Medica Hospitalia
Journal of Clinical Medicine
Med Hosp 2024; vol 11 (3) : 295–299

OPEN ACCESS

Original Article

Correlation between Urine Albumin Creatinin Ratio (UACR) Value to Urine Osmolality Value and Estimate Glomerular Filtration Rate (EGFR) Value on Patient with Kidney Failure

Lisa Anis Fadilatin[1], Andika Aliviameita

Medical Laboratory Technology Study Program, Faculty of Health Sciences,
Universitas Muhammadiyah Sidoarjo, Indonesia

p-ISSN: 2301-4369 e-ISSN: 2685-7898
https://doi.org/10.36408/mhjcm.v11i3.1184

Accepted: September 13th, 2024
Approved: November 27th, 2024

Author Affiliation:
Department of Medical Laboratory Technology,
Health Sciences Faculty of
Muhammadiyah Sidoarjo University,
Indonesia

Author Correspondence:
Andika Aliviameita
Mojopahit 666B street,
Sidoarjo 61215, Indonesia

E-mail:
aliviameita@umsida.ac.id

Abstract

Background : Kidney failure is one of the causes of death in the world. Laboratory tests related to kidney function are very important in the management of patients with kidney failure because they are useful in identifying any decline in kidney function, monitoring treatment and progression of kidney disease. The urine albumin creatinine ratio (UACR): is related to assess the protein filtration function in the glomerulus. The urine osmolality is to assess pre-renal, renal and post-renal hemodynamic status. The estimated glomerular filtration rate (EGFR) is to assess overall glomerular function. EGFR is the gold standard. The aim of this research is to determine 1). The correlation between UACR value to urine osmolality value, 2). The correlation between UACR value to EGFR value. Patient with kidney failure is the independent variable, meanwhile UACR value, urine osmolality value and EGFR value are dependent variables..

Methods : This study is a quantitative study with analytical observations through a cross sectional design using 30 sample patients with kidney failure either acute kidney injury (AKI) or chronic kidney disease (CKD). This study was conducted from May to June 2024 at the Central Laboratory Installation of Dr. Saiful Anwar Hospital, East Java Province. UACR and EGFR examination used the principle of photometric test while urine osmolality examination used the principle of electrical conductivity. The data were analyzed using the Shapiro-Wilk normality test and the Spearman non-parametric correlation test through SPSS 27.

Results : In the normality test results, it was found that UACR and EGFR values were not normally distributed (p = <0.001) while urine osmolality values were normally distributed (p = 0.523). Spearman's non-parametric correlation test showed that there was no correlation between UACR to urine osmolality (p = 0.342) and EGFR value (p = 0.481).

Conclusion : The results of this study showed no correlation between UACR value to urine osmolality value and EGFR value in patients with kidney failure.

Keywords : EGFR, Kidney Failure, UACR, Urine Osmolality

INTRODUCTION

Kidney failure is a significant contributor to mortality worldwide. Based on the 2018 data from the World Health Organization (WHO), over 10% of the global population suffers from chronic kidney disease (CKD). It is predicted that between 5 to 10 million individuals die annually owing to CKD, while roughly 1.7 million patients succumb to acute kidney injury (AKI) each year.[1] According to the 2018 National Riskesdas Report, there are 713,783 Indonesians aged ≥ 15 years who suffer from chronic kidney disease. Additionally, 113,045 individuals in East Java also experience chronic kidney disease.[2]

Screening for kidney function is crucial in the care of patients who have kidney failure or reduced kidney function. Kidney function screening is valuable for detecting any deterioration in kidney function, monitoring the effectiveness of treatment, and tracking the advancement of kidney disease. One of the laboratory tests used to assess kidney health is the estimate glomerular filtration rate (EGFR), which is considered the most reliable measure of glomerular function.[3] The estimate glomerular filtration rate (EGFR) is a laboratory test used to assess the function of glomerular filtration.[4] When assessing EGFR, serum creatinine levels are necessary. However, adjustments for race, gender, and age are required when utilising serum creatinine.[3] The proteinuria (albuminuria) examination is also important thing to know the kidneys function. Albuminuria is employed as a diagnostic tool to identify early-stage kidney disease in individuals with diabetes mellitus. It serves as a reliable indicator for cardiovascular illness, indicating higher levels of endothelial permeability. Additionally, it is also an indicator for chronic kidney problems. If albuminuria is seen in two separate examinations and urinary tract infection is ruled out, it suggests malfunction of the glomeruli.[3] Albuminuria is a significant indicator of chronic kidney disease and highly anticipates end-stage renal disease. Albuminuria can be assessed by conducting a urine albumin creatinine ratio (UACR) test utilising a sample of urine obtained during a single instance of urination.[5] UACR represents the quotient obtained by dividing the concentration of albumin in urine (mg/dl) by the concentration of creatinine in urine (g/dl).[6]

