The Relationship between Sodium and Potassium in Chronic Kidney Disease Patients

by Indranila Kustarini Samsuria

Submission date: 25-Jan-2021 08:58AM (UTC+0700)
Submission ID: 1493583520
File name: d-potassium-in-chronic-kidney-disease-patients-5fcc3a700b8da.pdf (259.79K)
Word count: 2932
Character count: 15697

Sapporo Medical Journal
Volume 54, Issue 10, October 2020

The Relationship between Sodium and Potassium in Chronic Kidney Disease Patients

IndranilaKustarini Samsuria[1]*, Anggie[1], Judiono[2], Purwanto Adhipireno[1]

[1]Clinical Pathology Department, Faculty of Medicine Diponegoro University, Semarang,
[2]Polikteknik Kesehatan Kemenkes Bandung, Jurusan Gizi.

Abstract— Background Chronic kidney disease (CKD) is a public health problem, as its prevalence continues to increase the incidence of kidney failure, poor prognosis, and high treatment costs from year to year. Reduction function and the number of nephrons caused kidney dysfunction, so a buildup of substances that are not needed by the body and electrolyte disturbances appears.The study aimed to determine the relationship between serum sodium and potassium electrolyte levels in patients suffering from chronic kidney disease (CKD). Analytic observational research by cross-sectional design was applied. The study was conducted on 30 patients with chronic kidney disease in RSUP Dr.Kariadi Semarang. Data collected were conducted by Na and K electrolytes, and they were analyzed by the Iodine Deficiency Disorders (GAKI) laboratory in the January-March 2020. Data were analyzed and presented on average ± SE, correlation statistics, Pearson and Spearman regression with significance levels of $p < 0.05$. The Research Ethics Commission approved this study. The results showed was not significant a correlation of potassium (K) with age ($p = 0.405$; $r = 0.158$). Potassium and ureum was significantly the relationship positive ($p = 0.003$; $r = 0.522$). The relationship between potassium and creatinine was significantly positive ($p = 0.024$; $r = 0.412$). Conclusion there was a significant serum K relationship with urea and creatinine

Keywords: *CKD, electrolytes, Sodium, Potassium*

Background

Chronic kidney disease (CKD) is a worldwide health problem, including in Indonesia. Prevalence increases kidney failure incidence as well as poor prognosis and high medication costs from year to year. The prevalence increases in the number of elderly, the incidence of diabetes mellitus and hypertension.[1)]

A meta-analysis conducted by Hill et al., 2016, showed that CKD attained a global prevalence of 13.4%[2)].According to the *Global Burden of Disease* in 2010, CKD was the 27th indication causing death in the world in 1990 and also rose to 19th in 2010. In Indonesia, the number of CKD has increased from year to year. Based on Basic Health Research (Riskesdas), the prevalence of CKD in Indonesia increased to 3,8% in 2018 compared to only 1,8% in 2013.[3)]

Kidney Dialysis Outcomes Quality Initiative (KDOQI), the process of reducing kidney function occurs gradually and is classified into 5 stages based on a decrease in glomerular filtration rate (LFG).[4)] Kidney is an important organ functioning to maintain blood composition by preventing waste accumulation and controlling fluid balance in the body, to maintain electrolyte levels such as sodium, potassium, and phosphate remain stable. In patients with kidney failure, ureum serum levels show the best picture to detect signs of ureum toxicity compared to creatinine.[5)]Decreased function and the number of nephrons causing disturbances in the process of filtration, reabsorption, and secretion of substances in the body, cause a buildup of substances that are not needed in the body and electrolyte imbalance.[6)]

