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Article

Impact of Chronic Renal Failure on Key Physiological and Biochemical Markers in Male and Female Patients in Iraq

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Abstract: Chronic renal failure (CRF), also known as chronic kidney disease (CKD), is characterized by progressive deterioration of kidney function, often necessitating renal replacement therapies such as dialysis or transplantation. This study aimed to evaluate immunological markers (IgG and IgA), liver function enzymes (AST, ALT, ALP), and key biochemical parameters (urea, creatinine, uric acid, calcium, sodium, potassium, chloride) in male and female patients diagnosed with CRF. A total of 90 subjects were enrolled, comprising 60 CRF patients (both male and female) aged 25 years and above, alongside 30 age-matched healthy controls aged 28 years and above. Our findings revealed significant elevations in IgG and IgA levels among CRF patients compared to controls, with a predominance in females (63.3%). Additionally, patients demonstrated increased liver enzyme activities and altered biochemical parameter levels relative to healthy individuals. Notably, the study also observed a possible association between celiac disease and an elevated risk of CKD development. These results underscore the importance of monitoring immunological and biochemical profiles to better understand CRF progression and its comorbidities. The findings highlight the critical role of immunological and biochemical markers in reflecting disease severity and associated complications in CRF patients. Monitoring these parameters can aid in early detection, improved management, and potentially slow disease progression. Moreover, exploring targeted therapeutic interventions aimed at modulating immune responses and metabolic imbalances may offer promising avenues to improve patient outcomes in CRF.

Keywords: Chronic Renal Failure, Male and Female Patients, Immunological Markers, Liver Function Enzymes, Kidney Function, Biochemical Parameters

Introduction

Kidney failure, commonly known as end-stage kidney disease, includes two major types: acute renal failure (ARF), characterized by rapid onset, and chronic kidney disease (CKD), which progresses over a longer duration. Clinical symptoms of kidney dysfunction can be presented as peripheral edema, fatigue, anorexia, vomiting, or confusion. Acute kidney injury frequently leads to complications such as uremia, fluid overload, and elevated serum potassium, whereas CKD is strongly associated with comorbidities, including hypertension, cardiovascular disease, and anemia (Norton et al., 2017).

CKD is a growing global public health concern, with its burden increasing worldwide (Bello et al., 2017). The diagnosis of CKD is confirmed either by a glomerular filtration rate (GFR) below 60 mL/min/1.73 m^2 or by persistent markers of kidney damage such as elevated urinary albumin for a duration exceeding three months, irrespective of the underlying etiology. Kidney failure, denoted as stage 5 CKD, represents the advanced progression of the disease (Webster et al., 2017). The etiology of ARF is often multifactorial and contributes significantly to morbidity and mortality, with reported death rates between 11% and 63% among pediatric and critically ill adult populations (Schneider et al., 2010).

Globally, CKD affects an estimated 11–13% of individuals, and data from Murray et al. (2021) showed that approximately one in seven adults in the United States (~37 million) has CKD, commonly linked to chronic illnesses such as hypertension and diabetes. CKD often presents alongside these chronic diseases and is complicated by cardiovascular conditions, anemia, progressive renal impairment, episodes of acute kidney injury, mineral and bone disorders, and cognitive decline (Pendse et al., 2005; Hill et al., 2016). The progression from CKD to cardiovascular disease markedly increases morbidity and mortality, exerting a significant impact on healthcare resources (Lv et al., 2019).

Common clinical manifestations of renal impairment include decreased urine output, swelling of the legs, ankles, and feet resulting from fluid retention, unexplained shortness of breath or fatigue, persistent nausea, leg discomfort, and drowsiness (Breyer et al., 2016). In resource-limited settings, patients frequently present at late stages of CKD requiring renal replacement therapies like dialysis or transplantation. Estimation of kidney function through GFR calculation, incorporating variables such as age, blood chemistry, and gender, plays a critical role in diagnosis and staging (Sin et al., 2020).

