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The relationship between water intake and the progression of urine albumin-creatinine ratio in patients with chronic kidney disease: A cohort-prospective study

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ABSTRACT

Introduction: The urine albumin-creatinine ratio (uACR) is a key biomarker for assessing kidney function in patients with chronic kidney disease (CKD), with elevated levels indicating kidney damage. Water and protein metabolism significantly impact kidney function. Proper hydration influences vasopressin feedback and osmolality regulation, while excessive protein intake exacerbates kidney stress through hyperfiltration and increased urea production. This study investigates the relationship between daily water and protein intake and uACR levels in CKD patients.

Methods: A cohort study was conducted on 10 non-dialysis CKD patients at Dr. Wahidin Sudirohusodo Hospital, Makassar, Indonesia. Demographic and clinical data were collected, and average daily water and protein intake were assessed. The Spearman correlation test analyzed the relationship between water and protein intake and changes in uACR, albumin, and creatinine levels.

Results: A strong negative correlation was found between daily water intake and uACR (ρ=-0.891, p=0.001), indicating that higher water consumption reduces uACR. Conversely, protein intake showed a strong positive correlation with uACR (ρ=0.770, p=0.009) and urine albumin levels (ρ=0.806, p=0.005), suggesting that higher protein consumption increases both uACR and albumin excretion. No significant correlation was found between water or protein intake and urine creatinine levels.

Conclusion: This study highlights the importance of hydration and dietary protein regulation in managing CKD progression. Increased water intake may reduce uACR, while excessive protein intake can exacerbate kidney damage, emphasizing the need for dietary management in CKD patients.

KEYWORDS

Chronic kidney disease, urinary markers, fluid regulation, glomerular filtration, kidney function.

ABBEREVIATION

BMI: Body Mass Index.

CKD: Chronic Kidney Disease.

DM: Diabetes Mellitus.

eGFR: Estimated Glomerular Filtration Rate.

uACR: Urine Albumin-Creatinine Ratio.

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INTRODUCTION

Chronic kidney disease (CKD) is a progressive condition that affects millions worldwide, leading to deteriorating renal function over time[1]. Understanding the factors that influence the progression of CKD is crucial for developing effective management strategies. Two major factors that play a significant role in kidney function are water and protein intake[2]. Previous studies have explored the impact of hydration and dietary protein on kidney health, but the specific relationship between these factors and the urine albumin-creatinine ratio (uACR), a critical biomarker of kidney function, remains an area of ongoing investigation[3].

In patients with CKD, the urine albumin-creatinine ratio is a reliable indicator of kidney damage, with elevated levels reflecting compromised renal filtration capabilities[4]. Water intake, through its effect on vasopressin feedback and osmolality regulation, is thought to influence this marker, potentially slowing disease progression[5]. Similarly, protein consumption can exacerbate kidney function decline through hyperfiltration and increased intraglomerular pressure, as excess protein metabolism byproducts, such as urea, strain the kidney's filtering capacity[6]. This study aims to investigate these correlations further, shedding light on the impact of daily water and protein intake on the uACR in CKD patients, and providing insights into dietary management for disease control.

METHODS

Subject's and data collections

A cohort study was conducted on 10 non-dialysis CKD patients in Dr. Wahidin Sudirohusodo Hospital, Makassar, South Sulawesi, Indonesia. This study was approved by the Research Ethics Commission of the Faculty of Medicine, Hasanuddin University (No: 824/UN4.6.4.5.31/PP36/2022). Demographic (age, gender) and clinical (age (years), body mass index BMI (kg/m^2), smoking status, alcoholic status, hypertension, nasopharynx cancer, diabetes mellitus, hyperuricemia dyslipidemia) were collected by collecting medical record data from patients who were examined in Clinical Laboratory of Dr. Wahidin Sudirohusodo Central Hospital. Water (dL/day) and protein intake (g/day) were collected by recall.

Statistical analysis

Baseline data were descriptively summarized and crosstabulated. Each of the demographic and clinical features was analyzed. The correlation between average water and protein intake with changes in uACR (mg/g from urine albumin mg/dL and urine creatinine g/dL) was analyzed using the Spearman correlation test. All statistical analyses were performed using the Statistical Program for Social Sciences (IBM SPSS 24, IL, USA).

RESULTS

A total of 121 patients with chronic kidney disease (CKD) were initially screened for the study. Following the screening process, 110 patients were excluded based on specific criteria: 60 patients were at stage 5 CKD, 30 were at stage 4 CKD and undergoing hemodialysis (HD), 2 were at stage 3b CKD and receiving antidiuretic treatment, and 18 were at stage 2 CKD. After these exclusions, 11 patients from the Nephrology and Hypertension clinic at Dr. Wahidin Sudirohusodo Central Hospital were identified as eligible participants. However, during the study, one patient dropped out, leaving a final enrollment of 10 participants. The average age of the patients was 52.70 (10.26) years, with an average BMI of 23.60 (3.77). The majority of patients were employed (70.0%), male (70.0%), hypertensive (90.0%), and half of them were smokers as mentioned in Table 1.

