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The Relationship between Renal Impairment and Specific Laboratory Markers: A Comprehensive Investigation Focusing on Athletes.

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Abstract

Background: Chronic kidney disease (CKD) is a notable public health issue that necessitates timely identification and efficient management to enhance patient outcomes. The primary objective of this study was to conduct a comprehensive investigation into the correlation between renal impairment and specific laboratory markers among athletes. The study included a total of 345 patients and 100 controls, making it a robust investigation. Special attention was paid to identifying potential biomarkers that could help predict renal impairment in athletes.

Results:The results showed that several laboratory markers were associated with an increased risk of renal impairment, including elevated levels of creatinine, urea, RBS, and cystatin C. Additionally, the study found that decreased levels of vitamin D3 and glomerular filtration rate (GFR) were significantly associated with renal impairment in athletes. 345 samples were collected from several hospitals in Baghdad (Al-Kadhimiya Teaching Hospital, Al-Yarmouk Teaching Hospital, and Neurological Hospital). In Addition, the results revealed strong correlations between RBS, Vitamin D3, Creatinine, Urea, Cystatin C levels, and GFR values. Specifically, negative correlations were observed for RBS ($p < 0.001$), creatinine ($p < 0.001$), urea ($p < 0.001$), cystatin C ($p < 0.001$), and Vitamin D3 ($p < 0.001$) as these markers increased, GFR values declined to signify impaired kidney function.

Conclusion: The study investigated the relationship between renal impairment and specific laboratory markers in athletes. Monitoring these parameters is crucial in identifying early signs of kidney disease that could aid in developing effective treatment strategies for managing CKD in athletes. Nonetheless, further research is needed to establish definitive causal relationships between these biomarkers and CKD progression.

Keywords- Chronic kidney disease (CKD), Specific Laboratory, Hospital

Introduction

The kidneys' primary function is to remove waste products from the blood through filtration. The effectiveness of this procedure can be assessed by estimating the glomerular filtration rate (GFR), which quantifies the volume of blood passing through the renal glomeruli per minute. GFR serves as a key indicator obtained through a medical examination to measure renal function. This test is an essential tool for evaluating kidney function. [1]. As kidney function decreases, GFR values decline as well.

Several laboratory tests have been employed in diagnosing and assessing kidney function. These tests are crucial in detecting early signs of kidney damage and monitoring its progression. By examining these markers' correlation with GFR, medical professionals gain valuable insights into renal disease management.

1. Random Blood Sugar (RBS)

Diabetes has been identified as a prominent etiological factor contributing to the prevalence of chronic kidney disease (CKD) and end-stage renal disease (ESRD) on a global scale [2]. Prolonged exposure to elevated blood glucose levels can result in detrimental effects on the blood vessels within the kidneys. Over time, this cumulative damage may lead to impaired renal function or even complete renal failure.

1.1 Correlation between RBS Levels and GFR

Numerous studies have provided evidence indicating a negative correlation between elevated levels of random blood sugar (RBS) and glomerular filtration rate (GFR) in individuals with diabetes [3]. Maintaining optimal control of blood glucose levels can effectively mitigate the progression of chronic kidney disease (CKD) and reduce the risk of complications such as end-stage renal disease (ESRD) [4].

2. Vitamin D3

Vitamin D3 plays an essential role in maintaining bone health and calcium-phosphorus balance. In addition, recent studies have suggested its potential protective effects on kidney function [5].

2.1 Correlation between Vitamin D3 Levels and GFR

Patients diagnosed with chronic kidney disease (CKD) and end-stage renal disease (ESRD) often exhibit reduced serum levels of Vitamin D3, suggesting a potential link between Vitamin D deficiency and declining glomerular filtration rate (GFR) [6]. Supplementation with Vitamin D may offer a potential avenue to decelerate the progression of kidney disease. However, further research is necessary to establish conclusive evidence regarding its efficacy

3. Creatinine

Creatinine is a waste product generated by muscle metabolism, filtered out by the kidneys. Therefore, its level in the blood can be used as an indicator of kidney function [7].

3.1 Correlation between Creatinine Levels and GFR

Elevated serum creatinine levels correlate with decreased GFR, reflecting impaired kidney function [8]. Monitoring creatinine levels can help assess the severity of renal disease and determine appropriate treatment plans.

4. Urea

Urea is another waste product generated during protein breakdown, typically removed from the blood through kidney filtration [9].

4.1 Correlation between Urea Levels and GFR

Increased urea levels are associated with reduced GFR, indicating poor kidney function [10]. However, factors like dehydration or high protein intake may also influence urea levels; hence it should be considered alongside other biomarkers for a comprehensive assessment.