Several modifiable risk factors contribute to CKD development and progression, including diabetes mellitus, hypertension, physical inactivity, excessive dietary salt intake, and tobacco smoking. Other factors such as familial predisposition, advanced age (over 60 years), cardiovascular disease, obesity, race or ethnicity differences, autoimmune diseases, and genetic conditions like polycystic kidney disease also influence CKD risk. Diet and lifestyle factors, including high red meat consumption and insufficient physical activity, have been correlated with increased CKD incidence and mortality (Kelly et al., 2017). Furthermore, disrupted sleep duration and patterns are associated with accelerated CKD progression (Bach et al., 2019).

Celiac disease, also referred to as celiac sprue or gluten intolerance, is a chronic autoimmune disorder triggered by a reaction to gluten proteins. This condition primarily affects the small intestine and commonly manifests with symptoms such as diarrhea, abdominal pain, weight loss, and malnutrition, all of which can severely impact patients' quality of life (Pinto-Sanchez et al., 2021; Catassi et al., 2022). Notably, individuals with celiac disease appear to have an elevated risk of developing kidney-related complications, particularly IgA nephropathy. The likelihood of renal involvement may vary depending on the specific celiac disease phenotype (Nurmi et al., 2022).

Although some studies suggest a link between celiac disease and impaired kidney function, the existing evidence is limited and lacks the robustness needed to conclusively define this association (Lai et al., 2023). This study aims to deepen the understanding of kidney-related complications in celiac disease and to evaluate kidney function along with key physiological and biochemical markers including immunological indicators (IgG, IgA) and liver enzymes in male and female patients with CRF. It also investigates the possible link between celiac disease and chronic kidney disease (CKD). The outcomes are intended to improve insight into CRF progression, associated comorbidities, and support better diagnosis, monitoring, and targeted treatment approaches.

Materials and Methods

Study design and setting

This cross-sectional study was carried out at the Department of Pathological Analysis and Fallujah Teaching Hospital, Iraq between January and June 2024. It involved 60 patients diagnosed with renal failure and 30 healthy control subjects, all aged 25 years or older. Five milliliters of venous blood were collected from each participant into sterile tubes. Serum was separated to assess liver function

markers, urea, creatinine, uric acid, calcium, sodium, potassium, and chloride levels. Additionally, participants completed a questionnaire gathering demographic information, including gender, age, marital status, residence, and any conditions related to renal failure.

Statistical analysis

The collected data were analyzed using SPSS version 18. Descriptive statistics such as the mean and standard deviation were calculated, and Pearson's correlation coefficient was applied to assess relationships among variables. Independent t-tests were conducted to compare means between the two study groups, with statistical significance set at $\alpha = 0.05$ (P-value < 0.05)/

Results and Discussion

The analysis revealed differences in immunoglobulin levels between male and female chronic kidney disease (CKD) patients, as well as between control males and females. Figure 1 illustrate the Immunoglobulin G (IgG) and Immunoglobulin A (IgA) levels in CKD patients and control groups. The results show a statistically significant difference, with control males exhibiting higher IgG levels than male CKD patients. In contrast, no significant differences were found among female controls. Additionally, both male and female CKD patients demonstrated a significant increase in IgA levels compared to their respective control groups.