A study conducted by Megumi Oshima, *et al* revealed a substantial association between changes in albuminuria and EGFR during a 2-year period and the likelihood of future kidney failure in patients with type 2 diabetes mellitus. The findings indicate that tracking albuminuria and EGFR over a period of time can effectively identify persons with diabetes mellitus who are at a significant risk of kidney failure. It also helps identify those who need careful monitoring to initiate timely preventative and therapeutic measures.[7] Nevertheless, Andrew S. Levey, *et al* stated that EGFR alterations are more effective in detecting the beginning stage of CKD compared to albuminuria changes, as albuminuria changes are specific to diseases characterised by albuminuria. However, when it comes to therapy effects, albuminuria changes are more effective than EGFR alterations.[8]

In addition to EGFR and UACR, urine osmolality is a crucial factor in assessing kidney function since it reflects the kidney's ability to either dilute or concentrate urine. Urine osmolality is a more precise measure for assessing kidney function compared to urine specific gravity. Urine osmolality refers to the level of concentration of all dissolved particles present in urine.[9] Dong-Won Yoo, *et al* stated that decreased urine osmolality can result from elevated water consumption, vasopressin insufficiency, or diabetes mellitus. High urine osmolality frequently arises under hypovolemic conditions, such as dehydration, resulting in decreased blood supply to the kidneys and injury to renal tubular cells, thereby hindering the kidney's capacity to concentrate urine.[10] Nevertheless, a separate study indicated that low urine osmolality is a distinct prognostic marker for unfavourable kidney outcomes in individuals with chronic kidney disease. However, its predictive capability did not surpass that of EGFR.[11] Boonsong K. Kitiwan, *et al*. discovered that there was no significant correlation between quartiles of urine osmolality and reduced EGFR and/or albuminuria. Nevertheless, there was a notable correlation between higher urine osmolality and lower estimated glomerular filtration rate (EGFR) in people with an EGFR of 60 mL/min/1.73 m^2 or higher. Conversely, there was a positive correlation between urine osmolality and improved kidney function in people with an estimated glomerular filtration rate (EGFR) of 60 mL/min/1.73 m^2.[12]

Considering the information provided and multiple studies, urine osmolality has not yielded significant insights regarding kidney function due to inconsistent outcomes in urine osmolality results. Consequently, additional research is required to investigate the correlation between urine albumin creatinin ratio (UACR) value to urine osmolality value and estimate glomerular filtration rate (EGFR) value in patients with kidney failure. This research is expected to aid in the early detection of abnormalities associated with declining kidney function. Furthermore, if there is a correlation between the urine albumin creatinin ratio (UACR) value and the urine osmolality value, the urine osmolality parameter can be included as a reportable parameter on the Sysmex UF-4000 equipment utilised in this investigation.

METHODS

This research has been approved by the Ethics Committee

of Dr. Saiful Anwar Hospital, East Java Province, with the reference number 400/120/K.3/102.7/2024. It was conducted during a period of 2 months, from May to June 2024, at the Central Laboratory Installation of Dr. Saiful Anwar Hospital, East Java Province.

The study employed a quantitative research design, analytic observations within a cross-sectional design.[13] The study population consisted of patients diagnosed with kidney failure at Dr. Saiful Anwar Hospital, East Java Province. A nonprobability sampling method called purposive sampling was used to select a sample of 30 in patients. The inclusion criteria include patients diagnosed with kidney failure, either Acute Kidney Injury (AKI) or Chronic Kidney Disease (CKD), aged 18–74 years, with urine samples collected using spot urine. Meanwhile, the exclusion criteria include patients aged less than 18 years and more than 74 years. The patients were both male and female. They underwent UACR, routine urinalysis, and serum creatinine examinations.

