# Potassium Electrolyte Serum - Urine , and Creatinine in Chronic Kidney Diseases

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# Abstract

**Background:** The kidneys are important organs in the human body that have many functions. Kidney function is divided into several processes, namely filtration, reabsorption and secretion of substances in the body. Nephron which is the smallest kidney functional unit that is responsible for accommodating all functions in the kidney. One of the functions of the kidneys is secretion, the secretions in the kidneys work by removing electrolytes and other substances that are no longer needed by the body through urine. When the function of the kidney nephrons is disturbed, it can result in an electrolyte imbalance (K), a buildup of waste from substances that are not needed by the body (creatinine). The objective of this research was to examine the relationship between electrolytes (K) serum, urine and creatinine in patients with CKD.

**Methods:** The research was conducted by observational, anamnesis, and sampling of CKD patients at Dr. Kariadi Semarang during the period March-May 2020.

**Results:** The results of the multivariate linear regression test showed that creatinine had a moderate significant positive effect at p = 0.024 and r = 0.412 on serum K. Meanwhile, from multivariate linear regression, it was found that creatinine had a moderate negative effect at p = 0.027 and r = -0.456 on urine K.

**Conclusions and suggestions:** The findings proved the relationship between creatinine levels and serum and urine potassium levels in patients with CKD. Serum and urine electrolytes can be used as an parameter for CKD management.


# Introduction

The kidneys are important organs in the human body that have many functions. Kidney function is divided into several processes, namely filtration, reabsorption and secretion of substances in the body. Inside there is a nephron which is the smallest kidney functional unit where all these kidney functions occur. To continue carrying out their duties, kidneys' functions must work properly because decreased functions will cause disruption of these three processes, causing a build up substances that are not needed in the body (for example creatinine and uric acid), as well as electrolyte imbalance (sodium, potassium, chloride); all of which are categorized as chronic kidney disease (CKD). Globally, the prevalence as well as incidence related to CKD are caused by kidney failure, a poor prognosis, and high cost. The increased prevalence of CKD is in line with the increased number of aging people and the diabetes mellitus as well as hypertension incidence. Hill et al (2016) found 13.4% global CKD prevalence.1) Global Burden of Disease (2010) reported that in 1990 CKD was the world deadly disease ranked 27 and in 2010 its rank was 18.2) Kidney Dialysis Outcomes Quality Initiative (KDOQI) defines CKD as a process of gradual decline in renal nephron function and is classified into 5 stages or categories based on a decrease in the glomerular filtration rate based on a certain formula.3) As the important organ, kidneys maintain blood composition by inhibiting waste accumulation. The kidneys are important organs that function to maintain blood composition by preventing the accumulation of waste,

regulating fluids balance in the body, and maintaining the level of electrolyte from serum levels to match the needs of the body's. The purpose of this research was to analyze the relationship between serum electrolyte levels of potassium (K) and urine electrolytes and creatinine in patients with CKD.

# Research Methods

The study was conducted in an observational manner, anamnesis, and the sampling of the study from CKD patients at Dr. Kariadi Semarang during the period March to May 2020 by meeting the specified sample criteria. Data collected were conducted by K electrolytes serum , urine , creatinine and they were analyzed by the Iodine Deficiency Disorders (GAKI) laboratory.

### INCLUSION CRITERIA AND EXCLUSION CRITERIA:

Inclusion criteria were samples aged 19-67 years, normal body temperature, normal blood pressure and smoking-free for at least 1 year. While the exclusion criteria were samples of patients who did not take anticoagulant drugs, corticosteroids and diuretics; did not consume alcohol in the past 1 month, did not have a history of malignancy and a history of renal failure / hemodialysis.

### SAMPLE SIZE :

The sample size formula is as follows:

$$N1 = N2 = 2\left\lceil \frac{(Z\alpha + Z\text{ß})\, S}{X1 - X2} \right\rceil 2$$

If the type I error (α) is set at 0.005 and the type II error (ß) is set at 0.1. The research power is 90%, then the value of Zα = 1.64 and Zß = 1.28. S is the standard deviation of the two groups and X1-X2 is the desired clinical difference of 9. The amount of standard deviation based on previous research by Basyouni was 14.85 which was rounded to 15. 11)

The sample size calculation is

$$N1 = N2 = 2\left\lceil \frac{(1{,}6 + 1{,}28)\, 15}{9} \right\rceil 2$$

By paying attention to the drop out factor of 10%, the sample required is a minimum of 26.4 samples for each group which the researchers made a minimum of 30 samples per group.

### STATISTICAL ANALYSIS

The data were processed using IBM SPSS Statistics computer program. Saphiro-Wilk was used to test data normality. Data that were not normal will be transformed, then the Saphiro-Wilk normality test would be repeated. The Pearson test was used to do correlation test if the data were normally distributed, but when the data were not normal, Spearman Rank correlation test was carried out. The significance of the p value is at p <0.05, with the degree of relationship criteria as follows:

- r = 0.00-0.199 shows a very weak relationship; - r = 0.20-0.399 shows a moderate relationship;- r = 0.60-0.799 shows a strong relationship.