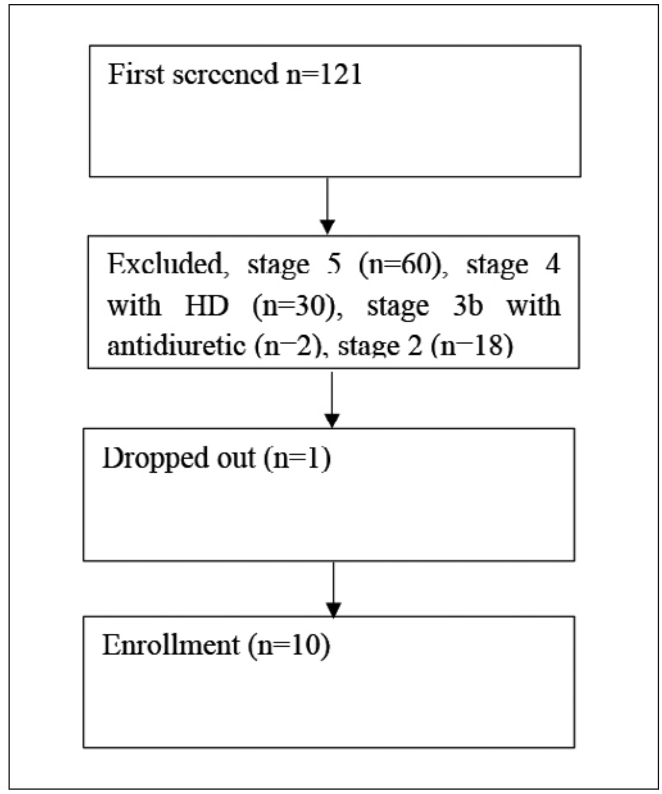

Figure 1. Subject enrollment

Based on the results of the Spearman correlation test, it was found that the average daily water intake was strongly negatively correlated with the urine albumin-creatinine ratio (ρ=-0.891, p-value=0.001), indicating that increased water consumption reduces uACR. The average daily protein intake was strongly positively correlated with the urine albumin-creatinine ratio (ρ=0.770, p-value=0.009), suggesting that reduced protein consumption lowers uACR. Furthermore, the average daily protein intake was very strongly positively correlated with urine albumin levels (ρ=0.806, p-value=0.005), indicating that decreased protein consumption reduces albumin levels. No correlation was found between the average total daily water intake and urine albumin or creatinine levels, nor between the average total daily protein intake and urine creatinine levels. All results can be seen in Table 2.

DISCUSSION

The research findings showed a significant strong negative correlation between average daily water consumption and the urine albumin-creatinine ratio as mentioned in Table 2 and Figure 1. This is consistent with previous studies showing that increased water intake of 2 (1.6-2.4) liters accelerates kidney function decline, leading to a faster decrease in eGFR. However, consumption of less than 1.0 liters per day also

Table 1. Patient's Demographic Data

Variable		Mean (SD)	Median (min-max)	n%
Age (years)		52.70 (10.26)	54.00 (40.00-67.00)	
BMI (kg/m^2)		23.60 (3.77)	23.80 (17.20-30.30)	
Profession	Employee			7 (70.0)
	Unemployed			3 (30.0)
Sex	Male			7 (70.0)
	Female			3 (30.0)
Smoking status	Yes			5 (50.0)
	No			5 (50.0)
Alcoholic	Yes			2 (20.0)
	No			8 (80.0)
Hypertension	Yes			9 (90.0)
	No			1 (10.0)
Nasopharynx cancer	Yes			1 (10.0)
	No			9 (90.0)
Diabetes mellitus	Yes			3 (30.0)
	No			7 (70.0)
Hyperuricemia	Yes			1 (10.0)
	No			9 (90.0)
Dyslipidemia	Yes			1 (10.0)
	No			9 (90.0)

n number, SD standard of deviation, min minimum, max maximum.

resulted in a decline in eGFR compared to those consuming 1.0-1.5 liters per day. The graph of kidney function decline is most evident with minimal water intake at 1.0-1.5 liters[7]. Water intake plays a role in the kidney's ability to concentrate urine in non-dialysis-dependent patients, allowing for tolerance of up to 0.7 liters per day, provided there are no signs of fluid overload[8-10]. Increasing water intake in CKD patients may provide positive effects through vasopressin feedback mechanisms, but it must be carefully monitored with regular assessments[11].

A significant strong positive correlation was found between CKD patients' daily protein intake and urinary albumin levels as mentioned in Table 2 and Figure 5. This indicates that increased protein intake leads to higher albumin excretion in the urine. This condition is related to protein metabolism, where protein is utilized as a substrate for albumin, the largest protein compartment in the body. In CKD patients, the filtration function is impaired due to the loss of charge on the glomerular basement membrane, causing albumin to leak into the urine[12]. Protein intake triggers glomerular hyperfiltration by increasing intraglomerular pressure due to elevated urea, a byproduct of protein metabolism. Therefore, protein restriction must be adjusted according to the patient's condition[13]. Strict protein restriction may lead to reduced glucagon and growth hormone levels, potentially causing malnutrition due to increased proteolysis within the body[14].