The UACR examination is conducted using the Cobas c-503 instrument, which employs a photometric test concept. In this process, urine albumin is checked using an immunoturbidimetric test principle, while urine creatinine is examined using an enzymatic test principle.

The UACR value is derived by calculating the ratio of urine albumin to urine creatinine using the formula :[6]

$$\frac{\text{Urine albumin (mg/dl)}}{\text{Urine creatinine (g/dl)}} = \text{ACR (mg/g)}$$

The Sysmex UF-4000 equipment is used for routine urinalysis examination. It employs the idea of Urine Flowcytometry with Blue Semiconductor. The device reports urine osmolality values as research parameters. Urine osmolality is determined by measuring electrical conductivity. The urine osmolality value is determined by performing the following calculation :[10]

Osmo. [mOsm/kg] = 34.294x
(where x is the urine conductivity level)

The Cobas c-503 device is utilised for serum creatinine examination, employing a photometric test principle. This examination measures serum creatinine levels through an enzymatic test. The EGFR value is then calculated using the CKD-EPI (Chronic Kidney Disease – Epidemiology Collaboration) 2021 equation, which excludes race as a factor :[14]

$$EGFR_{\alpha} = 142 \times \min(S_{\alpha}/\kappa, 1)^{a} \times \max(S_{\alpha}/\kappa, 1)^{-1,200} \times 0.9938^{Age} \times 1.012 \text{ [if female]}$$

Description:
κ : 0.7 for females or 0.9 for males
a : -0.241 for females or -0.302 for males
S_{α} : serum creatinine (mg/dL); divided by 88.4 for serum creatinine (μmol/L)
min : minimum for S_{α}/κ or 1
max : maximum for S_{α}/κ or 1
Age : age in years

The UACR and EGFR findings were obtained via the laboratory information system (LIS), whereas the urine osmolality results were obtained from the Sysmex UF-4000 equipment. In addition, the collected data were subjected to statistical analysis using IBM SPSS Statistics 27. The statistical analysis commenced with a normality test using the Shapiro-Wilk test due to the sample size being less than 50.[15] In addition, the Spearman non-parametric correlation test was conducted due to the non-normal distribution of the data.[13]

RESULTS

The normality test revealed that the UACR values were not normally distributed, as indicated by the significance value of < 0.001 (< 0.05). On the other hand, the urine osmolality values were found to be normally distributed, with a significance value of 0.523 (> 0.05). Similarly, the EGFR values were also not normally distributed, with a significance value of < 0.001 (< 0.05).

Table 1 is a descriptive analysis of 30 aged from 18 to 74 years old. Found 3 (10%) aged 11 to 20 years old, 8 (26.67%) aged 21 to 30 years old, 5 (16.67%) aged 31 to 40 years old, 6 (20%) aged 41 to 50 years old, 7 (23.33%) aged 51 to 60 years old, 1 (3.33%) aged 61 to 70 years old. However, there is no one aged 71 to 80 years old. In general, 10 males (33.33%) and 20 females (66.67%) of the total. 14 (46.67%) included acute kidney injury (AKI), 16 (53.33%) chronic kidney disease (CKD).

Shows that: 1). Median UACR ranged from 39.74 to 14766.46 mg/g was (Median ± SD: 1574.91000 ± 3840.948458; 2). Mean urine osmolality 129 to 576 mOsm/kg (Mean ± SD: 295.26667 ± 98.076302); 3). Median EGFR 1.322 to 37.966 mL/minute/1.73 m^2 (Median ± SD: 6.84350 ± 11.071225).

The data outcomes of the study were analysed using Spearman's non-parametric correlation test. Table 2 shows that the correlation test between UACR value and urine osmolality value resulted in a significance value (2-tailed) of 0.342 (>0.05), indicating that there is no correlation between UACR value and urine osmolality value. Similarly, the correlation test between UACR value and EGFR value yielded a significance value (2-tailed) of 0.481 (>0.05), indicating no correlation between UACR value and EGFR value.