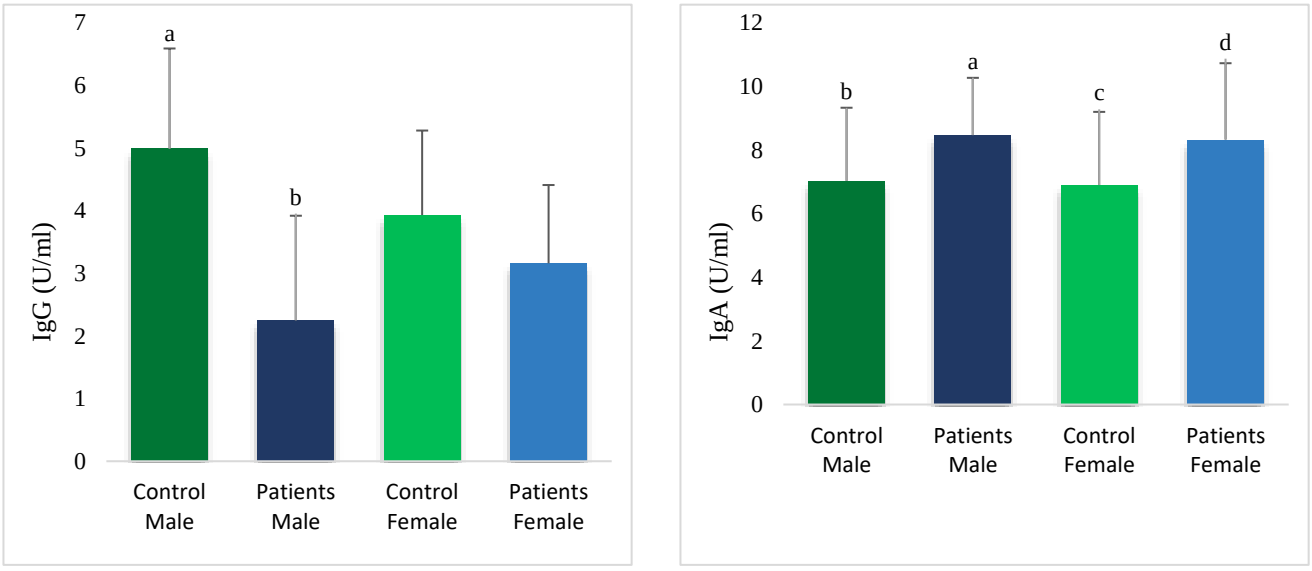

Figure 1. The concentration of Deamidated Gliadin Peptide (DGP) Antibodies (IgG) and (IgA), of patients with chronic kidney disease (CKD) and controls.

Mean values within a row not sharing a common superscript letters (a, b, c, d) were Significantly different, $p < 0.05$.

IgG = Immunoglobulin, IgA = Immunoglobulin A.

The differences in immunoglobulin profiles between male and female CKD patients, especially the elevated IgA levels in both groups compared to controls, support the growing evidence of immune dysregulation in kidney disease progression. Elevated serum IgA is particularly important due to its key role in IgA nephropathy, a common glomerulonephritis. Studies have linked celiac disease to a higher prevalence of IgA nephropathy; for example, Welander et al. (2013) reported that celiac patients have about a threefold increased risk of developing IgA nephropathy. Nurmi et al. (2018) found that kidney disease patients positive for tissue transglutaminase (tTG) antibodies a marker of celiac disease had poorer renal function, with 8.2% tTG positivity among IgA nephropathy patients versus 4.5% in the wider kidney disease population. Additionally, 12–22% of IgA nephropathy patients test positive

for anti-gliadin IgA antibodies, further supporting a connection between gluten-related immune responses and kidney damage (Sategna-Guidetti et al., 1992; Moeller et al., 2014).

More recent research reinforces this association. Ge et al. (2024) showed that celiac disease patients have a higher incidence of CKD, with elevated IgA correlating with disease severity. A 2016 meta-analysis by Wijarnpreecha et al. (2016) confirmed the increased risk of renal impairment in celiac patients, highlighting immunological markers as important indicators of kidney involvement. Overall, these findings emphasize the need to monitor immunoglobulin levels, particularly IgA, in CKD patients, especially those with autoimmune conditions like celiac disease. Immune-mediated mechanisms, with IgA at their core, likely play a crucial role in linking intestinal and kidney pathology. Improved understanding of these connections can guide better clinical management to identify high-risk patients and tailor therapies to reduce kidney damage.

Figure 2 show the levels of Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), and Alkaline Phosphatase (ALP) in patients with CKD compared to controls. No significant differences were observed in enzyme levels among female controls. However, both male and female CKD patients exhibited a significant increase in AST levels compared to their respective control groups. Additionally, ALT and ALP levels were significantly higher in male and female CKD patients than in controls. These results demonstrate clear enzyme elevation associated with CKD across.

