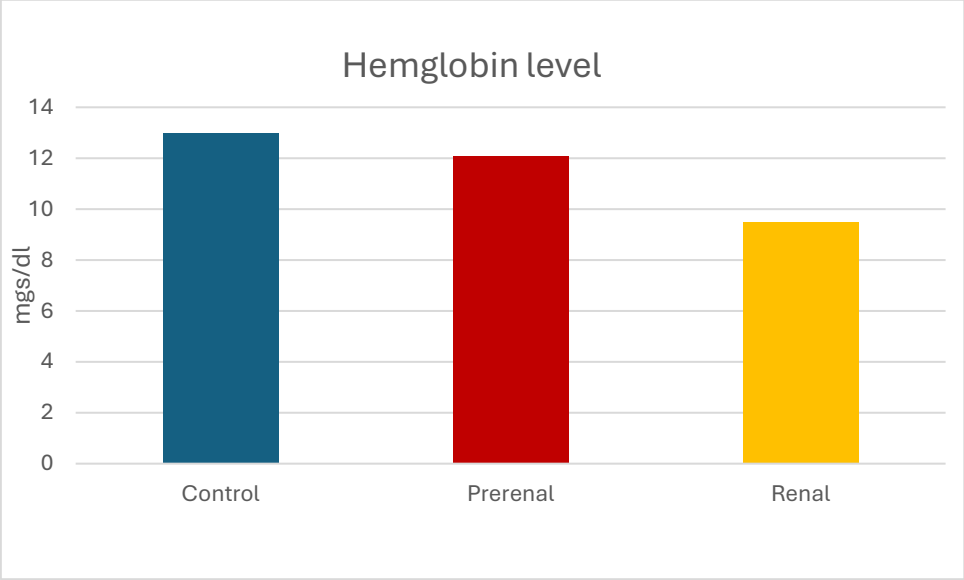

Figure 4: Examination of hemoglobin levels.

5-Kidney functions

There is a significant difference when examining kidney function between CKD patients with different stages and control subjects. The results for creatine reached an average of between 2.296672 to 9.488mg/dl and for urea between 96.06667 to 139.1 mg/dl. (**Figure 5).**

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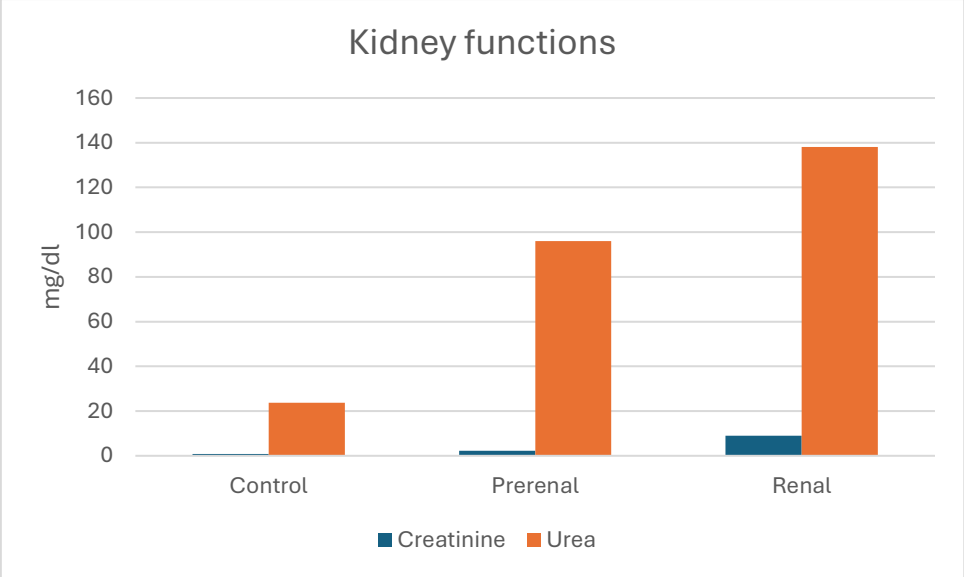

Figure 5: Kidney Functions include Urea (mg/dL), Creatinine (mg/dL).

6- The rate of glomerular filtration (GFR)

Figure 6 illustrates the significant differences in GFR values among the three groups.