5. Cystatin C

A protein synthesized uniformly by all nucleated cells in the body and subsequently filtered freely by the glomeruli [11], has garnered acknowledgment as a potentially valuable alternative marker for assessing renal function.

5.1 Correlation between Cystatin C Levels and GFR

Cystatin C levels demonstrate an inverse relationship with GFR, providing a more accurate estimation of renal function than creatinine levels, particularly in patients with reduced muscle mass [12]. The combined measurement of Cystatin C and creatinine may improve precision when evaluating kidney function [13].

Methods and Materials

Study Design

This retrospective cross-sectional analysis included 345 athletes diagnosed with various stages of chronic kidney disease (CKD) between January 2018 and December 2020 from several hospitals in Baghdad, including Al-Kadhimiya Teaching Hospital, Al-Yarmouk Teaching Hospital, and Neurological Hospital. The study also included a control group of 100 age-matched healthy individuals to compare laboratory test results and their

correlation with GFR. Through this investigation, potential biomarkers were identified, which can aid in detecting early signs of renal impairment in athletes. These findings could help clinicians develop appropriate treatment strategies for managing CKD in athletes and ultimately lead to better health outcomes.

Participants

This study focused on athletes aged 18 or older diagnosed with chronic kidney disease (CKD), excluding individuals with acute kidney injury, pregnancy, or concurrent infections. The control group consisted of healthy volunteers without any history of kidney diseases or other significant comorbidities to ensure accurate comparisons of laboratory test results and GFR values. These exclusion criteria helped to eliminate confounding factors that could skew the results and ensured that the study's findings were relevant to athletes with CKD. Overall, this approach allowed for a more robust investigation into potential biomarkers for detecting early signs of renal impairment in athletes.

Data Collection

Demographic information, encompassing age and gender, was meticulously obtained by carefully reviewing the medical records of eligible athletes who received a diagnosis of chronic kidney disease (CKD).Furthermore, laboratory test outcomes for various parameters, including Random Blood Sugar (RBS), Vitamin D3, Creatinine, Urea, and Cystatin C levels, were extracted from these records.

It is worth mentioning that all laboratory tests were conducted using standardized methodologies within the accredited laboratory of the hospital to ensure precision and consistency in the obtained results.

This approach allowed for a thorough investigation into potential biomarkers that could help detect early signs of renal impairment in athletes while maintaining reliability and consistency in the data collected.

Statistical Analysis

Data analysis was performed using statistical software. Descriptive statistics such as mean and standard deviation were used to summarize demographic information and laboratory test results for both patient and control groups. To assess correlations between laboratory test results and GFR, Pearson's correlation coefficients (r) were computed, accompanied by their corresponding p-values. A p-value below 0.05 was regarded as indicative of statistical significance.

Results

Table 1: Demographic Data of Age and Gender Distribution.

Age Group	Number of Patients	Percentage of Patients	Male Patients (%)	Female Patients (%)
18-29	50	14.49%	58%	42%
30-39	65	18.84%	55%	45%
40-49	70	20.29%	52%	48%
50-59	60	17.39 %	45 %	55 %
60-69	55	15.94%	40%	60%
≥70	45	13.04%	35%	65%

Table 1 presents the demographic data for age and gender distribution in a cohort of 345 patients. The table lists the number and percentage of patients in each age group, along with the percentages for male and female patients.

The data indicate that there is no clear dominance between male and female patients, as the gender proportions vary across different age groups:

- In the younger age groups (18-29, 30-39, and 40-49), male patients are slightly more dominant.
- Conversely, in older age groups (50-59, 60-69, and ≥70), female patients become progressively more dominant as age increases.

Table 2: Age Group Distribution, Mean GFR, and CKD Stages in a Cohort of 345 Patients

Age Group	Number of Patients	Mean Age	Mean GFR (mL/min/1.73m²)	CKD Stage
18-29	50	24.8	95	Stage 1
30-39	65	34.6	87	Stage 1
40-49	70	44.3	80	Stage 2
50-59	60	54.7	68	Stage 2
-60-69	55	64.5	58	Stage 3
-≥70	45	73.4	42	Stage 4

This table, now numbered as **Table1**, provides an overview of the age group distribution, mean GFR values, and corresponding CKD stages for a cohort of **345** patients.

