LABORATORY PROFILE OF RENAL FUNCTION IN PATIENTS FROM A SCHOOL LABORATORY

PERFIL LABORATORIAL DA FUNÇÃO RENAL DE PACIENTES EM UM LABORATÓRIO ESCOLA

Karolina Lares Fernandes Assis[1], Lara Mendonça da Cruz[2], Isabella Barbosa Machado[3], Thalyta Renata Araújo Santos[4], Clayson Moura Gomes[5]*, Sérgio Henrique Nascente Costa[6]

[1]Undergraduate student in Biomedical Sciences at the Federal University of Goiás (UFG), Goiânia, GO, Brazil; [2]Undergraduate student in Medicine at the Pontifical Catholic University of Goiás (PUC-Goiás), Goiânia, GO, Brazil; [3]Undergraduate student in Medicine at the Pontifical Catholic University of Goiás (PUC-Goiás), Goiânia, GO, Brazil; [4]Pharmacist and Coordinator of the Rômulo Rocha Clinical Laboratory at the Federal University of Goiás (UFG), Goiânia, GO, Brazil; [5]Permanent faculty member of the Graduate Programs in Environmental and Health Sciences and Genetics at the Pontifical Catholic University of Goiás (PUC-Goiás), Goiânia, GO, Brazil; [6]Permanent faculty member of the Graduate Program in Health Care and Evaluation at the Federal University of Goiás (UFG), Goiânia, GO, Brazil.

*Corresponding author: Clayson Moura Gomes – Email: claysonmoura@yahoo.com.br

ABSTRACT: Kidney failure is a serious condition that occurs when the kidneys cannot filter the blood properly. Characterizing specific populations, comparing and optimizing diagnostic techniques are important for advancing the understanding of IR and improving clinical conditions. This study investigated the prevalence of changes in renal function, using the estimate of e-GFR and the albumin-creatinine ratio. A cross-sectional study was carried out on 584 patients who underwent creatinine and albuminuria tests, with 61.5% women and 38.5% men. The majority of patients (83.4%) had preserved or slightly reduced renal function (G1/G2), while 16.6% had moderate to severe impairment (G3-G5). Albuminuria was absent or mild in 58.08% (A1), moderate in 36.81% (A2) and severe in 10.1% (A3). The analysis revealed variation in kidney function, highlighting the importance of risk stratification and early management of chronic kidney disease to guide appropriate clinical decisions.

KEYWORDS: Renal Insufficiency Chronic. Albuminuria. Glomerular Filtration Rate. Creatinine.

RESUMO: A insuficiência renal é uma condição grave que ocorre quando os rins não conseguem filtrar o sangue adequadamente. Caracterizar populações específicas, comparando e otimizando as técnicas de diagnósticos são importantes para a evolução do entendimento da IR e melhoria das condições clínicas. Este estudo investigou a prevalência de alterações na função renal, utilizando a estimativa da e-TFG e a relação albumina-creatinina. Foi realizado um estudo transversal de 584 pacientes que realizaram exames de creatinina e albuminúria, com 61,5% mulheres e 38,5% homens. A maioria dos pacientes (83,4%) apresentou função renal preservada ou levemente reduzida (G1/G2), enquanto 16,6% tinham comprometimento moderado a severo (G3-G5). A albuminúria estava ausente ou leve em 58,08% (A1), moderada em 36,81% (A2) e grave em 10,1% (A3). A análise revelou uma variação na função renal, destacando a importância da estratificação de risco e do manejo precoce da doença renal crônica para guiar decisões clínicas adequadas.

PALAVRAS-CHAVE: Insuficiência Renal Crônica. Albuminúria. Taxa de Filtração Glomerular. Creatinina.

INTRODUCTION

Renal failure (RF) is a severe condition that affects millions of people worldwide. This condition occurs when the kidneys are unable to properly filter the blood, leading to the accumulation of toxic substances such as urea and creatinine in the bloodstream.[1]

RF has a high prevalence in the Brazilian population and is often associated with other health conditions, such as anemia, diabetes, and hypertension.[2] RF can manifest in two main forms: Acute Kidney Injury (AKI) and Chronic Kidney Disease (CKD). The latter is characterized by slow, gradual, and irreversible progression.[3]

The diagnosis of RF is performed through blood and urine tests, in addition to imaging exams such as ultrasound, magnetic resonance imaging (MRI), or computed tomography (CT) scans. Early diagnosis is crucial for initiating treatment and reducing complications and disease-related mortality.[4]

