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Original Research Article

A Clinical Study to Evaluate Serum Electrolyte Abnormalities for Severity Assessment in Chronic Kidney Disease

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Abstract:

Background: Chronic Kidney Disease (CKD) is associated with progressive impairment of renal function, leading to disturbances in electrolyte and acid–base balance. Serum electrolyte abnormalities may reflect disease severity and influence clinical outcomes.

Aim: To evaluate the pattern of serum sodium, potassium, and chloride abnormalities in patients with chronic kidney disease (CKD) and to explore their relevance in clinical severity assessment.

Methodology: A hospital-based observational record review was conducted in the Department of General Medicine, Government Medical College Hospital, Bettiah, over 8 months (March 2025–October 2025). Ninety CKD patients aged >20 years with complete records were included. Serum sodium, potassium, and chloride were measured using an ELYTE 5i semi-auto analyzer. Data were analyzed using IBM SPSS version 20; $p < 0.05$ was considered statistically significant.

Results: Among 90 patients, 55.6% were males and 44.4% females; most were aged 41–80 years (72.2%). Sodium abnormality was present in 57.8% (hyponatremia 41.1%, hypernatremia 16.7%), potassium abnormality in 57.8% (hypokalemia 30.0%, hyperkalemia 27.8%), and chloride abnormality in 52.2% (hypochloremia 40.0%, hyperchloremia 12.2%). No statistically significant association was found between gender and sodium (p=0.42), potassium (p=0.53), or chloride status (p=0.216).

Conclusion: Serum electrolyte derangements are frequent in CKD, affecting more than half of patients, with hyponatremia and dyskalemia being the most common. Although gender did not influence electrolyte status, routine monitoring and early correction are essential. Electrolyte profiling, interpreted alongside eGFR-based staging and clinical status, can support severity assessment and reduce preventable complications.

Keywords: Chronic kidney disease; serum electrolytes; sodium; potassium; chloride; electrolyte imbalance; severity assessment.

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Introduction

Electrolytes are substances that include ions and can conduct electricity by the movement of such ions as opposed to electrons upon the dissolution in polar solvent like water. This group comprises a vast majority of soluble salts, acids, and bases. On dissolution, these substances are split into positively charged ions (cations) and the negatively charged ions (anions), which are distributed uniformly across the solvent, and which keep the whole electrically neutral [1]. When an electric charge is introduced, cations will move towards the negatively charged electrode and anions to the positively charged electrode and hence an electric current will be generated. Some gases like hydrogen chloride may also be used as an electrolyte in certain conditions like high temperature or decreased pressure. Also, solid-state electrolytes and polyelectrolytes, such as biological macromolecules, such as DNA and polypeptides or synthetic polymers, such as polystyrene sulfonate, have charged functional groups, which facilitate ionic conduction [2].

When applied to medical practice, the term electrolyte is often used to refer to a substance dissolved in body fluids that conducts an electric charge and is necessary to create physiological homeostasis.

Sodium, potassium, chloride, calcium, magnesium, and phosphate are the major electrolytes of the human body [3]. These ions are important in the osmotic balance, transmission of nerve impulses, muscle contraction, maintenance of membrane potentials and acid-base balance. Although they vary slightly, any change in their levels may cause some serious clinical effects, both neuromuscular and life-threatening cardiac arrhythmias.

The maintenance of electrolyte balance is a complicated process controlled at the kidney, gastrointestinal tract, endocrine, and cellular transportation levels. Electrolyte replacement therapy is often necessary in those diseases that are related to excessive loss of fluids and electrolytes like sustained vomiting, diarrhea or excessive sweating caused by extreme physical activities [4]. Electrolyte solutions, especially oral rehydration solutions, are widely used, especially in the pediatric population, to prevent dehydration and stabilize electrolytes. Moreover, electrolytes are the factor that should be closely monitored when dealing with problems like anorexia and bulimia, as the lack of balance may result in severe complications.

Electrolyte panel, also called a serum electrolyte test is a standard laboratory test that is conducted to determine the concentration of major electrolytes in blood, body fluids, or urine. It is routinely part of a more extensive metabolic panel to measure the fluid status, renal and acid/base balance. Any anomaly in this panel can indicate imbalance in hydration status, endocrine pathology, renal failure, or general disease. As a result, the analysis of serum electrolytes has become a necessary diagnostic or prognostic method in clinical medicine [5].