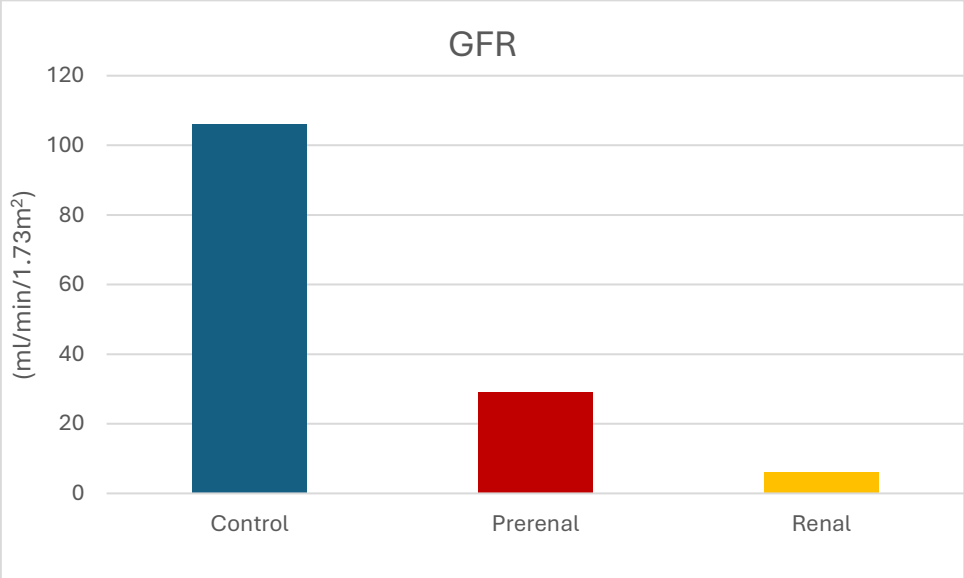

Figure 6: Glomerular filtration rate values for the studied groups

7-The electrolytes level in blood

The sodium levels didn't show much variation in the conditions involved, but there was a significant difference in potassium and calcium levels, as shown in figure 7and 8.

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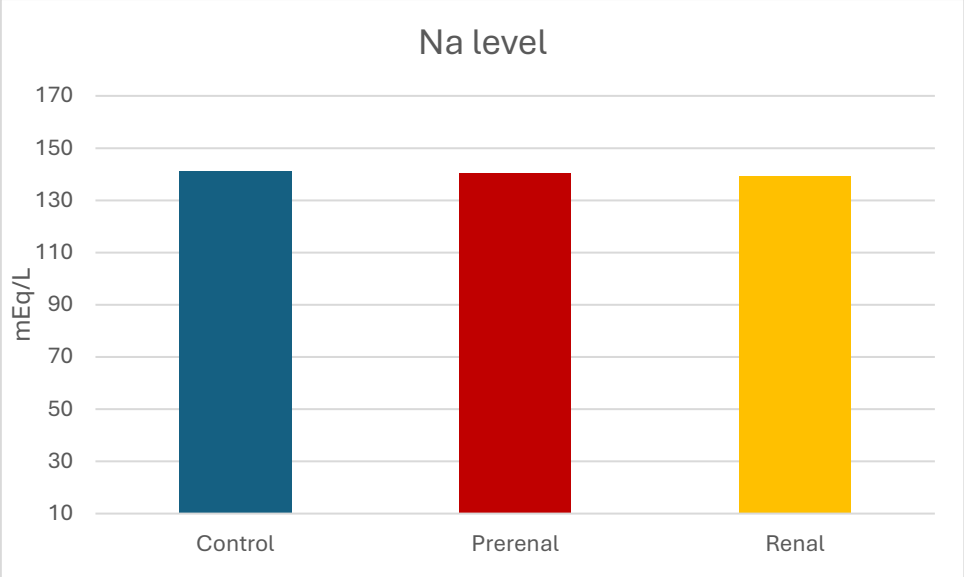

Figure 7: Examination of Sodium level.