A strong positive correlation was also found between CKD patients' daily protein intake and the urine albumin-creatinine ratio as mentioned in Table 2 and Figure 4. This occurs because albumin increases in the numerator, with no significant change in creatinine levels, leading to an increase in the albumin-creatinine ratio.

Table 2. Correlation between variables and changes in the urine albumin-creatinine ratio (uACR) based on the Spearman correlation

Variable		Δ uACR (ratio mg/g)	Δ albumin (mg/dL)	Δ creatinine (g/dL)
Average of water (dL/day) consumption	ρ	-0.891	-0.564	-0.055
	p-value	0.001*	0.090	0.881
Average of protein (gr/day) consumption	ρ	0.770	0.806	0.224
	p-value	0.009*	0.005*	0.533

Spearman correlation test, *significant.

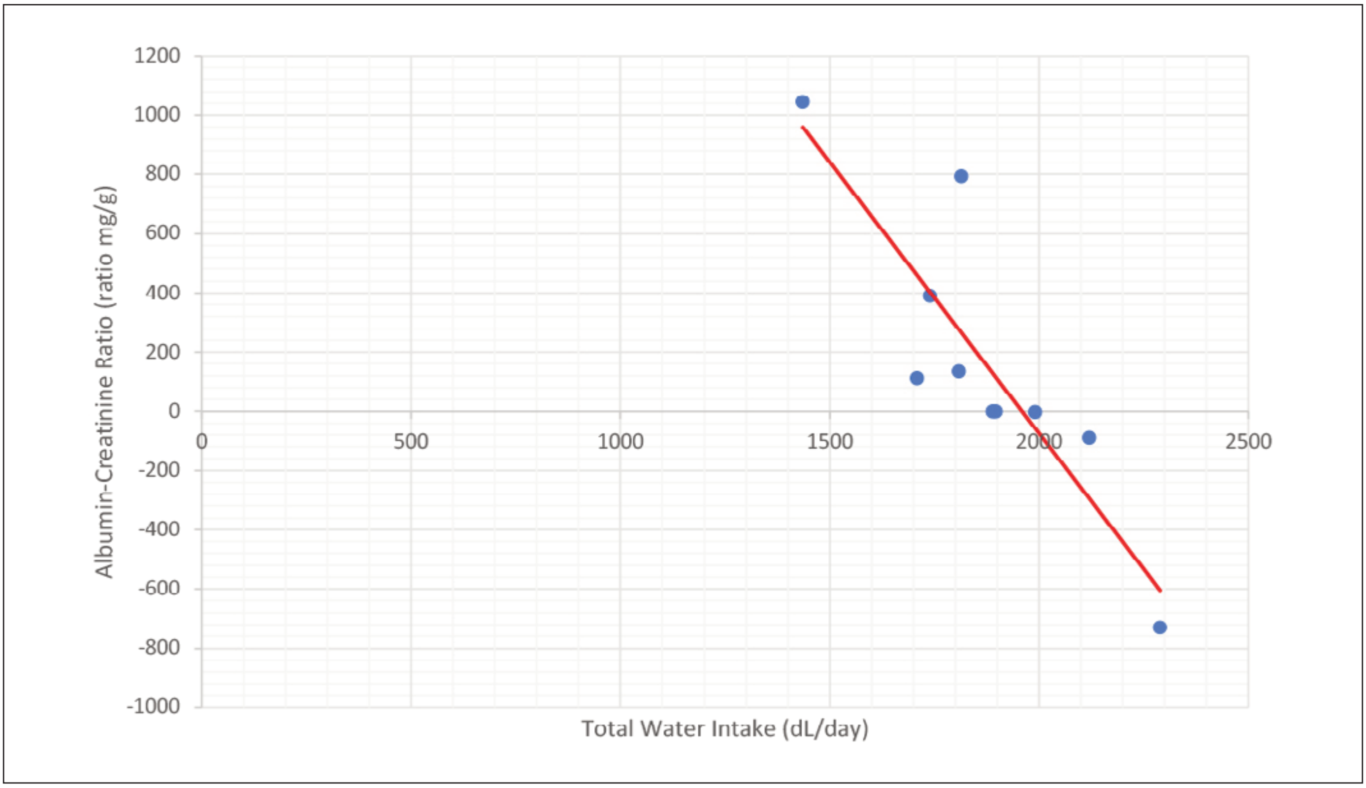

Figure 1. Correlation between average daily water intake and the urine albumin-creatinine ratio (uACR)