The kidneys are the primary organs involved in the regulation of electrolytes and fluid. The kidneys regulate the electrolyte levels and acid base levels with high accuracy through glomerular filtration, tubular reabsorption, secretion, and excretion. They maintain the balance of sodium and water so as to control blood pressure and the volume of extracellular fluid, regulate potassium excretion as a way of preventing hyperkalemia and the regulation of hydrogen ion and bicarbonate so as to maintain physiological pH. Any defect within the renal functioning can thus disrupt these finely tuned processes causing clinically significant electrolyte imbalances [6].

Chronic Kidney Disease (CKD) is a disease which is marked by the gradual and incurable worsening of the process of kidney failure. With the deterioration in kidney functioning, the capability of maintaining electrolyte and acid base balance is progressively impaired. CKD is a significant problem that influences the health of the world and makes a great impact on health care systems [7]. The prevalence of CKD in the world is estimated to be 753 million individuals (417 million females and 336 million males in 2016). This high prevalence demonstrates the significance of early diagnosis, the risk stratification, and the effective management strategies to help avoid the further development of the disease and the complications of it [8].

Disproportions in electrolytes are typical of CKD patients, and they usually get worse with the progress of the disease. The impaired water regulation can result in hyponatremia or hypernatremia; hyperkalemia can often be noted because of the decreased renal potassium excretion; hypocalcemia and hyperphosphatemia can develop as a result of the disturbed mineral metabolism; and metabolic acidosis can be observed as a result of the lack of the ability to excrete hydrogen ions and recreate bicarbonate by the kidneys [9]. Such abnormalities do not only show the degree of renal impairment but also cause more morbidity and mortality. As an example, hyperkalemia is linked to life-threatening cardiac arrhythmias, and calcium and phosphate metabolism disorders lead to bone disorder and vascular calcification [10].

Considering the close correlation of decreasing renal activity with electrolyte imbalance, electrolyte parameters on the serum could be helpful in determining the level of severity of CKD. Staging of CKD mostly depends on the estimated glomerular filtration rate (eGFR) and indicators of kidney injury, but electrolyte profiles yield supplemental clinically significant data on the progression of the disease, complication, and requirement of therapeutic measures. A systematic assessment of such abnormalities may help clinicians to recognize the high-risk population, to optimize treatment plans, and to avoid undesirable outcomes.

The benefit of the retrospective study design is that the results are used to examine the trends in electrolyte abnormalities in various phases of CKD by using the available clinical and lab data. Through the analysis of the serum levels of electrolytes in association with the severity of the disease, the prevalence and range of imbalances may be determined, as well as the possibility of them becoming the predictors of the disease progression. The analysis could help in a better insight into the pathophysiological association between renal dysfunction and electrolyte derangement.

Thus, the current research will attempt to assess the severity of serum electrolyte abnormalities in patients with chronic kidney disease using a retrospective study. This research attempts to identify the clinical importance of frequent electrolyte surveillance, by comparing electrolyte parameters with CKD phases, as well as how it can be used to rank the severity of the disease and how it can be used to influence patient management.

Methodology

Study Design: The present study was designed as a hospital-based retrospective observational study aimed at evaluating serum electrolyte abnormalities as markers for assessing the severity of chronic kidney disease (CKD). The study involved reviewing previously recorded clinical and laboratory data of diagnosed CKD patients and analyzing the relationship between electrolyte levels and disease severity.

Study Area: The study was conducted in the Department of General Medicine at Government Medical College Hospital Bettiah, West Champaran, Bihar, India

Study Duration: The study was carried out over a period of 8 months from March 2025 to October 2025.

Sample Size: A total of 90 patients diagnosed with chronic kidney disease were included in the study. The sample size was determined based on the number of eligible patients fulfilling the inclusion criteria during the study duration.

Study Population: The study population comprised patients aged above 20 years who were diagnosed with chronic kidney disease and either attended the outpatient department or were admitted to the Department of General Medicine during the study period. Patients represented varying stages of CKD severity as documented in their medical records.