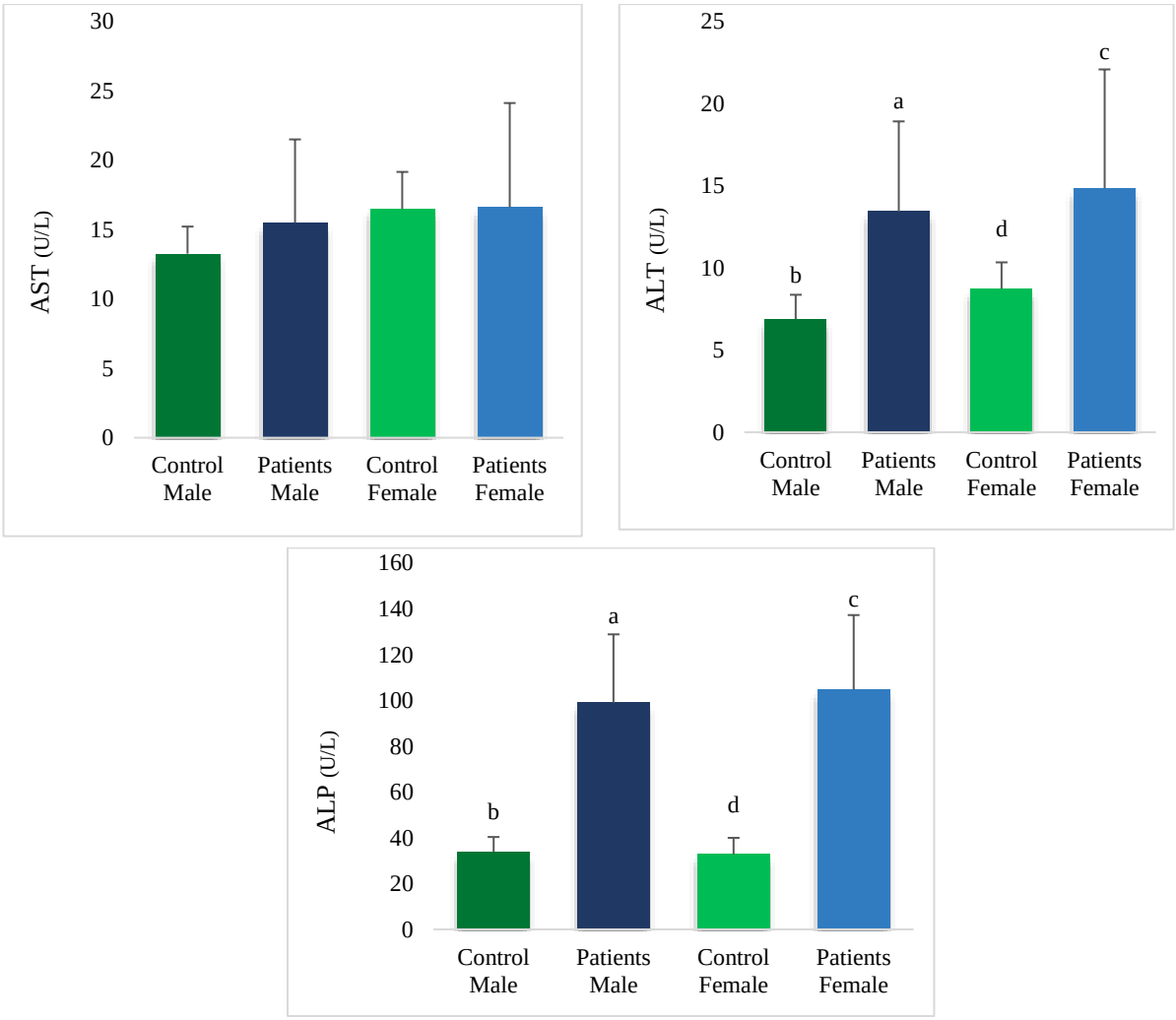

Figure 2. The concentration of AST, ALT, and ALP in patients with chronic kidney disease (CKD) and controls for males and females.