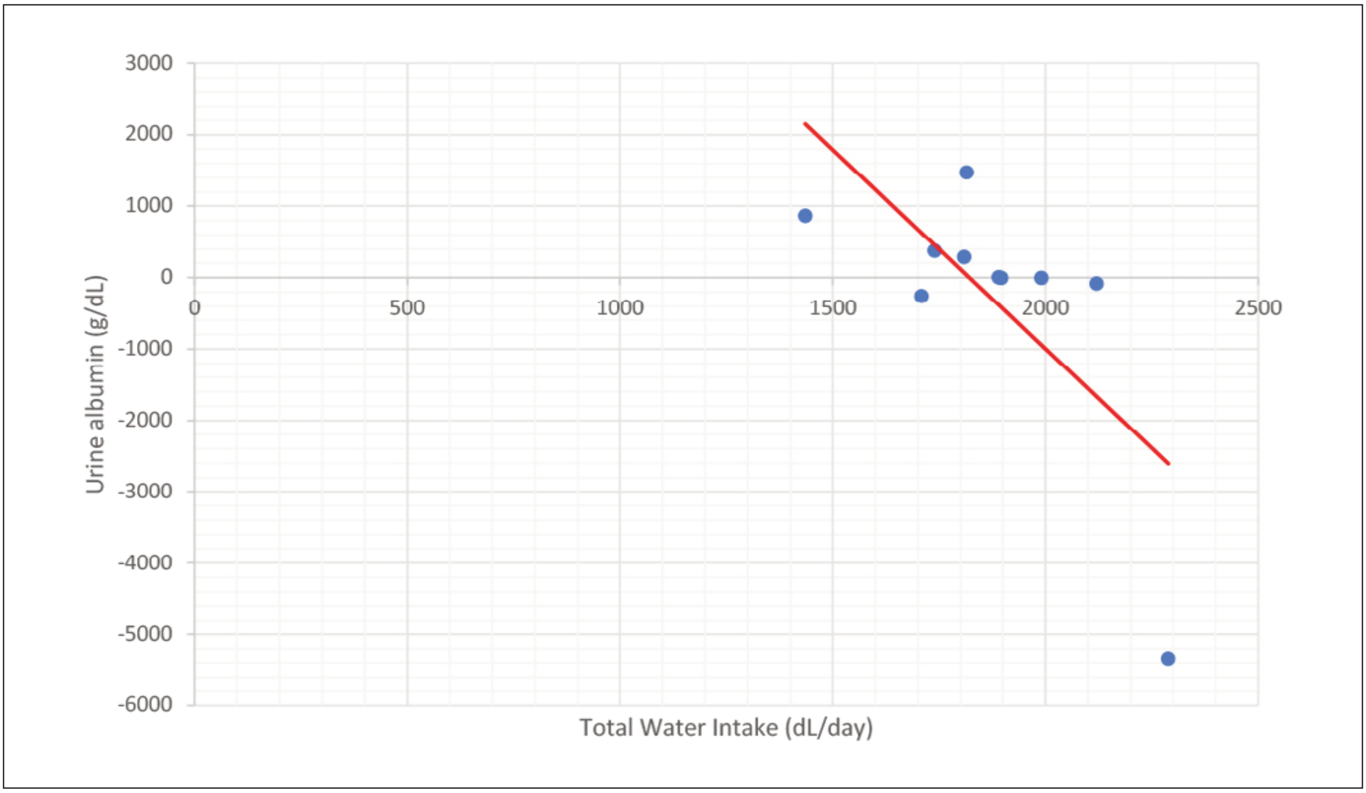

Figure 2. Correlation between average daily water intake and urine albumin levels