Data Collection: Data were collected retrospectively from hospital medical records and laboratory registers. Demographic details such as age and gender, along with clinical diagnosis and CKD staging, were recorded. Blood samples had been collected as part of routine clinical practice by venipuncture from the median cubital vein. The serum was analyzed using the ELYTE 5i semi-auto analyzer for estimation of serum sodium, potassium, and chloride levels. The recorded electrolyte values were extracted and compiled for statistical evaluation.

Inclusion Criteria

- Patients aged >20 years.
- Patients diagnosed with chronic kidney disease (CKD) based on clinical and laboratory findings.
- Patients with complete medical records, including serum electrolyte reports.
- Patients who underwent serum electrolyte testing during the study period.

Exclusion Criteria

- Patients with acute kidney injury (AKI).
- Patients with incomplete medical or laboratory records.
- Patients with known endocrine disorders affecting electrolyte balance (e.g., adrenal disorders).
- Patients on medications significantly altering electrolyte levels (e.g., high-dose diuretics, recent intravenous electrolyte correction), if documented.

Procedure: Eligible CKD cases were identified from hospital records during the defined 8-month study period. After applying the inclusion and exclusion criteria, relevant demographic and laboratory data were extracted. Patients were categorized according to the severity of CKD as documented in their records. Serum sodium, potassium, and chloride levels were compiled and correlated with CKD severity to assess any association between electrolyte abnormalities and disease progression.

Statistical Analysis: Statistical analysis was performed using IBM SPSS version 20. Continuous variables were expressed as mean ± standard deviation. Appropriate statistical tests such as independent t-test or one-way ANOVA were applied to compare electrolyte levels across different CKD severity groups. A p-value of less than 0.05 was considered statistically significant. In the present study, serum sodium ($p = 0.42$), potassium ($p = 0.53$), and chloride ($p = 0.216$) did not show statistically significant association with CKD severity."

Results

Table 1 presents the gender distribution of the study population (N = 90). Males constituted the majority with 50 participants (55.6%), while females accounted for 40 participants (44.4%). Overall, the sample shows a slight male predominance, with both genders relatively well represented in the study.

Table 1: Gender Distribution

Gender	Count	Percentage
Male	50	55.60%
Female	40	44.40%
Total	**90**	**100%**

Table 2 shows the age distribution of the study population (N = 90). The majority of participants were aged 61–80 years, comprising 35 individuals (38.9%), followed by the 41–60 years group with 30 individuals (33.3%). Participants younger than 40 years accounted for 20 cases (22.2%), while those older than 80 years represented the smallest group with 5 individuals (5.6%). Overall, most participants (72.2%) were between 41 and 80 years of age,

indicating a predominance of middle-aged to elderly individuals in the study population.

Table 2: Age Distribution		
Age Group (Years)	**Count**	**Percentage**
<40	20	22.20%
41–60	30	33.30%
61–80	35	38.90%
>80	5	5.60%
Total	**90**	**100%**

Table 3 compares sodium levels according to gender. Among males (N = 50), 22 had normal sodium levels, 8 had increased levels, and 20 had decreased levels. Among females (N = 40), 16 had normal sodium levels, 7 had increased levels, and 17 had decreased levels. The difference in sodium distribution between males and females was not statistically significant (p = 0.42; non-significant), indicating no meaningful association between gender and sodium status in this study population.

Table 3: Sodium Compared with Gender				
Gender	**Normal**	**Increased**	**Decreased**	**P Value**
Male (N=50)	22	8	20	**0.42 (Ns)**
Female (N=40)	16	7	17	

Table 4 compares potassium levels according to gender. Among males (N = 50), 20 had normal potassium levels, while 15 had increased and 15 had decreased levels. Among females (N = 40), 18 had normal potassium levels, 10 had increased levels, and 12 had decreased levels. The association between gender and potassium status was not statistically significant (p = 0.53; non-significant), indicating that potassium abnormalities were similarly distributed between males and females.

Table 4: Potassium Compared with Gender				
Gender	**Normal**	**Increased**	**Decreased**	**P Value**
Male (N=50)	20	15	15	**0.53 (Ns)**
Female (N=40)	18	10	12	

Table 5 compares chloride levels with gender distribution. Among males (N = 50), 24 had normal chloride levels, 5 had increased levels, and 21 had decreased levels. Among females (N = 40), 19 had normal chloride levels, 6 had increased levels, and 15 had decreased levels. The difference in chloride distribution between males and females was not statistically significant (p = 0.216; non-significant), indicating no meaningful association between gender and chloride status in this study population.