Mean values within a row not sharing a common superscript letter (a, b, c, d) were significantly different, $p < 0.05$.

AST= Aspartate Aminotransferase, ALT= Alanine Aminotransferase, ALP =Alkaline Phosphatase

Elevated alkaline phosphatase (ALP) levels have been strongly linked to an increased risk of vascular calcification and cardiovascular mortality in patients with chronic kidney disease (CKD), indicating that ALP serves not only as a marker of liver dysfunction but also as an indicator of systemic complications associated with kidney impairment (Blayney et al., 2008; Shantouf et al., 2009). Additionally, a 2025 systematic review by Ammar et al. highlighted that CKD is characterized by significant alterations in various biochemical parameters, including raised ALP and reduced serum albumin and aminotransferases (AST and ALT), all of which are closely associated with disease severity and progression. These changes likely reflect the metabolic imbalances, persistent inflammation, and malnutrition frequently observed in CKD patients (Ammar et al., 2025). The disturbances in liver enzymes especially AST, ALT, and ALP offer valuable insights into the complex interplay between renal dysfunction and hepatic metabolism. Regular assessment of these enzymes, alongside kidney function markers, provides a more comprehensive evaluation of patient health and prognosis.

Figure 3 illustrate the levels of blood urea, serum creatinine, uric acid, serum calcium, sodium, serum potassium, and serum chloride in patients with CKD compared to controls. Significant differences were observed between CKD patients and controls for both males and females. Specifically, blood urea, serum creatinine, and uric acid levels were significantly elevated in male and female CKD patients compared to their respective control groups, with no significant differences noted among female controls.