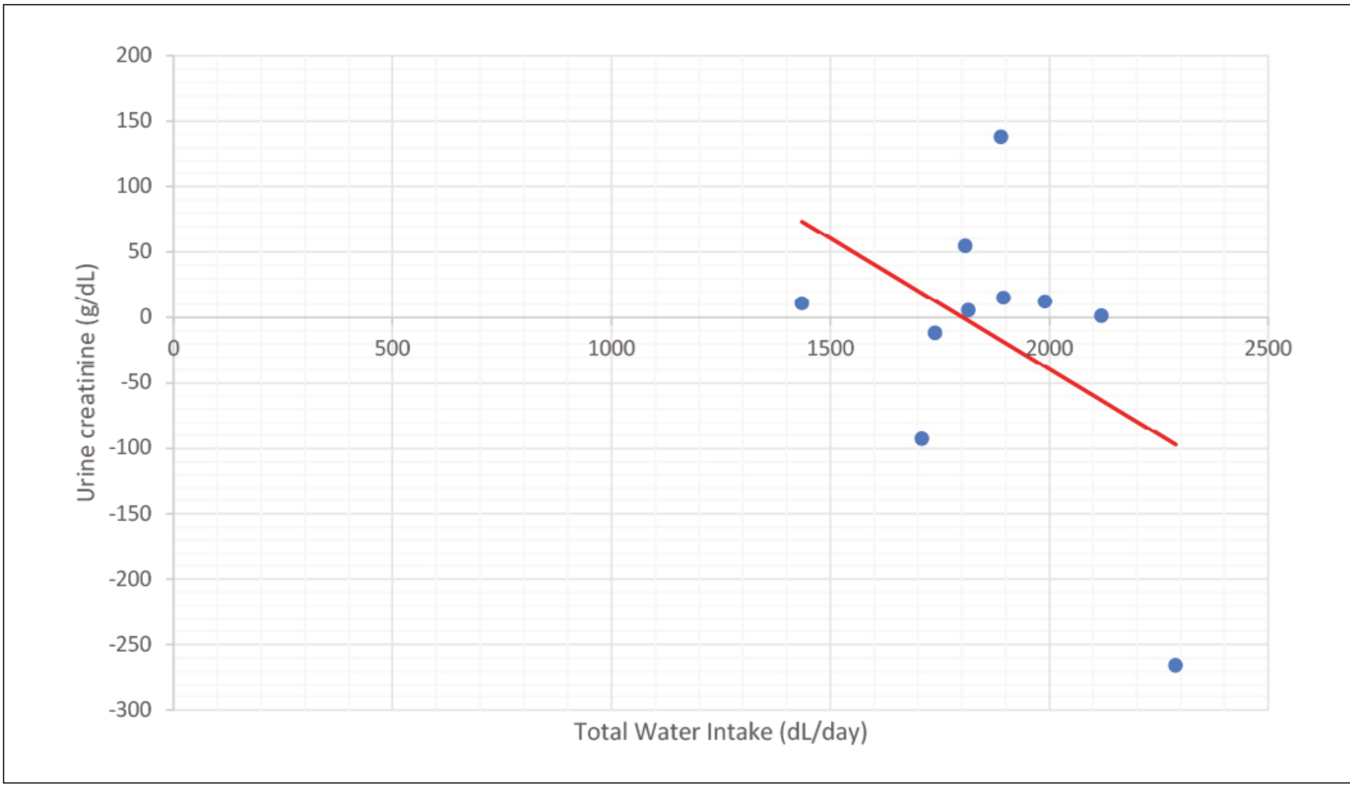

Figure 3. Correlation between average daily water intake and urine creatinine levels

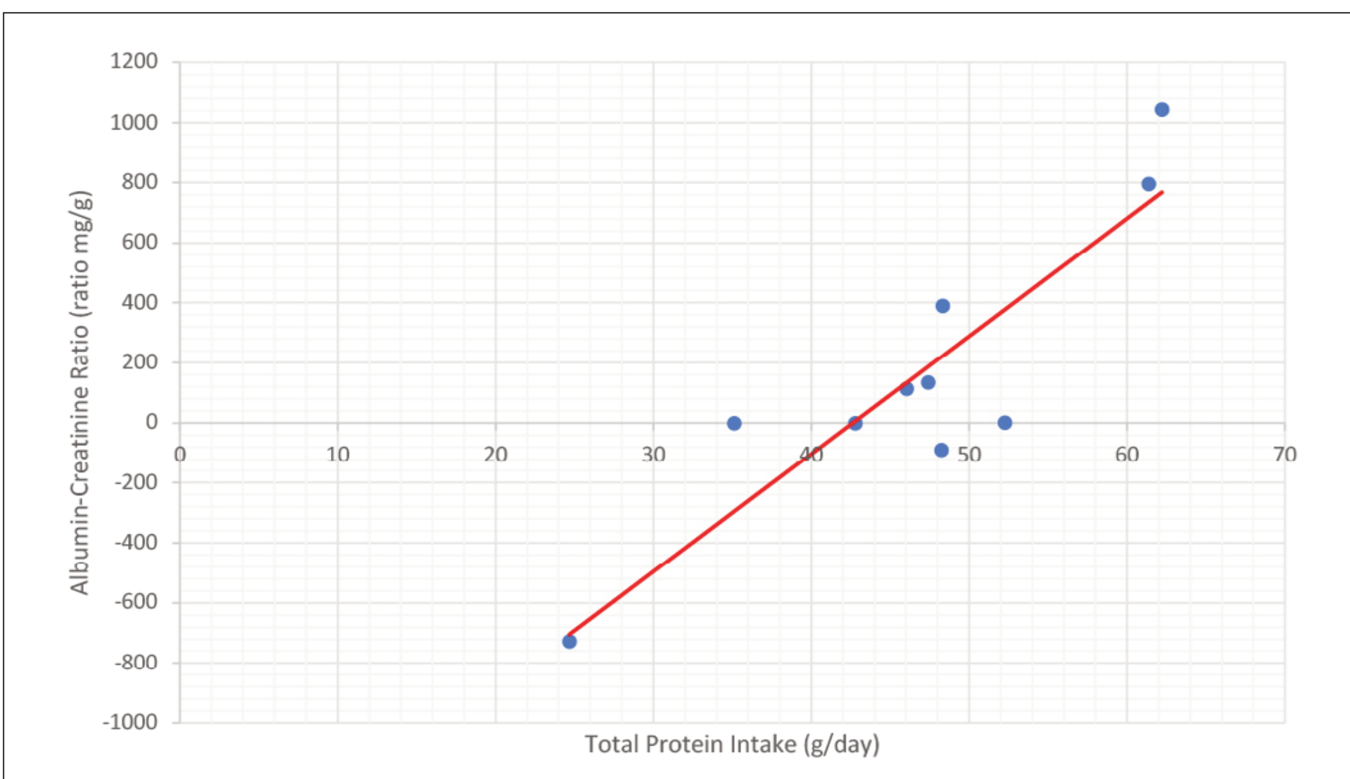

Figure 4. Correlation between average daily protein intake and the urine albumin-creatinine ratio (uACR)