CKD is a complex disease that significantly affects the quality of life of those affected. Various treatments are available, including renal replacement therapy, such as hemodialysis, peritoneal dialysis, and kidney transplantation.[5]

Chronic kidney disease (CKD) is defined as structural or functional kidney alterations persisting for at least three months. It is classified based on the glomerular filtration rate (GFR), staged from G1 to G5, and albuminuria, categorized from A1 to A3.[6] CKD is a severe condition associated with high morbidity and mortality rates. It involves kidney injury of varying degrees with progressive loss of function, ultimately leading to end-stage uremic syndrome. The latter condition becomes evident when the kidneys can no longer properly filter the blood, failing to eliminate excess or toxic substances from the body.[6]

Among the markers used to assess kidney function, albumin is the most commonly utilized protein, particularly in detecting damage to the glomeruli, which are the functional units of the kidneys. Under normal kidney function, albumin is retained in the blood and does not pass into the urine in significant amounts. However, in CKD, damaged glomeruli allow albumin and other proteins to pass into the renal filtrate, resulting in proteinuria.[7] The detection of albumin in urine, especially in abnormal quantities, is a key indicator of kidney dysfunction.

Another important marker is serum creatinine measurement. Creatinine is a degradation product of muscle creatine, a substance continuously produced by the body. It is filtered by the kidneys and excreted in the urine at a relatively constant rate, making it a useful indicator of kidney function. Thus, when its levels in the urine are elevated, along with an increase in other proteins, it suggests renal dysfunction.[7]

Serum creatinine levels can be used to estimate the Glomerular Filtration Rate (GFR), which assesses the kidneys' ability to filter blood. A decrease in GFR is a key marker of chronic kidney disease. It can be estimated based on serum creatinine levels, along with other factors such as age and sex. Conditions such as diabetes and hypertension are the leading causes of kidney disease and can contribute to reduced GFR. The lower the filtration rate, the more advanced the stage of kidney disease. Therefore, GFR assessment is recommended for monitoring kidney function in patients with renal disease or those using nephrotoxic medications.[8,10]

The Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) developed a new equation in 2009, which is a variation of the previously existing Modification of Diet in Renal Disease (MDRD) formula. This equation was derived from a cohort study that included individuals with and without CKD.[11] However, this formula was later adjusted by Inker et al. (2021) to remove race as a variable, recognizing it as a social construct rather than a biological determinant.[12]

Health promotion and disease prevention are fundamental to reducing the impact of CKD on the population. Based on the findings of this study, strategic actions could be implemented to enable early identification of renal dysfunction, allowing for more effective monitoring of at-risk patients. Furthermore, this reinforces the importance of kidney function monitoring, particularly among individuals with risk factors such as hypertension and diabetes, as well as the relevance of laboratory findings. Such initiatives emphasize the role of prevention and facilitate early interventions, reducing CKD progression and improving patients' quality of life.

Thus, the objective of the present study was to assess the prevalence of renal function impairment in patients attended at the Rômulo Rocha Laboratory from January to December 2023. This was achieved through the estimation of glomerular filtration rate (eGFR) using serum creatinine and the albumin-to-creatinine ratio (ACR) in urine.

METHODOLOGY

STUDY TYPE AND POPULATION

This was a cross-sectional, retrospective study, based on the collection of secondary data from patients attended at the Rômulo Rocha Laboratory of the Federal University of Goiás (UFG), during the period from January to December 2023.

INCLUSION CRITERIA

Patients who underwent serum creatinine and albuminuria tests simultaneously between January and December 2023 were included in the study.

CRITERIA FOR RENAL PROFILE CLASSIFICATION

The classification of the renal profile was based on the estimated glomerular filtration rate (eGFR), obtained from serum creatinine, and albuminuria in an isolated urine sample (albumin-to-creatinine ratio).

The equation used to calculate eGFR was derived from the CKD-EPI (2021) calculator, available at https://www.kidney.org/content/ckd-epi-creatinine-equation-2021 The CKD-EPI (2021) equation used was: e-TFG = $142 \times \min(S_{CR}/\kappa, 1)\alpha \times \max(S_{CR}/\kappa, 1)\text{-}1.200 \times 0.9938$Idade $\times 1.012$ [if female].

Where Scr corresponds to serum creatinine (mg/dL), κ (kappa) is 0.7 for women and 0.9 for men, α (alpha) is -0.241 for women and -0.302 for men, min indicates the minimum value between S_{CR}/κ or 1, max indicates the maximum value between Scr/κ or 1.[12]

Based on eGFR, renal profile classification followed the criteria established by Kidney Disease: Improving Global Outcomes (KDIGO, 2024), which is also adopted by the Brazilian Society of Nephrology and the Ministry of Health. The classification criteria are as follows.