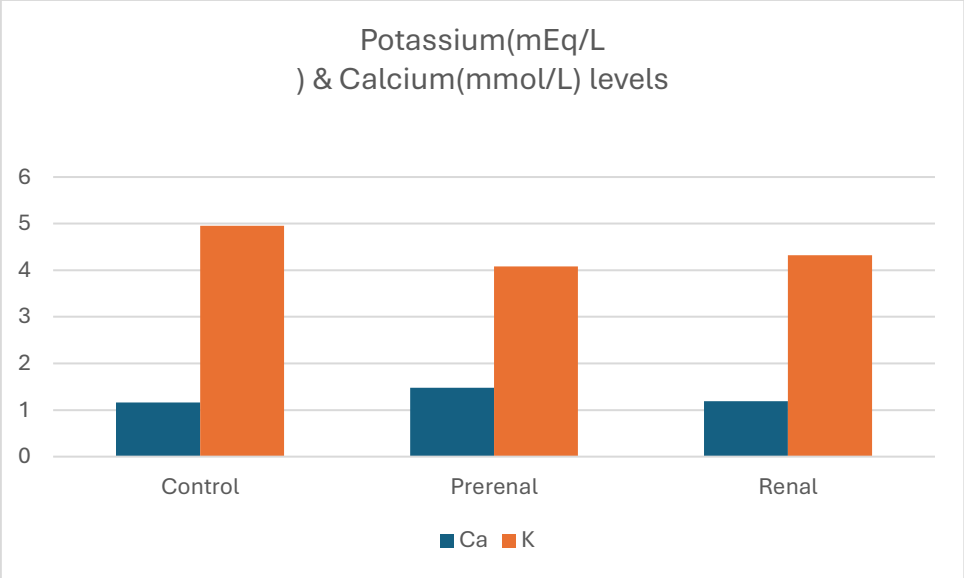

Figure 8: Examination of K& Ca levels.

Discussion

Chronic kidney disease and hypertension are closely linked, and the studying of the associated parameters can help identify biomarkers for the disease and improve healthcare outcomes.

In our study we found that hypertension is associated with the progression of CKD, which is supported by the study of (Nagib et al., 2023), where he discovered that chronic kidney disease (CKD) affected 33% of hypertensive non-diabetic individuals, and the investigation of (Suenaga et al., 2023) which found that Increased blood pressure is noticed which can be a

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result of kidney damage caused by hypertension, where the kidneys lose their ability to control blood pressure.

Our study's findings demonstrated that the three groups' hemoglobin levels significantly decreased. which is consistent with previous studies that have a reported correlation between CKD and a decreased hemoglobin level. For example, a studies by (Kamal et al., 2018; Latheef et al., 2020), where they found that this decrease can be a result of anemia associated with CKD , where erythropoietin, a hormone that promotes the creation of red blood cells, is no longer produced by the kidneys. We noticed a significant difference in low blood sugar levels in the later stages of CKD which can be a result of changes in glucose metabolism or the use of certain medications, but this difference is still within the normal range of random blood sugar levels.

Our study revealed a significant increase in urea and creatinine levels, which indicates a decline in kidney function as the kidneys' capacity to remove toxins and waste from the circulation declines. This is consistent with previous studies by (Hassafy et al., 2023) and (Neveen et al., 2019). Additionally, decreased glomerular filtration rate that can be a result of kidney damage caused by hypertension, this is consistent with (Neveen et al., 2019).

Overall, our study demonstrates the complex relationship between chronic kidney disease associated with hypertension and biochemical parameters.

Results of our study emphasize the importance of monitoring kidney function and biochemical parameters in patient CKD and highlight the need for further research into the underlying mechanisms of disease progression.

Conclusions

This study assessed how kidney functions in hypertensive patients were affected by chronic kidney disease. The findings show that kidney functions are greatly impacted by chronic kidney disease, which causes blood hemoglobin and blood sugar levels to drop while kidney functions decline with the decreasing of glomerular filtration rate. These results demonstrate how important it is to detect chronic kidney disease early and provide appropriate treatment to halt the disease's progression. These results underscore the necessity for further research to gain a deeper understanding of the impact of chronic kidney disease on blood parameters, kidney

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functions, and public health, and They can help patients with hypertension and chronic kidney disease receive better care.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this study.

Ethical Approve

This study forms part of the first author's master's thesis and was carried out within the scope of a project funded by the National Research Centre (NRC), Egypt. Ethical approval for the project was approved by the Medical Research Ethics Committee of the NRC (Approval No. 13060121). The principal investigator (PI) of the project also serves as the primary supervisor of the master's thesis.

Authors contributions

Weaam Gouda, Mohamed D. E. Abdelmaksoud, and Mie Afify developed the study design and methodology, conducted the analysis, and contributed to data collection.

Eman E. Abdelatey contributed to data collection, result interpretation, and manuscript writing.

Mohamed A. Khalil and Samir Azazy assisted with data collection and manuscript review.

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