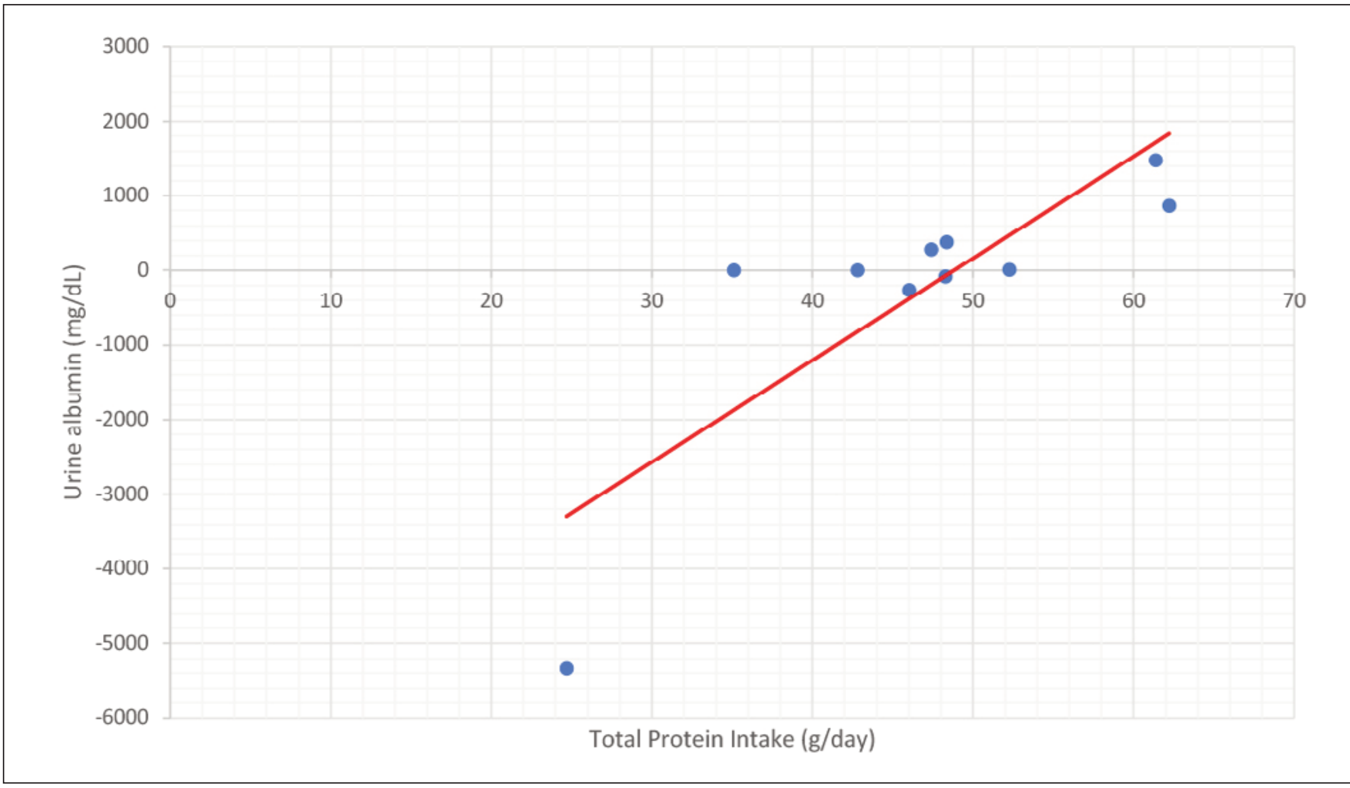

Figure 5. Correlation between average daily protein intake and urine albumin levels