## Research Results

The number of patient observed was 30 data, and the data obtained were based on the exclusion and inclusion criteria for patients with CKD at Dr. Kariadi Hospital Semarang.

The figure showed that the p value was <0.05, indicating that creatinine and serum potassium were significantly related to urine. Meanwhile, the relationship between variable sodium and chloride in serum and urine did not show a significant relationship. Figure 1.

## Limmitation Of This Research:

In this study did not measure other intermediate variables such as TGF-ß which could have an effect on tubular function. this study also did not assess the degree of tubular and glomerular damage, which would have an effect on renal filtration and reabsorption.

## Discussion

Fluid and electrolyte changes when creatinine decreases, where the ability to concentrate or dilute urine is impaired. Limitation of water intake can result in volume contraction and fluid hypernatremia, on the other hand, if salt and water intake is excessive, hyponatremia, edema or both can occur. Body fluids and substances or electrolytes / ions dissolved in them always tend to change due to metabolic processes. On the other hand, so that it remains constant, the kidneys help maintain the amount of electrolytes or ions within certain limits, so that there is no disturbance in the body and this is one of the functions of the kidneys. The process of hemostasis is by concentrating or diluting the urine, through a counter current process in the kidneys.4) In chronic renal failure, hyperkalemia, hyperkalemia, hyperphosphatemia, hypocalcemia and bicarbonate deficiency (metabolic acidosis) often occur.

Potassium is a cation with the highest number of cells in the cell. Maintaining the proper distribution of potassium across cell membranes is essential for normal cell function. Transfer of potassium between extracellular and intracellular is influenced by various endogenous and exogenous factors. The state of acidosis and alkalosis affects potassium, as it can compensate the protons movement (Hydrogen ions). In acidosis, the H + ions move to the cells, and to maintain the electrical balance, potassium is moved outside the cell. In alkalosis the opposite occurs.5)

The level of potassium of less than 3.5 mEq/L indicated hypokalemia and the level of potassium which is more than 5.3 mEq/L indicated hyperkalemia. One of the causes of hypercalemia is reduced renal excretion of potassium which occurs in hyperaldosteronism, renal failure, use of cyclosporine or due to excessive potassium ion correction and in cases receiving angiotensin-converting enzyme inhibitor therapy, and potassium sparing diuretic.5)

Potassium is passively handled in the kidneys by being reabsorbed at the proximal tubule end. Then, it is supplemented to tubular fluid at the henle arch's descending limbs. The thick ascending of the henle arch is the major spot of the active potassium to be reabsorbed. The filtered potassium remain in the tubular lumen is only 10% to 15% at the end of the distal convoluted tubule. Potassium is primarily excreted by cortical collecting duct main cells and collecting duct outer medullary. The reabsorption of potassium takes place through intercalated cells in the medullary collecting duct. As the total potassium of the body is depleted, it reabsorption is increased. It reabsorption firstly moves in the medullary interstitium; however, it is secreted into the pars recta from the henle arch's descending limb. The recycle of the medullary potassium, as part of its physiological role, can reduce "backleak" exit from the collecting tubule lumen or to increase renal secretion of potassium when potassium is overloaded.5)

The CKD patients with LFG less than 10-20% of normal can still maintain serum potassium concentrations. If the LFG is less than 25%, the activity of Na +, K +, ATPase will increase in the liver and muscle, so there will be an increase in the transport of potassium ions from extracellular to intracellular.6)

Hans et al, concluded that the occurrence of hyperkalemia in CKD can predict the occurrence of complications in the heart and mortality.7) This study contradicts the previous ones that a reduced LFG value can result in a significantly high serum sodium level. Serum and urine potassium concentrations can be independently associated with impaired renal function.8.9, 10)

# Conclusions And Suggestions

It can be concluded that potassium (serum) and potassium (urine) significantly relate to creatinine in patients with CKD. Potassium can be used as a parameter in the management of chronic kidney disease. The suggestion for further research is that further research is needed to see clearly the effect of potassium (serum and urine) in patients with CKD with a larger sample size.

Further research is concerned with other inflammatory variables such as TGF-ß and the degree of glomerular and tubular scraping that influence renal filtration and reabsorption.

# Abbreviations

**CKD** = chronic kidney disease; **GAKI**=Gangguan akibat kekurangan iodium; **KDOQI**=Kidney Dialysis Outcomes Quality Initiative ;TGF-ß = Transforming Growth Factor-Beta

# Declarations

### CONFLICT OF INTEREST

The rese-archers do not have any conflict of interest with any party in conducting this series of studies.


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### AUTHORS CONTRIBUTIONS

IKS: conduct laboratory examinations of potassium and creatinine electrolytes, and become a contributor major in script writing. PKS: analyzes and interprets patient data on CKD patients. AA: processing and collecting data. All authors read and approved the final manuscript.