TABLE 1
Descriptive Analysis of Research Sample

Characteristics	Total (n=30)	Percentage
Age		
11 – 20 years old	3 people	10 %
21 – 30 years old	8 people	26.67 %
31 – 40 years old	5 people	16.67 %
41 – 50 years old	6 people	20 %
51 – 60 years old	7 people	23.33 %
61 – 70 years old	1 person	3.33 %
71 – 80 years old	0 people	0 %
Gender		
Male	10 people	33.33 %
Female	20 people	66.67 %
Diagnosis		
Acute Kidney Injury (AKI)	14 people	46.67 %
Chronic Kidney Disease (CKD)	16 people	53.33 %

TABLE 2
Spearman Correlation Test Results

Variables	UACR Value	Urine Osmolality Value	*p*-value
UACR value	–	0.342*	0.481*
Urine osmolality value	0.342*	–	–
EGFR value	0.481*	–	–

**p*-value

DISCUSSION

The correlation test study between UACR value and urine osmolality value, as well as EGFR value, in patients with kidney failure indicates a lack of association between UACR value and either urine osmolality value or EGFR value. This discrepancy arises due to the differing diagnoses observed in this study, specifically between acute kidney injury (AKI) and chronic kidney disease (CKD). According to the RIFLE criteria, patients with AKI are classified into five categories based on the decline in kidney function, with each category having a distinct diagnostic significance.[16] Meanwhile according to KDIGO, patients with CKD are classified based on a decrease in kidney function, measured by a decrease in GFR, and an increase in albuminuria. The decrease in GFR is divided into six categories, while the increase in albuminuria is divided into three categories and each category also has different diagnostic implications.[17]

Currently, the most reliable method for examining urine osmolality is the freezing point drop method.[18] However, in this study, the urine osmolality value was estimated using the principle of electrical conductivity.[10] Research conducted by Matthijs Oyaert, *et al* has shown that the principle of electrical conductivity still needs further investigation before it can be used to accurately report urine osmolality in routine clinical practice.[19]

There is no correlation between UACR value and EGFR value in patient with kidney failure. According to a study conducted by Andrew S. Levey, *et al*, changes in albuminuria are more effective indicators of therapy outcomes in individuals with chronic kidney disease (CKD) than changes in estimated glomerular filtration rate (EGFR).[8] It is unclear in this study which samples

have undergone medication that alters the UACR value while the EGFR value remains low. This can result in the absence of an expected correlation.

Furthermore, Boonsong K. Kitiwan, *et al* discovered in their research that the correlation between urine osmolality and EGFR exhibited a non-linear pattern. After controlling for demographic, social, cardiovascular, and dietary risk factors, there was no statistically significant relationship found between quartile urine osmolality and the decline in kidney function and/or the presence of albuminuria. Kidney function decline was defined as having estimated glomerular filtration rate (EGFR) values below 60 mL/min/1.73 m^2, and albuminuria was defined as having urine albumin creatinine ratio (UACR) values equal to or greater than 30 mg/g.[12]

CONCLUSION

There was no correlation between the urine albumin creatinin ratio (UACR) value and the urine osmolality value (p = 0.342) or the estimate glomerular filtration rate (EGFR) value (p = 0.481) in individuals diagnosed with kidney failure. The findings of this investigation cannot be utilized to establish the urine osmolality parameter as a reportable parameter on the Sysmex UF-4000 equipment employed in this study. In future research, there is an expectation for a more even distribution of samples, particularly in terms of patient diagnoses and the forms of therapy received by kidney failure patients included in the study. Furthermore, the evaluation of urine osmolality should employ the method of freezing point depression.