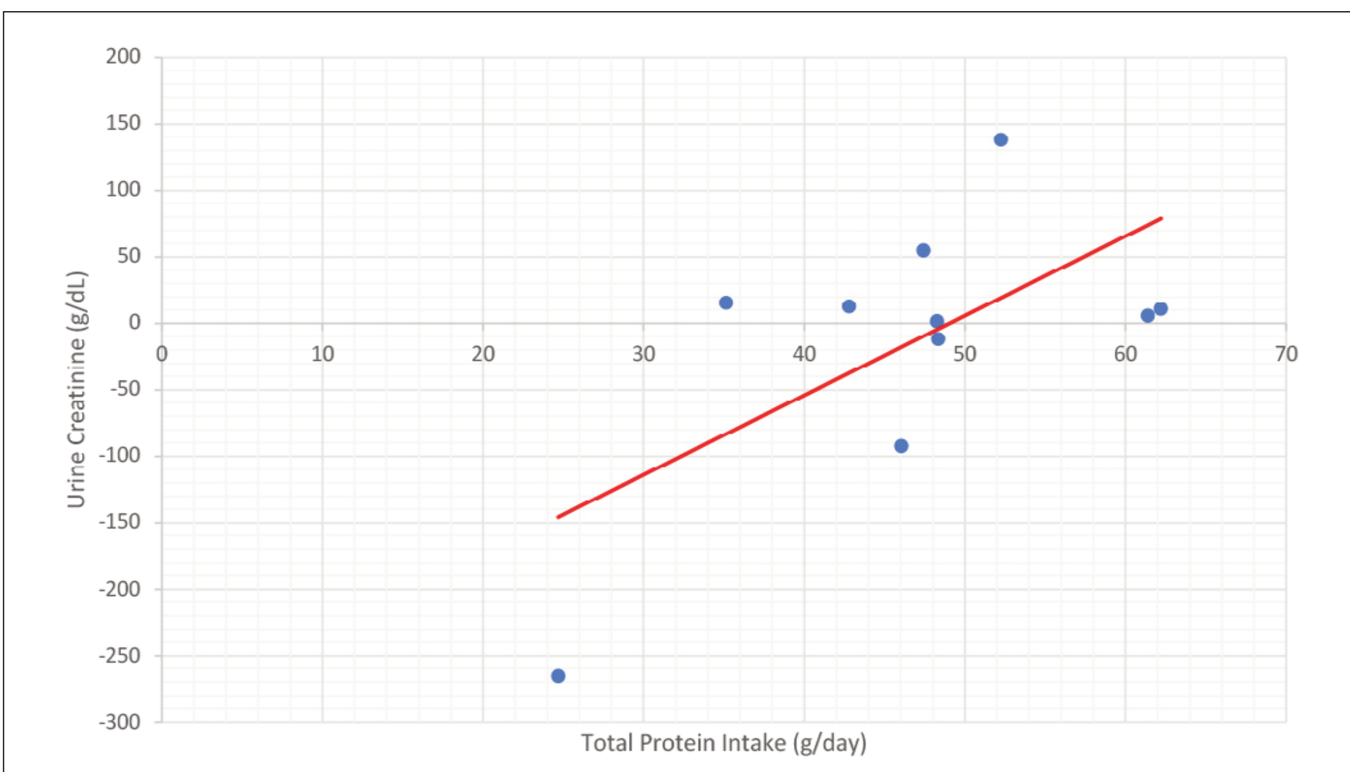

Figure 6. Correlation between average daily protein intake and urine creatinine levels

Increased protein intake increases protein metabolism waste products such as urea excretion. This correlation indicates the progressive decline in kidney function associated with protein consumption[15-17].

No correlation was found between water consumption and urine albumin or creatinine levels, nor was there a correlation between protein consumption and urine creatinine levels. This is because water intake is not directly related to kidney function decline, and excessive restriction can cause the kidney to lose its ability to concentrate urine through the vasopressin feedback mechanism. Another mechanism that contributes to kidney function improvement is the reduction of urea metabolites, which lowers intraglomerular pressure, thus reducing albumin leakage during filtration. All these effects are related to protein intake and not to water consumption. Although previous studies suggested that water intake is associated with albuminuria, the patient population in those studies followed a strict protein diet[18]. Nevertheless, excessive protein consumption is the most closely related factor to kidney function decline[19].

Water and protein intake differ in their mechanisms of regulating kidney filtration. Water consumption is linked to vasopressin feedback mechanisms, osmolality regulation, and improved kidney function at appropriate volumes. Protein intake, on the other hand, is associated with urea metabolism and glomerular hyperfiltration[7,13,18].

Using the urine albumin-creatinine ratio as a monitoring tool for kidney function is crucial for assessing short-term CKD progression, as it is directly linked to the control of protein and water consumption. Therefore, controlling kidney function should be the basis for dietary protein regulation and fluid monitoring[20,21].

The limitations of this study include the relatively small number of patients, and the absence of analysis on critical factors such as diabetes mellitus and hypertension, which may influence the outcomes. Furthermore, the study was conducted over a short period, thus failing to provide data on long-term disease progression in the patients studied.

CONCLUSION

There is a correlation between water intake and the urine albumin-creatinine ratio, indicating that hydration levels may influence this key biomarker in patients with chronic kidney disease. Additionally, protein intake has been shown to correlate with both urine albumin levels and the albumin-creatinine ratio, suggesting that dietary protein may play a role in kidney function and albumin excretion. These relationships highlight the importance of both hydration and dietary management in controlling the progression of kidney disease.