Table 1. Stages of Kidney Function According to eGFR.

Stage	Description	eGFR
G1	Normal or High	>90 ml/min/1.73m²
G2	Mildly Decreased	60-89 ml/min/1.73m²
G3a	Mild to Moderate Decrease	45-59 ml/min/1.73m²
G3b	Moderate to Severe Decrease	30-44 ml/min/1.73m²
G4	Severe Decrease	15-29 ml/min/1.73m²
G5	Kidney Failure	<15 ml/min/1.73m²

The KDIGO (2024) classification was also used for albuminuria, based on the albumin-to-creatinine ratio (ACR) in mg of albumin per g of creatinine in urine, as shown below:

Table 2. Kidney Function Categories Based on Albumin-to-Creatinine Ratio (ACR) in an Isolated Urine Sample.

Category	Description	ACR
A1	Normal or mildly increased	<30 mg/g
A2	Moderately increased	30-300 mg/g
A3	Severely increased	>300 mg/g

DATA SOURCE AND ANALYSIS

The secondary data collection was conducted using the Multilab® software, which allows for patient registration, interfacing, and release of laboratory reports, as well as the storage of pre-analytical, analytical, and post-analytical information related to the tests. The data from this collection were tabulated using Excel 365® and analyzed descriptively using PAST 4.03® software, applying the Chi-square test with a significance level of $p<0.05$.

ETHICAL CONSIDERATIONS

This study is part of the research project titled: "Survey of Transmissible and Non-Transmissible Diseases in the Databases of the Rômulo Rocha Laboratory (FF-UFG) and the Transplant Immunology Laboratory of Goiás (HLAGYN)." The project was approved by the Research Ethics Committee (CEP) of the Federal University of Goiás (UFG) under approval number 6.6526503 (CAAE 76580723.0.0000.5083).

RESULTS

Applying the defined inclusion criteria, 584 patients aged 40 to 75 years were selected and assessed for their renal profile. Among them, 359 (61.5%) were female and 225 (38.5%) were male. The evaluation included the albumin-to-creatinine ratio (ACR), serum creatinine levels, and the estimated glomerular filtration rate (eGFR), with data collected between January and December 2023.

The classification of the patients' renal profile based on eGFR is presented below (n = 584) (Figure 1). The results indicate that the majority of individuals fall into G1 (41.79%) and G2 (41.61%), suggesting preserved or mildly reduced kidney function. In contrast, G3a (8.90%) and G3b (4.97%) reflect moderate impairment of renal function. More advanced stages, such as G4 (2.39%) and G5 (0.34%), were observed with lower frequency.
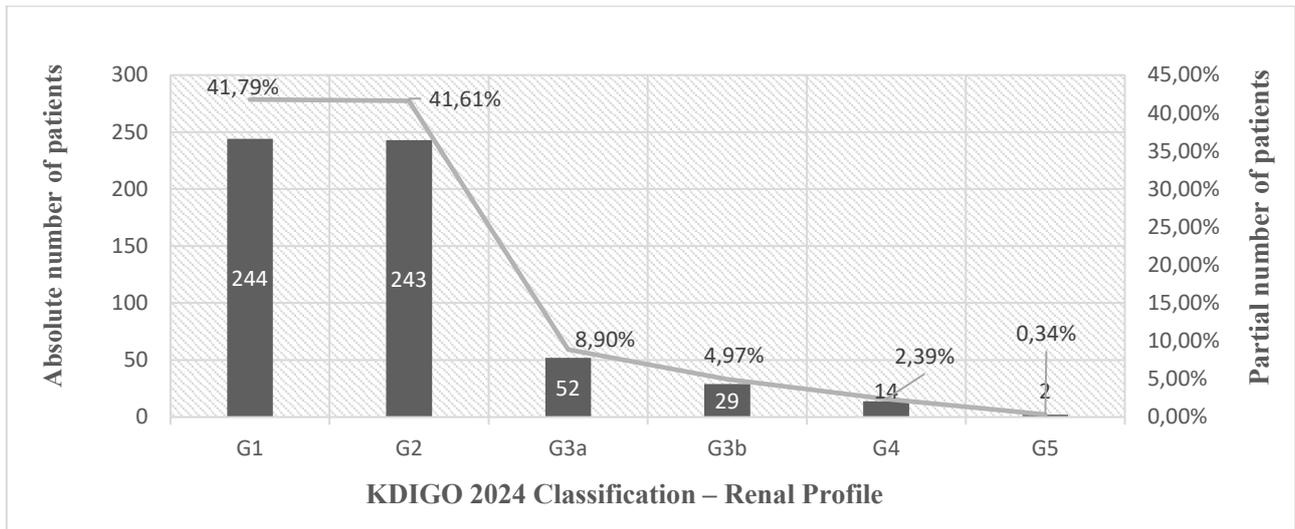
Figure 1. Renal profile of patients based on eGFR. G1 – Normal; G2 – Slightly decreased; G3a – Mild to moderately decreased; G3b – Moderately to severely decreased; G4 – Severely decreased; G5 – Kidney failure.