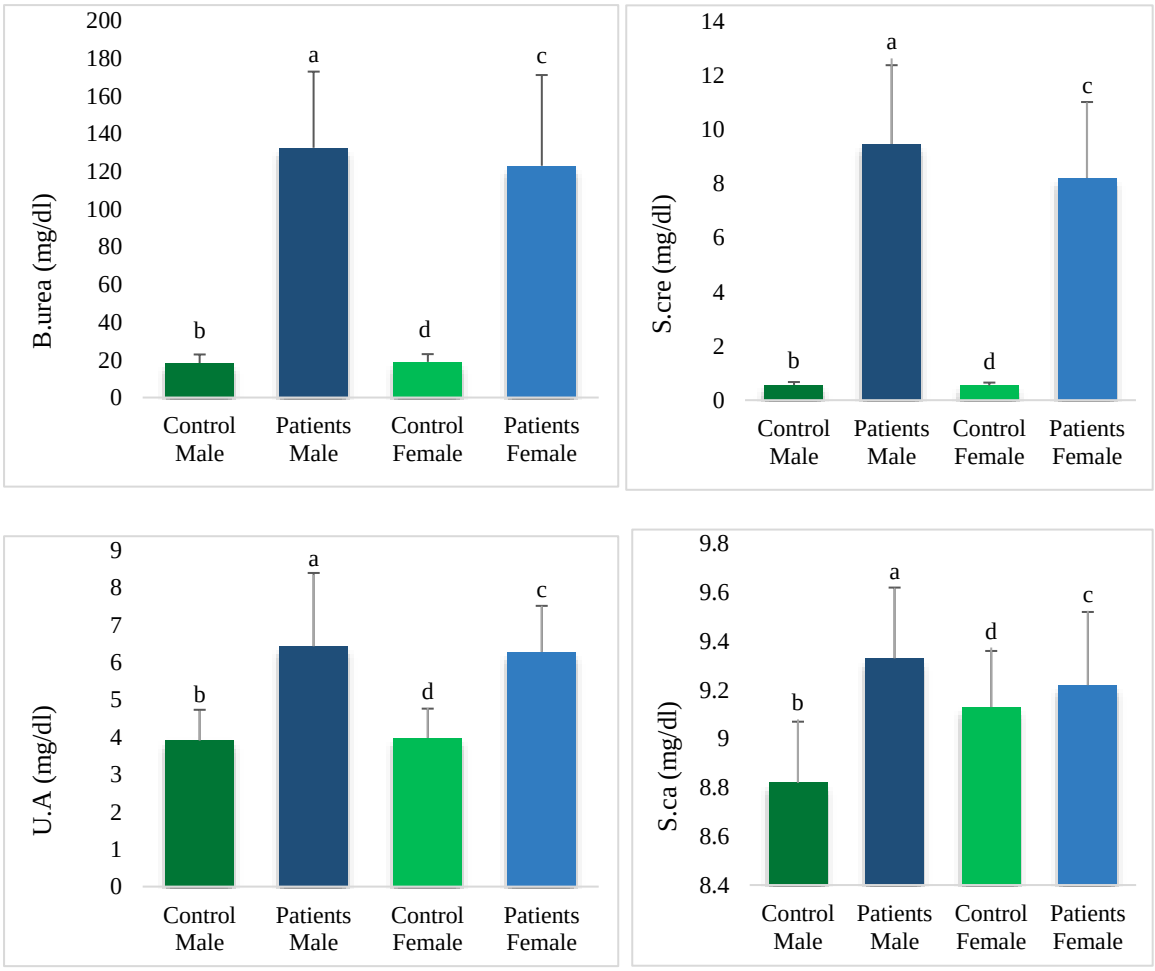

Figure 3. The concentration of B. Urea, S. Cre, U.A, and S. Ca of patients with CKD and controls for different males and females.

Mean values within a row not sharing a common superscript letter (a, b, c, d) were Significantly different, $p < 0.05$

B. Urea = Blood urea, S. Cre = Serum Creatinine, U.A = Uric Acid, S. Ca = Serum Calcium.

The marked elevation of blood urea, serum creatinine, and uric acid levels in male and female CKD patients compared to controls confirms their status as key indicators of impaired kidney function. These findings align with previous studies highlighting the accumulation of metabolic waste products in the blood due to reduced renal clearance in CKD (Meri et al., 2022). While urea is partially reabsorbed and less specific for kidney dysfunction, its elevated levels, alongside those of creatinine, remain critical markers for diagnosing and monitoring both acute and chronic kidney failure (Edward Arnold et al., 2008). Electrolyte imbalances observed, including increased serum potassium and chloride levels, underscore the kidney's reduced ability to maintain homeostasis. Potassium is primarily excreted by the kidneys, and dysfunction leads to hyperkalemia, a potentially life-threatening complication in CKD. Studies suggest that serum chloride elevation correlates with a decline in glomerular filtration rate (eGFR), emphasizing its role as a marker for worsening kidney function (Hassab et al., 2023).

Regarding enzyme markers, significant increases in AST, ALT, and ALP among CKD patients indicate hepatic involvement and systemic metabolic disturbances commonly seen in renal impairment. Elevated ALP, in particular, has been linked to an increased risk of vascular calcification and cardiovascular mortality in patients undergoing maintenance hemodialysis, underscoring its prognostic relevance (Shantouf et al., 2009). These enzyme elevations reflect a complex interplay between renal dysfunction, inflammation, and liver metabolism alterations in CKD. Together, these biochemical and enzymatic changes highlight the multisystem impact of CKD and the importance of comprehensive monitoring to guide clinical management and mitigate complications.

Conclusion

This study reveals significant changes in immunological markers, liver enzymes, and key biochemical parameters in male and female chronic renal failure (CRF) patients in Iraq, highlighting the disease's systemic impact. Elevated IgG and IgA levels point to immune dysregulation, especially the link between IgA, intestinal, and kidney pathology. Increases in liver enzymes and metabolic markers further demonstrate the multisystem disturbances in CRF, with variations observed between genders. However, the study's small sample size, cross-sectional design, and region-specific population limit causal conclusions and wider applicability. Future research should involve larger, multicenter, and longitudinal studies to better understand biomarker dynamics and their predictive value. Exploring genetic and environmental influences across diverse populations and integrating clinical with biochemical and immunological data may enhance early diagnosis, risk assessment, and personalized CRF management.

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