REFERENCES

1. Ammirati AL. Chronic Kidney Disease. Rev Assoc Médica Bras 2020;66:s03–9. https://doi.org/10.1590/1806-9282.66.s1.3.
2. Kramer H. Diet and Chronic Kidney Disease. Adv Nutr 2019; 10:S367–79. https://doi.org/10.1093/advances/nmz011.
3. Wu J, Xu J, Zhao M, Li K, Yin G, Ge X, et al. Threshold effect of urinary chromium on kidney function biomarkers: Evidence from a repeated-measures study. Ecotoxicol Environ Saf 2023;262:115139. https://doi.org/10.1016/j.ecoenv.2023.115139.
4. Mizdrak M, Kumrić M, Kurir TT, Božić J. Emerging Biomarkers for Early Detection of Chronic Kidney Disease. J Pers Med 2022; 12:548. https://doi.org/10.3390/jpm12040548.
5. Kanbay M, Yilmaz S, Dincer N, Ortiz A, Sag AA, Covic A, et al. Antidiuretic Hormone and Serum Osmolarity Physiology and Related Outcomes: What Is Old, What Is New, and What Is Unknown? J Clin Endocrinol Metab 2019;104:5406–20. https://doi.org/10.1210/jc.2019-01049.
6. Tantisattamo E, Kalantar-Zadeh K. Diet and Hypertension. In: Bakris GL, Sorrentino MJ, Laffin LJ, editors. Hypertens. Fourth Ed., New Delhi: Elsevier; 2024, p. 17–48. https://doi.org/10.1016/B978-0-323-88369-6.00002-5.
7. Wagner S, Merkling T, Metzger M, Bankir L, Laville M, Frimat L, et al. Water intake and progression of chronic kidney disease: the CKD-REIN cohort study. Nephrol Dial Transplant Off Publ Eur Dial Transpl Assoc - Eur Ren Assoc 2021. https://doi.org/10.1093/ndt/gfab036.
8. Clark W, Sontrop J, Huang S, Gallo K, Moist L, House A, et al. The chronic kidney disease Water Intake Trial (WIT): results from the pilot randomised controlled trial. BMJ Open 2013;3. https://doi.org/10.1136/bmjopen-2013-003666.
9. Clark W, Sontrop J, Huang S, Moist L, Bouby N, Bankir L. Hydration and Chronic Kidney Disease Progression: A Critical Review of the Evidence. Am J Nephrol 2016;43:281–92. https://doi.org/10.1159/000445959.
10. Munaqisah M, Rasyid H, Aminuddin A, As'ad S, Taslim NA, Ashari N. The relationship between water intake and progressivity glomerular filtration rate of chronic kidney disease patients. Nutr Clínica Dietética Hosp 2024;44. https://doi.org/10.12873/443munaqisah.
11. Wu L-W, Chen W, Liaw F-Y, Sun Y-S, Yang H-F, Wang C-C, et al. Association between fluid intake and kidney function, and survival outcomes analysis: a nationwide population-based study. BMJ Open 2016;6. https://doi.org/10.1136/bmjopen-2015-010708.
12. Liu Y, Tan R, Zhou D, Xiao X, Ran J, Qin D, et al. The effects of protein intake on albuminuria in different estimated glomerular filtration rate: A population-based study. Eur J Intern Med 2017; 48:80–8. https://doi.org/10.1016/j.ejim.2017.10.022.
13. Ko GJ, Obi Y, Tortorici AR, Kalantar-Zadeh K. Dietary protein intake and chronic kidney disease. Curr Opin Clin Nutr Metab Care 2017; 20:77–85. https://doi.org/10.1097/MCO.0000000000000342.
14. Ria P, De Pascalis A, Zito A, Barbarini S, Napoli M, Gigante A, et al. Diet and Proteinuria: State of Art. Int J Mol Sci 2022;24:44. https://doi.org/10.3390/ijms24010044.

15. Ariyanopparut S, Metta K, Avihingsanon Y, Eiam-Ong S, Kittiskulnam P. The role of a low protein diet supplemented with ketoanalogues on kidney progression in pre-dialysis chronic kidney disease patients. Sci Rep 2023;13:15459. https://doi.org/10.1038/s41598-023-42706-w.

16. Hahn D, Hodson E, Fouque D. Low protein diets for non-diabetic adults with chronic kidney disease. Cochrane Database Syst Rev 2018;10. https://doi.org/10.1002/14651858.CD001892.pub4.

17. Heo G, Koh HB, Kim H, Kim K, Jung C-Y, Kim H, et al. Association of Plant Protein Intake With Risk of Incident CKD: A UK Biobank Study. Am J Kidney Dis Off J Natl Kidney Found 2023. https://doi.org/10.1053/j.ajkd.2023.05.007.

18. Wang H-W, Jiang M-Y. Higher volume of water intake is associated with lower risk of albuminuria and chronic kidney disease. Medicine (Baltimore) 2021;100:e26009. https://doi.org/10.1097/MD.0000000000026009.

19. Raikou VD. Protein intake, chronic renal disease progression and cardiovascular morbidity. Nutr Health 2023;29:21–3. https://doi.org/10.1177/02601060221118897.

20. Christofides EA, Desai N. Optimal Early Diagnosis and Monitoring of Diabetic Kidney Disease in Type 2 Diabetes Mellitus: Addressing the Barriers to Albuminuria Testing. J Prim Care Community Health 2021;12:215013272110036. https://doi.org/10.1177/21501327211003683.

21. Mernagh P, Folkerts K, Garreta Rufas A, Meredith K, Harris J, Wanner C, et al. The Health Economic Impact of Accurately Diagnosing CKD With and Without a UACR Test at Different Points in the Pathway of Disease Progression. Nephrol Dial Transplant 2022;37:gfac069.008. https://doi.org/10.1093/ndt/gfac069.008.