The electrolyte imbalance is very dangerous in the body. Normal sodium will be adjusted so that the balance is maintained between intake and expenditure with the volume of extracellular fluid remains stable. More than 90% osmotic pressure in the extracellular fluid is determined by salts in the form of sodium chloride (NaCl) and sodium bicarbonate ($NaHCO_3$), so changes in osmotic pressure in extracellular fluid represent changes in sodium concentration.[7)] Potassium is a passive mechanism process, which is reabsorbed at the end of the proximal contortustubule. Potassium is then added to the tubular fluid in *descending limbs* from the Henle arch. The main site of active potassium reabsorption is *thick ascending* from the Henle arch. At the end of the distal tubule, only 10% to 15% of filtered potassium remains in the tubular lumen. Potassium is mainly excreted by the main cells of the *cortical collecting duct*. During total body potassium reduction, potassium reabsorption is increased. Potassium reabsorption initially enters the medullary interstitial but is then excreted into recta pars from the descending limb in the Henle arch. The physiological role of medullary potassium recycling can minimize the "backleak" coming out of collecting lumen tubules or increasng renal potassium secretion during an excess of potassium. [8,9)] In CKD, patients with LFG less than 10-20% of normal can still maintain serum potassium concentration. If the LFG is less than 25%, the Na + activity. K + and ATPase will increase in liver and muscle so it will increase potassium ion transport from extracellular to intracellular. [9)]

Ureum and creatinine are chemical compound products that can be used as indicators of kidney function. Ureum is a nitrogen product secreted by kidneys derived from protein. Creatinine is the result of creatine and phosphocreatine metabolism. Biosynthesis takes place in the kidneys. Creatinine formation is not a mechanism for reuptake by the body, but mostly creatinine excretion is through the kidney. So if there is renal dysfunction, creatinine filtration ability decreases.[10)]

This research was conducted to analyze the relationship between electrolyte levels, ureum and creatinine in serum and urine of patients with chronic kidney disease (CKD) in the hospital Dr Kariadi Semarang.

Methods and Materials

Analytic observational research by cross-sectional approach was applied. The study was conducted on 30 patients suffering from chronic kidney disease in RSUP Dr Kariadi Semarang. Data collected wereNa and K electrolytes carrying out in the laboratory of Iodine Deficiency Disorders (GAKI) of the Faculty of Medicine, Diponegoro University, Semarang from January to March 2020.

The ureum was measured by was the waste product formed in the liver when the body breaks down proteins. The ureum was examined by ADVIA 1800, the *chemistry system* method, with a blood serum sample having a normal value of 7-20 mg / dL.

The creatinine was measured by was a residual product formed when muscle creatinine was used for muscle metabolism. Creatinine was analyzed by ADVIA 1800 *chemistry system* with blood serum samples having normal values of 0.6-1.3 mg / dL.

Sodium measurement was a major cation in the body's extracellular fluid which function of maintaining the body's fluid and acid-base balance and plays a role in nerve transmission and muscle contraction. Sodium was analyzed by the *Dimension chemistry system* ISE method in blood samples. The normal serum values 136-145 mmol / L; urine 40-220 mmol/ L.

Potassium was the main cation in the body's intracellular fluid which function to maintain the balance of body fluids and acid and plays a role in nerve transmission and muscle contraction. Potassium was analyzed by the *Dimension chemistry system ISE method* in blood samples. The normal serum values 98-107 mmol / L; urine 110-250 mmol / L.

Data were processed using a computer program. The normality test was done by Shapiro-Wilk. It was because the sample is less than 50. Abnormal data was transformed, then the Shapiro-Wilk normality test was repeated. The correlation test used was the Pearson test if the data distribution is normal; meanwhile, the Spearman correlation test was used if the data distribution is not normal. The p-value was considered significant when $p < 0.05$. The degree of relationship showed a very weak relationship

Sapporo Medical Journal
Volume 54, Issue 10, October 2020

if r = 0.00 - 0.199; a weak relationship if r = 0.20-0.399; moderate relationship if r = 0.40-0.599; strong relationship if r = 0.60-0.799 and very strong relationship if r = 0.80-1. If you get a strong relationship, then continue with the regression test. The research ethics was obtained from the medical and health research ethics committee of RSUP dr. Kariadi Semarang. No. 456 / EC / KEPK-RSDK / 2020.