The number of patients evaluated for the urinary albumin-to-creatinine ratio (ACR) was 584. The majority of patients (58.08%) fell into category A1 (ACR < 30 mg/g), indicating no or mildly increased albuminuria. Meanwhile, 36.81% of patients were classified as A2 (ACR between 30–300 mg/g), suggesting moderately increased albuminuria. In contrast, 10% of individuals had ACR values above 300 mg/g (A3), reflecting more advanced kidney impairment (Figure 2).
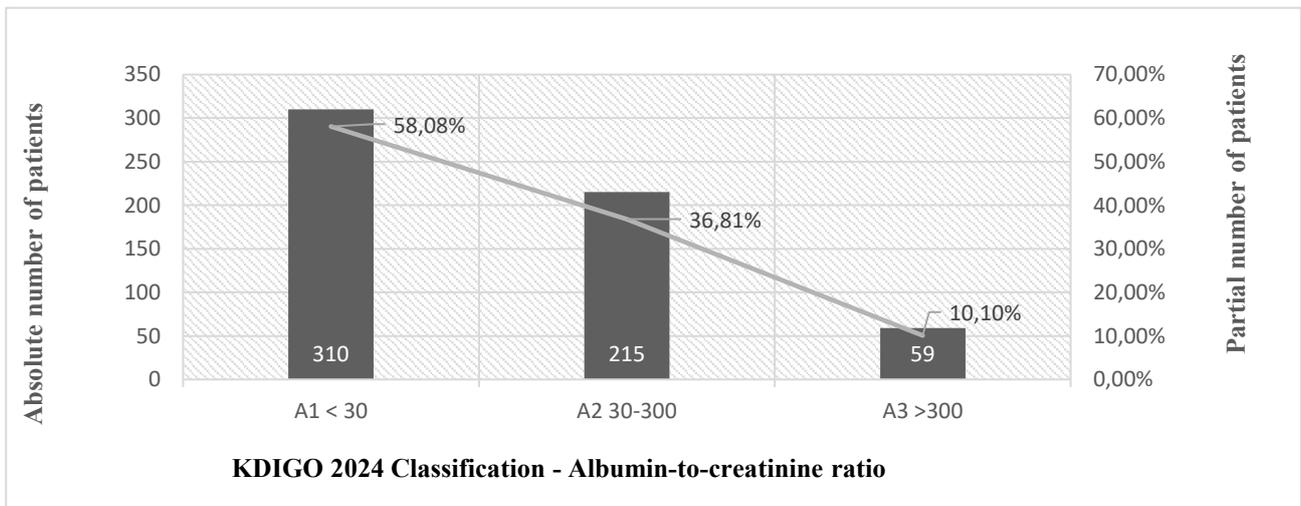

Figure 2. Distribution of patients according to the albumin-to-creatinine ratio: A1, normal to mildly increased; A2, moderately increased; A3, severely increased.

Table 3 presents the classification of patients' kidney function based on eGFR and urinary albumin-to-creatinine ratio (n=584).

The distribution of the albumin-to-creatinine ratio (ACR), serum creatinine, and estimated glomerular filtration rate (eGFR) according to albuminuria levels is presented in Table 4.