REFERENCES

1. Syahputra E, Laoli EK, Alyah J, Bahagia HBS EY, br. Tumorang EYE, Nababan T. Dukungan Keluarga Berhubungan Dengan Kualitas Hidup Pasien Gagal Ginjal Kronik Yang Menjalani Terapi Hemodialisa. J Penelit Perawat Prof [Internet]. 2022;4:793–800.
2. Riskesdas Kementrian Kesehatan RI. Laporan Riskesdas 2018 Nasional.pdf [Internet]. Lembaga Penerbit Balitbangkes. 2019.
3. Gounden V, Bhatt H, Jialal I. Renal Function Tests [Internet]. StatPearls Publishing; 2023.
4. Susianti H. Memahami Interpretasi Pemeriksaan Laboratorium Penyakit Ginjal Kronis. Malang: UB Press; 2019. 1–117 p.
5. Larkins NG, Kim S, Carlin JB, Grobler AC, Burgner DP, Lange K, *et al*. Albuminuria: Population epidemiology and concordance in Australian children aged 11–12 years and their parents. BMJ Open. 2019;9:75–84.
6. Afera SL, Santoso SD, Santosa RI. Rasio Albumin Kreatinin Urin Sebagai Deteksi Dini Gangguan Fungsi Ginjal Pada Diabetes Melitus. J SainHealth [Internet]. 2021;5(2):1–5.
7. Oshima M, Toyama T, Hara A, Shimizu M, Kitajima S, Iwata Y, *et al*. Combined changes in albuminuria and kidney function and subsequent risk for kidney failure in type 2 diabetes. BMJ Open Diabetes Res Care. 2021;9(1).
8. Levey AS, Gansevoort RT, Coresh J, Inker LA, Heerspink HL, Grams ME, *et al*. Change in Albuminuria and GFR as End Points for Clinical Trials in Early Stages of CKD: A Scientific Workshop Sponsored by the National Kidney Foundation in Collaboration With the US Food and Drug Administration and European Medicines Agency. Am J Kidney Dis [Internet]. 2020;75(1):84–104.
9. Milani DAQ, Jialal I. Urinalysis [Internet]. StatPearls Publishing; 2023.
10. Yoo DW, Lee SM, Moon SY, Kim IS, Chang CL. Evaluation of conductivity-based osmolality measurement in urine using the Sysmex UF5000. J Clin Lab Anal. 2021;35(1):1–7.
11. Lee MJ, Chang TI, Lee J, Kim YH, Oh KH, Lee SW, *et al*. Urine Osmolality and Renal Outcome in Patients with Chronic Kidney Disease: Results from the KNOW-CKD. Kidney Blood Press Res. 2019;44(5):1089–100.
12. Kitiwan BK, Vasunilashorn SM, Baer HJ, Mukamal K, Juraschek SP. The association of urine osmolality with decreased kidney function and/or albuminuria in the United States. BMC Nephrol. 2021;22(1):1–11.
13. Syapitri H, Amila, Aritonang J. Buku Ajar Metodologi Penelitian Kesehatan [Internet]. 1st ed. Medan: Ahlimedia Press; 2021. 1–214 p.
14. Miller WG, Kaufman HW, Levey AS, Straseski JA, Wilhelms KW, Yu HYE, *et al*. National Kidney Foundation Laboratory Engagement Working Group Recommendations for Implementing the CKD-EPI 2021 Race-Free Equations for Estimated Glomerular Filtration Rate: Practical Guidance for Clinical Laboratories. Clin Chem. 2022;68(4):511–20.
15. Suardi S. Pengaruh Kepuasan Kerja Terhadap Kinerja Pegawai Pada Pt Bank Mandiri, Tbk Kantor Cabang Pontianak. Business, Econ Entrep. 2019;1(2):9–19.
16. Yaqub S, Hashmi S, Kazmi MK, Ali AA, Dawood T, Sharif H. A Comparison of AKIN, KDIGO, and RIFLE Definitions to Diagnose Acute Kidney Injury and Predict the Outcomes after Cardiac Surgery in a South Asian Cohort. CardioRenal Med. 2022;12(1):29–38.
17. KDIGO. Clinical practice guideline for evaluation and manegement of chronic disease. Kidney Int Suppl. 2023;(July).
18. Larkins MC., Zubair M, Thombare A. Osmometer [Internet]. StatPearls Publishing; 2024.
19. Oyaert M, Speeckaert MM, Delanghe JR. Estimated urinary osmolality based on combined urinalysis parameters: a critical evaluation. Clin Chem Lab Med. 2019;57(8):1169–76.