Research results

From the total sample of 30 patients, the average age is 50.63 ± 11.40 with the median (min-max) of 53.5 (19-67). The mean and standard deviation of the Ureum are (72.90 ± 43.16), the median (min-max) is 72.5 (15 - 195), the creatinine is 4.75 ± 3.35, 4.5 (0.7 - 11.35), and the electrolyte Na is 145.33 ± 5.91; 146 (128 - 155). K is 4.54 ± 1.04; 4.4(3.2-6.9).(Table 1)

Table 1. Description and results of normality test Shapiro Wilk

Variable	Mean ± SD	Median (min-max)	p	Information
Age	50.63 ± 11.40	53.5 (19 - 67)	0.099	Normal
Ureum	72.90 ± 43.16	72.5 (15 - 195)	0.100	Normal
Creatinine	4 , 75 ± 3.35	4.5 (0.7 - 11.35)	0.017	Not normal
Serum				
Na	145.33 ± 5.91	146 (128 - 155)	0.059	Normal
K	4.54 ± 1.04	4.4 (3.2 - 6.9)	0.050	Normal

* Shapiro Wilk normality test

Meanwhile, table 2 shows that the relationship between Na and age was not significantly correlated (p = 0.161; r = 0.262), the relationship between sodium and urea was not significantly correlated (p = 0.513; r = 0.124), and the relationship between Na serum and creatinine was correlated insignificantly (p = 0.369; r = 0.170).

Table 2. Results of correlation test age, urea and creatinine to serum Na

Variable	Na serum		Specification
	p	r	
Age	0.161§	0.262	Not significant
Urea	0.513§	0.124	Not significant
Creatinine	0.369‡	0.170	Not significant

Description: §; Pearson Correlation Sp Spearman's

Table 3 Shows that the correlation of potassium (K) with age was not significant, (p = 0.405; r = 0.158), the relationship between potassium and ureum was significantly positive (p = 0.003; r = 0.522), and the relationship between potassium and creatinine was significantly positive (p = 0.024; r = 0.412).

Table 3. Age, urea and creatinine correlation test results on serum K

Variable	K		Information
	p	r	
Age	0.405‡	0.158	Not significant
Ureum	0.003‡	0.522	Significant, positive, moderate
Creatinine	0.024‡	0.412	Significant, positive, moderate

Description: ‡Spearman's correlation

Based on the results of the study, as K positive relationship was significantly correlated, linear regression test of K was carried out. The result was that K to ureum was linearly significant correlated (B = 0.013; p = 0.03) while the linearity of K to creatinine was not significant (B = 0.019; p = 0.800). See table 4.

Table 4. Results of linear regression test for serum K

Variable	B	P	Information
Ureum	0.013	0.003	Significant
Creatinine	0.019	0,800	Not significant

Discussion:

Based on research conducted in the hospital Dr Kariadi Semarang it was found 30 respondents suffering from CKD from January to March 2020 meet the inclusion and exclusion criteria.

Age

The findings showed that the average age of the patients, both men and women, was 50.63 ± 11.40 with a median of 53.5 (19-67). Previous studies have shown that the increased age will be followed by the decreased kidney function, as at the age of more than 40 years nephron loss process begins.[11] in the increased age, coupled with the presence of chronic diseases such as hypertension, diabetes mellitus, the kidneys would tend to be damaged quickly and could not be recovered.

Correlation Sodium(Na), ureum, and creatinine.

Data analyzed from patients with CKD showed the relationship (correlation) of Na to age was not significant (p = 0.405; r = 0.158), sodium with urea was not significantly correlated (p = 0.513; r = 0.124), and the relationship between serum Na and creatinine correlated insignificantly (p = 0.369; r = 0.170).