Table 3. Kidney Function Classification Based on eGFR and Urinary Albumin-to-Creatinine Ratio (n=584).[6]

eGFR CATEGORIES	ALBUMINURIA CATEGORIES		
	A1 normal or mild increase (N=310) ACR <30 mg/g	A2 moderate increase (N=215) ACR 30-300mg/g	A3 severe increase (N=59) ACR >300mg/g
G1: Normal or High (eGFR >90 ml/min/1.73m²)	132/584 (22,60%)	96/584 (16,44%)	16/584 (2,75%)
G2: Slightly Decreased (eGFR 60-89 ml/min/1.73m²)	142/584 (24,30%)	83/584 (14,21%)	18/584 (3,08%)
G3a: Mild to Moderate Decrease (eGFR 45-59 ml/min/1.73m²)	26/584 (4,45%)	18/584 (3,08%)	8/584 (1,37%)
G3b: Moderately to Severely Decreased (eGFR 30-44 ml/min/1.73m²)	7/584 (1,20%)	12/584 (2,05%)	10/584 (1,71%)
G4: Severely Decreased (eGFR 15-29 ml/min/1.73m²)	3/584 (0,51%)	5/584 (0,86%)	6/584(1,03%)
G5: Kidney Failure (eGFR <15 ml/min/1.73m²)	0/584 (0,00%)	1/584 (0,17%)	1/584 (0,17%)

Caption: ACR = Albumin-to-creatinine ratio, eGFR = Estimated glomerular filtration rate.

⬤ - Low risk (if no other marker of kidney disease is present, CKD is not diagnosed);

⬤ - Moderately increased risk; ⬤ - High risk; ⬤ - Very high risk.

Table 4. Distribution of the mean and 95% confidence interval for albumin-to-creatinine ratio (ACR), serum creatinine, and estimated glomerular filtration rate (eGFR) results according to albuminuria levels (n=584).

Categorical Variables	ACR (mg/g) Mean (95% CI)[1]	Creatinine (mg/dL) Mean (95% CI)[2]	eGFR (ml/min) Mean (95% CI)[3]	p-value
A1 Female (n=189)	14,62 (13,50 - 15,73)	0,80 (0,78 - 0,83)	86,73 (83,95 - 89,52)	[1] p = 0,114
A1 Male (n=121)	13,22 (11,91 - 14,53)	1,10 (1,04 - 1,17)	81,67 (77,69 - 85,65)	[2] p < 0,001 [3] p = 0,034
A2 Female (n=145)	74,15 (65,27 - 83,03)	0,87 (0,81 - 0,94)	83,44 (79,46 - 87,42)	[1] p = 0,1190
A2 Male (n=70)	87,39 (71,73 - 103,04)	1,10 (1,00 - 1,20)	82,97 (77,45 - 88,50)	[2] p = 0,0001 [3] p = 0,8926
A3 Female (n=25)	863,76 (625,46 – 1102,10)	1,53 (0,63 – 2,42)	63,12 (51,25 – 74,99)	[1] p = 0,5344
A3 Male (n=34)	975,35 (716,43 – 1234,30)	1,48 (1,21 – 1,76)	68,94 (58,15 – 79,73)	[2] p = 0,9102 [3] p = 0,4648

Caption: Mean and 95% Confidence Interval for ACR, Creatinine, and eGFR by Sex (Female and Male) in Groups A1, A2, and A3.

DISCUSSION

The integrated analysis of the data allows for a comprehensive assessment of patients' kidney function, based on two fundamental measures: the estimated glomerular filtration rate (eGFR) and the urinary albumin-to-creatinine ratio (ACR). eGFR is a crucial parameter for evaluating the kidneys' efficiency in filtering blood, while ACR reflects the presence and severity of kidney damage, indicated by the amount of albumin in the urine. For instance, patients with an apparently healthy eGFR (classified as G1 or G2) may still present significant albuminuria (A2 or A3), suggesting the presence of kidney damage

despite a good glomerular filtration capacity. This set of information provides valuable guidelines for healthcare professionals in assessing renal health, particularly in managing chronic conditions.

When analyzing sex as a variable, it is observed that in the A1 female group, the mean ALB/CRE ratio was 14.62 mg/g (confidence interval of 13.50 to 15.73 mg/g). Normal ACR values in healthy adults are typically below 30 mg/g; however, in patients with chronic kidney disease, even values below this threshold may indicate excessive protein loss. Regarding serum creatinine, the A1 female group had a mean of 0.80 mg/dL (confidence interval of 0.78 to 0.83 mg/dL). Serum creatinine is widely used to estimate kidney function, with reference ranges varying by age and sex. For adult women, values between 0.5 and 1.1 mg/dL are considered normal, depending on the laboratory and population studied.

Additionally, the mean eGFR in the A1 female group was 86.73 ml/min (confidence interval of 83.95 to 89.52 ml/min), which falls within the expected range for healthy adults. Since normal eGFR values vary based on age, sex, and ethnicity, a filtration rate above 90 ml/min and 120 ml/min is generally considered normal. Values below this threshold may indicate impaired kidney function, as defined by national and international guidelines.