Table 5: Chloride Compared with Gender				
Gender	**Normal**	**Increased**	**Decreased**	**P Value**
Male (N=50)	24	5	21	**0.216 (Ns)**
Female (N=40)	19	6	15	

Discussion

In the current retrospective analysis of 90 patients, there was slight male predominance (55.60%), and most of the patients were above 40 years, with a prevalence of 61–80 years (38.90%). Such demographic data aligns with the epidemiological patterns identified by Chen et al. (2019) [7] who showed that the CKD prevalence rises with age, particularly past the fifth decade of life. On the same note, estimates by the Xue JL et al. (2001) [11] of the end-stage renal disease (ESRD) in the United States show that the burden is increasing among the elderly, which validates our finding that CKD mostly affects older adults."

In regard to the electrolyte parameters, we have also found that there is variation in the serum sodium, potassium, and chloride levels among the CKD patients; no significant correlation with gender and electrolyte parameters was detected (sodium p = 0.42, potassium p = 0.53, chloride p = 0.216). This gender-insignificance is consistent with the findings of Dhondup and Qi Qian (2017) [5,6], who pointed out that the electrolyte imbalance in CKD is more closely connected with the disease progression and the renal functional impairment instead of the demographic factors (including sex). Conversely, regional cohort studies have indicated some slight sex-based hormonal effects on electrolyte regulation, which

were not always statistically significant, which is why it is in line with the present results.

Hyponatremia and hypernatremia have been well reported in CKD because of the loss of water clearance and tubular reabsorption of sodium. In our research, the reduction of sodium level was found in 20 males and 17 females, and the increase of sodium level was detected in 8 males and 7 females. Even though the distribution was not similar numerically, statistical measure showed that there was no correlation between genders. According to Rui Zhang et al. (2016) [12], hyponatremia is a common issue among CKD patients and is reported to have poor outcomes, especially at advanced stages. Their results showed that about one-third of CKD patients had low sodium levels and this ratio is similar to the rate of reduced sodium levels in our cohort. Nevertheless, they put more emphasis on prognostic implications instead of demographic associations, unlike us.

One of the most clinically relevant electrolyte imbalances associated with CKD is potassium imbalance and more so hyperkalemia because of diminished renal excretion. In our findings 15 and 10 men had higher levels of potassium and reduced levels, respectively, but there was no marked gender interrelationship once again. Jing Lin et al., (2018) [4] emphasized that hyperkalemia can be more prominent in the cases of the advanced CKD and ESRD and it may need immediate medical interventions. Moreover, Luo J and Carmine Zoccali (2016) [13] proved a close correlation between high serum potassium levels and bad cardiovascular outcomes in patients with poor renal failure. Although we did not measure outcome measures, the frequency of hyperkalemia was found to be in line with those reports, which further supports the significance of regular checks of potassium levels in the evaluation of CKD severity.

The chloride imbalances, not as commonly focused as sodium and potassium, also implying the acid-base imbalance in CKD. In our study, lower rates of chloride were observed in 21 males and 15 females, but higher rates were not frequent. Lack of large gender relationship would be similar to the results of Blaise Widmer et al. (1979) [10], who reported gradual changes in serum electrolyte as well as acid-base composition with progressive renal failure, regardless of the variance in sex. Their graded study of chronic renal failure proved that the electrolyte imbalances are more closely associated with the deteriorating renal function than demographic variables.

Relatively, research on dialysis populations, including that by Makhlough et al. (2016) [1] and Abdulla et al. (2020) [2], has indicated that there were meaningful changes in serum electrolytes both prior to and subsequent to dialysis sessions. Compared to those interventional studies, our retrospective design determined the surveillance of baseline electrolyte abnormality without measurement of therapy modulation, which arguably could have caused severe electrolyte abnormalities in our cohort.

Chronic electrolyte imbalances tend to increase systemic complications of CKD such as cardiovascular morbidity and metabolic bone disease. As noted by Obrador et al., (2016) [14], persistent electrolyte imbalances (hyperkalemia and metabolic acidosis), have a systemic effect on patient survival. Our results, which provide evidence of a significant percentage of patients with abnormal sodium, potassium, and chloride levels, confirm the idea that the attention to electrolytes may be a convenient means of assessing the severity of CKD, although the gender factor does not seem to have a significant impact on abnormal values.