Sodium is the main cation in extracellular fluid. An increase in the plasma sodium concentration of more than 148 mmol with a plasma osmolality of more than 295 mOsm / kg is called hypernatremia. Meanwhile, excessive sweating can cause loss of water, and electrolytes, especially sodium and chloride. The difference in sodium levels in extracellular and intracellular fluid is caused by the presence of active transport of sodium out of the cell, which is exchanged with the entry of potassium into the cell (Na + K + pump). The amount of sodium in the body is a picture of the balance between sodium intake and sodium excretion. Normal sodium levels in the body are 135-145 mmol / L. Disorders of sodium balance in CKD are hyponatremia and hypernatremia.[12] Creatinine has less sensitivity, in renal dysfunction with sensitivity - the specificity of creatinine was 64% and 47%, respectively.[13] It was also concluded that sodium and potassium electrolyte levels were also related to hormone activity.[14]

Correlation of Potassium (K), ureum, and creatinine

The data showing the correlation of potassium (K) with age is not significant, (p = 0.405; r = 0.158), the relationship between potassium and ureum was significantly related (p = 0.003; r = 0.522), and the relationship between potassium and creatinine was significantly and positively related (p = 0.024; r = 0.412).

Potassium, the most mineral in the body, is influenced by kidney disorders including chronic kidney disease. Chronic kidney disease is a result of a progressive decline in kidney function. Overview of potassium levels in chronic kidney disease shows that when the glomerular filtration rate (GFR) decreases, the ureum concentration will positively increase, the phosphate concentration increases, and will combine with Ca2 + to form calcium phosphate so that Ca2 + decreases. Hypocalcemia stimulates the release of parathyroid hormone (PTH) from the parathyroid gland, thereby mobilizing calcium from the bones.[14)]

The weakness of this study is because that it does not examine factors that influencing the cause and effect of intermediary variables such as other electrolytes; therefore, it is difficult to determine which variables are dominantly affecting or contributing to CKD.

Conclusions and recommendations

It can be concluded that there is a significant relationship between potassium (K) with urea and creatinine. The relationship between sodium, urea, and creatinine is correlated insignificantly. The electrolyte K can be used for the managing of CKD patients by improving levels of urea, creatinine, and electrolytes, especially K. Further studies are recommended for ureum, creatinine, and electrolyte (Na, K, Cl) tests as well as in the urine of CKD patients.

Conflict of interest

The research did not find any conflicting interest in this study.

Authors' contributions

Indranila KS was PI and designed the research. Anggie conducted experiments and statistical analysis written manuscripts. Purwanto AP and Judiono conducted data processing, preparation of a research reporting draft. All authors have read and agreed to the final version of the manuscript.

Funding Recognition

The study was conducted and supported by independent funding of researchers.

References :

[1] Sreenivasulu U, Bhagyamma SN, Anuradha R. Study of Serum Electrolyte Change in End-Stage Renal Disease Patients Before and After hemodialysis Sessions: A Hospital Based Study. Sch Acid J Biosci.2016;4(3B):283-287.
[2] Hill NR. Fatoba ST, OK JL, Hirst JA, O 'Callaghan CA, Lasserson DS. The Global prevalence of chronic kidney disease - A systematic review and meta-analysis. Plos One 2016 ; 11 (7): e0158765.doi: 10.1371 / journal.pone.0158765.
[3] RI Ministry of Health, Chronic kidney disease situation. Infodatin. Indonesian Ministry of Health Jakarta data and information centre 2017.
[4] National Kidney Foundation. (KDOQI). Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification and Stratification. New York: National Kidney Foundation, Inc. 2002: p. 3-4.
[5] Arnold F, Barton L, Mariano R. Pathophysiology of Calcium, Phosphate and Magnesium dysregulation in Chronic Kidney Disease. Seminar in dialysis: PTH, Phosphate and vitamin D; Current issues and concern 2015;8(6): 546-477.
[6] Sherwood L. Human physiology from cell to system. 2nd ed. Jakarta EGC. 2001: 461-499.
[7] Mc Quarrie EP, Traynor JP, Taylor AH, Freel EM, Gox JG, Jardine AG, Mark PB. Association between urinary sodium, creatinine, albumin, and long-term survival in chronic kidney disease. Hypertension 2014;64(1):111-117. DOI:10.1161/HYPERTENSIONAHA.113.03093.
[8] Collins, Allan J et al. "Association of Serum Potassium with All-Cause Mortality in Patients with and without Heart Failure, Chronic Kidney Disease, and/or Diabetes." American journal of nephrology vol. 46,3 (2017): 213-221. doi:10.1159/000479802

[9] Blaine J, Michel C, Moshel L. Renal control of calcium, phosphate and magnesium homeostasis. Clin. J. Am. Soc. Nephrol. 2015;10(7): 1257-1272. DOI: https://doi.org/10.2215/CJN.09750913

[10]Amirrasooli H, tabatabaeefar M, MoeaniB.The efficacy of serum cystatin C and creatinine to diagnose impaired renal function in cancer patients under treatment with cisplatin. UHOD.2015;1(25) :51-59. DOI 10.4999/uhod.15436.