The differences between groups were statistically significant in several comparisons. In the A1 male group, a significant difference was observed in serum creatinine levels ($p < 0.001$), while in the A2 male group, there was a significant difference in eGFR ($p = 0.0001$). This reinforces the importance of considering demographic characteristics, such as sex, when analyzing kidney function data, as relevant differences can be observed between groups.

These results have significant clinical implications. The stratification of patients based on eGFR and ACR is an essential tool for identifying patterns and trends in kidney impairment, aiding in the monitoring and early intervention of patients at risk of renal dysfunction. Healthcare professionals can use this information to intervene early, particularly in cases of chronic kidney disease (CKD), a condition that affects a substantial portion of the population and can progress asymptomatically until advanced stages.

In managing CKD patients, early detection and regular monitoring are crucial. The use of the CKD-EPI equation to estimate eGFR has proven effective in clinical evaluation, allowing for more precise risk stratification and the implementation of appropriate therapeutic measures.

Chronic kidney disease (CKD) is characterized by structural or functional kidney abnormalities that persist for at least three months and impact patients' overall health. The classification of CKD includes categories based on cause, estimated glomerular filtration rate (eGFR) (G1–G5), and albuminuria (A1–A3), as defined by Kidney Disease Improving Global Outcomes. The present study observed that approximately 45% of patients had a moderately increased to high risk of developing CKD, while around 8% were at very high risk of developing the disease.

In this context, understanding the prevalence of chronic kidney disease enables healthcare professionals to anticipate future needs, adapt treatment protocols, and promote awareness programs. This contributes to a more effective approach to disease management and improving the quality of life of affected individuals.

Given the prevalence of this condition in the population, the study seeks to identify the most commonly used palliative treatments, both pharmacological and non-pharmacological, in chronic kidney patients. Among the non-pharmacological approaches, the main therapeutic interventions include renal replacement therapy through hemodialysis (HD), performed with the aid of an artificial kidney machine, continuous ambulatory peritoneal dialysis (CAPD), cyclic peritoneal dialysis, intermittent peritoneal dialysis, and transplantation.

Understanding the prevalence of CKD among patients allows healthcare professionals to anticipate future needs, adjust protocols, and promote awareness programs, optimizing disease management and improving patient quality of life.

Therefore, the careful interpretation of these parameters—eGFR, ACR, and serum creatinine—plays a fundamental role in monitoring and early intervention, aiding in the effective management of CKD and enabling a more efficient approach to preventing severe complications.

The study presents limitations that should be considered, as it is an observational study based on laboratory data without detailing the clinical condition of patients, as factors such as detailed medical history, lifestyle habits, and treatment adherence were not evaluated. Additionally, the sample was obtained from a single laboratory, which may limit the generalization of findings to other populations and regions with different epidemiological profiles.

For future research, longitudinal studies are recommended to track the progression of chronic kidney disease over time, as well as the inclusion of additional variables such as inflammatory and genetic biomarkers for a more comprehensive assessment of risk factors and prognosis. Further studies comparing different laboratories and populations are also suggested. Additionally, research comparing different therapeutic approaches, including prevention strategies and personalized management, may contribute to optimizing care for patients with chronic kidney disease.

CONCLUSION

Chronic Kidney Disease (CKD) is a complex condition that affects a significant portion of the population, with severe impacts on quality of life and public health. This study investigated the prevalence and associated factors of CKD in patients treated at the Rômulo Rocha Laboratory during the year 2023. The results revealed a high prevalence of renal function alterations among the studied patients, primarily characterized by a reduction in estimated glomerular filtration rate (eGFR) and the presence of albuminuria at varying degrees. Data analysis showed that most patients presented moderate renal function alterations, classified mainly under G2 (slightly decreased kidney function) and A2 (moderately increased albumin-to-creatinine ratio). These findings are consistent with the current literature, which associates conditions such as diabetes mellitus, hypertension, and chronic glomerulonephritis as the main risk factors for the development and progression of CKD.

Furthermore, the data provided in this study contribute to the development of more effective preventive and therapeutic strategies, aiming to mitigate the impact of CKD on public health. Understanding renal health patterns in different population groups, as demonstrated in the stratified analysis by sex and age, is essential for formulating targeted health policies and personalized interventions. Therefore, this study not only provides a comprehensive overview of CKD in the local context but also serves as a foundation for future research and for improving clinical practices aimed at managing and preventing chronic kidney diseases.

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