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### ETHICAL CLEARANCE

Research permit with Ethical Clearance from the Medical and Health Research Ethics Commission Dr. Kariadi hospital Semarang through written informed consent. No.456/EC/KEPK-RSDK/2020.

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# Tables

**Table 1.** Descriptive data and results of the Shapiro Wilk normality test

| Variable | Mean ± SD | Median (min – max) | P | Information |
|---|---|---|---|---|
| Ages | 50.63 ± 11.40 | 53.5 (19 – 67) | 0.099 | Normal |
| Creatinine | 4.75 ± 3.35 | 4.5 (0,7 – 11,35) | 0.017 | Not normal |
| K serum | 4.54 ± 1.04 | 4.4 (3,2 – 6,9) | 0.050 | Normal |
| K Urine | 18.46 ± 12.48 | 16.35 (7 – 70,4) | 0.000 | Not normal |

**Table 2.** Results of correlation Creatinine tests on serum and urine K

| Variable | Creatinine | | Information |
|---|---|---|---|
| | P | R | |
| K serum | 0.024‡ | 0.412 | Significant, positive moderate |
| K urine | 0.011‡ | -0.456 | Significant negative moderate |

**Table 3.** The results of the linear regression test for creatinine on serum K and urine

| Variable | B | P | Information |
|---|---|---|---|
| K serum | 0.019 | 0.800 | Not significant |
| K urine | 1.510 | 0.027 | Significant |

# Figures

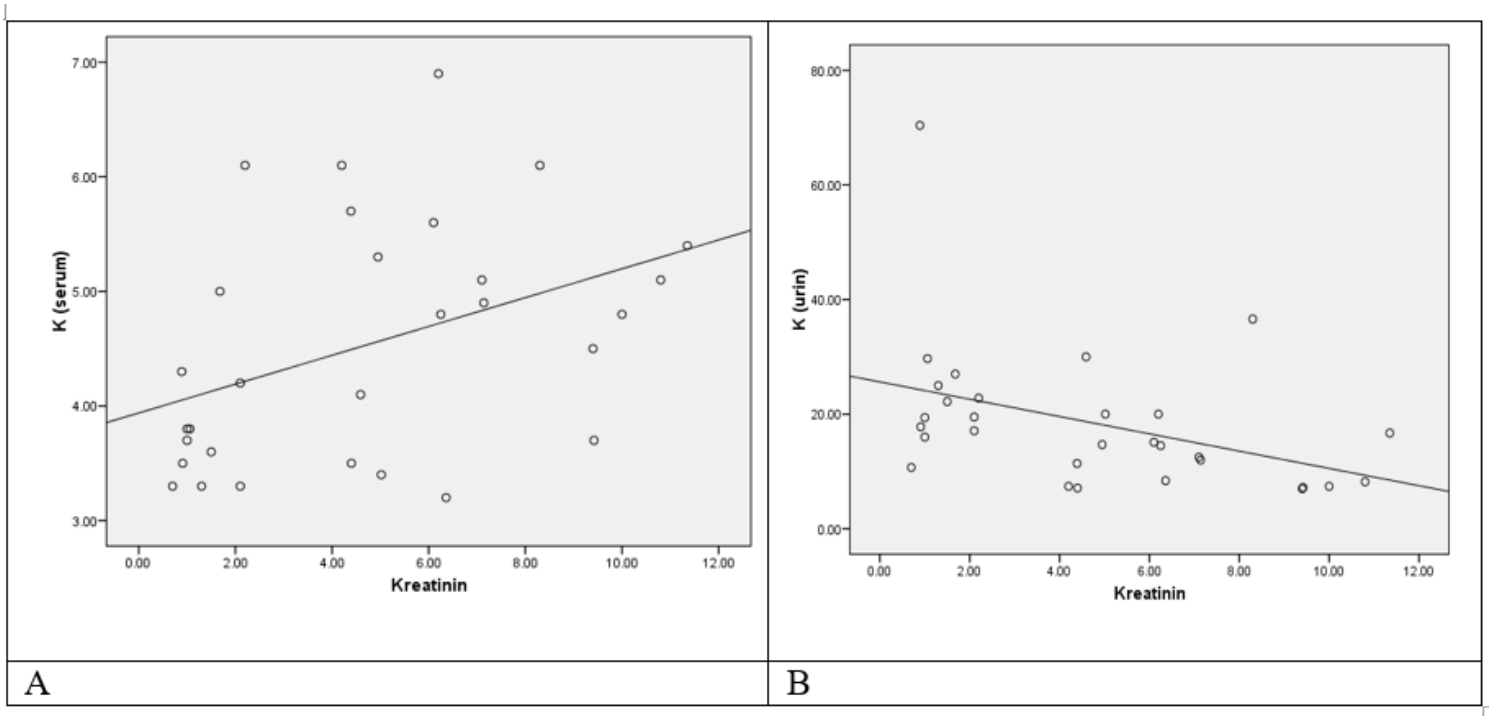


**Figure 1**

Diagram of the relationship between Creatinine and A. Potassium levels (Serum); B levels of Potassium (Urine)