[11]Indranila KS. The relationship between sodium, potasium, and hypothyroidism in Chronic Kidney Disease (CKD) patients. Bali Med J.2019;8(1):2264-266.Doi :10.115562/bmj.v8i1.1344.

[12]Bushinsky, D. A. (2017). Association of Serum Potassium with All-Cause Mortality in Patients with and without Heart Failure, Chronic Kidney Disease, and/or Diabetes. American journal of nephrology, 46(3), 213–221. https://doi.org/10.1159/000479802

[13]lins AJ, Pitt B, Reaven N, Funk S, McGaughey K, Wilson D, Bushinsky DA. Association of Serum Potassium with All-Cause Mortality in Patients with and without Heart Failure, Chronic Kidney Disease, and/or Diabetes. Am J Nephrol. 2017;46(3):213-221. doi: 10.1159/000479802. Epub 2017 Sep 2. PMID: 28866674; PMCID: PMC5637309.

[14]Tommaso Filippini, MD; AndronikiNaska, PhD; Maria-IosifinaKasdagli, MSc; Duarte Torres, PhD; Carla Lopes, PhD; Catarina Carvalho, MSc; Pedro Moreira, PhD; Marcella Malavolti, BSc, PhD; Nicola Orsini, PhD; Paul K. Whelton, MB, MD, MSc; Marco Vinceti, MD, PhD. Potassium Intake and Blood Pressure: A Dose-Response Meta-Analysis of Randomized Controlled Trials J Am Heart Assoc. 2020;9:e015719. DOI: 10.1161/JAHA.119.015719

The Relationship between Sodium and Potassium in Chronic Kidney Disease Patients

ORIGINALITY REPORT

9%	5%	7%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Haria Sukma, Emy Yuliantini, Tetes Wahyu Witradharma. "The Occurrence of Hypertension in Adult Groups of Fishermen Families", Jurnal Ilmu dan Teknologi Kesehatan, 2020 Publication	2%
2	www.ncbi.nlm.nih.gov Internet Source	1%
3	"Augstuma pieauguma mainība parastās egles (Picea abies (L.) H. Karst.) Tīraudzēs juvenilā vecumā = Variation of height growth of young pure Norway spruce (Picea abies (L.) H. Karst.) Stands", Latvia University of Life Sciences and Technologies, 2020 Publication	1%
4	www.medicolegalupdate.org Internet Source	1%
5	Hudila Rifa Karmia, Afriwardi Afriwardi, Hirowati Ali, Johanes Cornelius Mose, Yusrawati Yusrawati. "The Correlation of L-citrulline Levels	1%

	with Blood Pressure in Severe Preeclampsia", The Indonesian Biomedical Journal, 2020 Publication	
6	Submitted to Arizona Western College Student Paper	1%
7	Evelyne Wiskerke, Margaretha van Dijk, Rhea Thuwis, Chesny Vandekerckhove et al. "Maximum weight-shifts in sitting in non-ambulatory people with stroke are related to trunk control and balance: a cross-sectional study", Gait & Posture, 2021 Publication	1%
8	www.scilit.net Internet Source	<1%
9	www.medicinaoral.com Internet Source	<1%
10	bmcnephrol.biomedcentral.com Internet Source	<1%
11	www.researchgate.net Internet Source	<1%
12	www.studystack.com Internet Source	<1%
13	www.nice.org.uk Internet Source	<1%
14	Understanding Kidney Diseases, 2016.	

	Publication	<1%
15	www.legacyhealth.org Internet Source	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		

The Relationship between Sodium and Potassium in Chronic Kidney Disease Patients

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6