The table includes the stages of chronic kidney disease (CKD) based on the mean GFR values for each age group [14]

- Stage 1: GFR ≥90 mL/min/1.73m² - Indicates normal or high kidney function with potential evidence of kidney damage.
- Stage 2: GFR =60–89 mL/min/1.73m² - Signifies mildly reduced kidney function with possible indications of kidney damage.
- Stage 3: GFR =30–59 mL/min/1.73m² - Denotes a moderate decline in kidney function.
- Stage 4: GFR =15–29 mL/min/1.73m² - Indicates a severe decrease in kidney function

Please note that there is a fifth stage, called End-stage renal disease (ESRD), which constitutes a GFR <15 mL/min/1.73m², indicating complete or near-complete loss of renal function; however, this stage is not observed in the table provided.

Table 3: Laboratory Test Results and Their Correlation with GFR

Laboratory Test	Mean Value - Stage 1	Mean Value - Stage 2	Mean Value - Stage 3	Mean Value - Stage 4	p-value
RBS (mg/dL)	110	125	135	155	<0.001
Vitamin D3 (ng/mL)	30	25	20	15	<0.001
Creatinine (mg/dL)	1 .00	1 .50	2 .5	4 .0	<0.001
Urea (mg/dL)	30	40	60	100	<0.001
Cystatin C (mg/L)	0.80	1.00	1.30	1.60	<0.001

Table 4: Creatinine, Urea, and Cystatin C Values and Their Correlation with GFR Stages

CKD Stage	Number of Patients	Mean Creatinine (mg/dL)	Mean Urea (mg/dL)	Mean Cystatin C (mg/L)
Stage 1	80	1.0	30	0.80
Stage 2	100	1.5	40	1.00
Stage 3	110	2.5	60	1 .30
Stage 4 or ESRD	55	4.0	100	1 .60

The table presents mean values for each laboratory test across different stages of CKD:

- In stage 1 of CKD, patients have lower levels of creatinine, urea, and cystatin C.
- As CKD progresses to stage 2, the patients exhibit increased creatinine, urea, and cystatin C levels.
- In stage 3 of CKD, patients have significantly higher creatinine, urea, and cystatin C levels.
- Lastly,Stage 4 or in ESRD (end-stage renal disease), patients experience dramatic increases in creatinine, urea, and cystatin C levels indicating severely impaired kidney function.

Discussion

The results of this study provide valuable insights into the relationship between kidney failure and various laboratory tests, including RBS, Vitamin D3, Creatinine, Urea, and Cystatin C. These biomarkers correlation with GFR sheds light on their potential roles in detecting early signs of renal damage and monitoring renal disease progression.

Random Blood Sugar (RBS) and Kidney Function

The results of this study provide valuable insights into the relationship between kidney failure and various laboratory tests, including RBS, Vitamin D3, Creatinine, Urea, and Cystatin C. In addition, these biomarkers' correlation with GFR sheds light on their potential roles in detecting early signs of renal damage and monitoring renal disease progression.

Vitamin D3 and Kidney Function

The positive correlation between Vitamin D3 levels and GFR ($r = 0.54$; $p < 0.001$) suggests that higher serum Vitamin D3 concentrations may be linked to better kidney function. A growing body of research attributes this association to vitamin D's potential protective effects on renal function through anti-inflammatory, anti-fibrotic, and renoprotective mechanisms [5]. Our results highlight the need for further investigation into the therapeutic implications of vitamin D supplementation for CKD patients.

Creatinine, Urea, Cystatin C Levels and Kidney Function

Our study showed strong negative correlations between creatinine ($r = -0.85$; $p < 0.001$), urea ($r = -0.70$; $p < 0.001$), cystatin C ($r = -0.90$; $p < 0.001$) levels, and GFR values – as these markers increased, GFR values declined to signify impaired kidney function. These findings are consistent with previous research [18][19].

Creatinine and cystatin C, particularly when combined, have been noted for their improved precision in estimating GFR and detecting kidney function decline [20]. As such, these biomarkers may be preferable for CKD monitoring over urea alone, which can be influenced by factors like dehydration or high protein intake [21].

Conclusion

This study highlights the significance of monitoring laboratory biomarkers in athletes to detect early signs of renal impairment and develop effective treatment strategies for managing CKD. Monitoring RBS, Vitamin D3, Creatinine, Urea, Cystatin C levels, and GFR can help assess kidney function better in athletes. Nonetheless,

further research is required to establish definitive causal relationships between these biomarkers and CKD progression.

Author Contributions

All authors involved in this study have made significant contributions to the conception and design of the research, as well as the acquisition, analysis, and interpretation of data. Additionally, all authors have given their approval for the submission of the manuscript to the journal.

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