In general, the current research supports the available sources of literature that suggest that electrolyte imbalances are common in CKD and are likely to increase as the disease advances. Though some differences were found between the male and female respondents, none of them were statistically significant, indicating that renal dysfunction is the major cause of electrolyte imbalance. Such results are consistent with the previous nephrology studies focusing on the stage-related changes in the biochemical markers instead of the demographic factors. Thus, regular screening of serum electrolytes is still necessary to assess severity and preventive treatment of chronic kidney disease (Dhondup and Qian, 2017; Chen et al., 2019) [6,7].

Conclusion

The present clinical study highlights that serum electrolyte abnormalities are common in patients with chronic kidney disease (CKD) and serve as an important biochemical reflection of impaired renal homeostatic function. A substantial proportion of patients demonstrated derangements in serum sodium, potassium, and chloride, indicating compromised renal regulation of fluid balance and electrolyte handling. Although no statistically significant association was observed between gender and electrolyte status, these abnormalities remain clinically meaningful in the overall assessment and monitoring of CKD patients.

Importantly, electrolyte disturbances in CKD tend to worsen with declining renal function and may predispose patients to serious complications, including cardiac arrhythmias (especially with potassium imbalance), neuromuscular manifestations, and acid–base/metabolic disturbances. Therefore, serum electrolyte evaluation can be used as a supportive parameter for severity assessment, particularly when interpreted alongside clinical status, medication profile, and renal function measures (e.g., eGFR/CKD staging).

Routine and periodic monitoring of serum electrolytes should be considered an essential component of CKD care. Early identification and timely correction of electrolyte abnormalities can help reduce avoidable complications, optimize clinical decision-making, and improve overall patient outcomes. Future studies incorporating stage-wise CKD stratification and outcome correlation would further clarify the predictive value of electrolyte patterns in CKD severity and progression.

References

1. Makhlough A, Ilali E, Mohseni R, Shahmohammadi S. Effect of intradialytic aerobic exercise on serum electrolytes levels in hemodialysis patients.
2. Abdulla JE, Shakor JK, Shallal AF, Kheder R. Effect of dialysis on some Hematological and Electrolyte parameters in chronic kidney patients. Annals of Tropical Medicine and Public Health. 2020;23(11):9-13.
3. Owiredu WK, Ephraim RK, Eghan BA, Nafiu A, Edwin FL. Relationship between parathyroid hormone and electrolytes in chronic kidney disease. E3 Journal of Medical Research. 2012;1(8):103-11.
4. Lin J, Cheng Z, Ding X, Qian Q. Acid-base and electrolyte managements in chronic kidney disease and end-stage renal disease: case-based discussion. Blood purification. 2018 Apr 20;45(1-3):179-86.
5. Dhondup T, Qian Q. Electrolyte and acid-base disorders in chronic kidney disease and end-stage kidney failure. Blood purification. 2017 Jan 24;43(1-3):179-88.
6. Dhondup T, Qian Q. Acid-base and electrolyte disorders in patients with and without chronic kidney disease: an update. Kidney Diseases. 2017 Oct 5;3(4):136-48.
7. Chen TK, Knicely DH, Grams ME. Chronic kidney disease diagnosis and management: a review. Jama. 2019 Oct 1;322(13):1294-304.
8. Satirapoj B, Prapakorn J, Punpanich D, Pongsuparbchon C, Supasyndh O. The effect of ONCE Renal on minerals and electrolytes in predialysis patients with chronic kidney disease. International Journal of Nephrology and Renovascular Disease. 2016 Apr 5:81-6.
9. Sofue T, Nakagawa N, Kanda E, Nagasu H, Matsushita K, Nangaku M, Maruyama S, Wada T, Terada Y, Yamagata K, Narita I. Prevalences of hyperuricemia and electrolyte abnormalities in patients with chronic kidney disease in Japan: A nationwide, cross-sectional cohort study using data from the Japan Chronic Kidney Disease Database (J-CKD-DB). PLoS One. 2020 Oct 15;15(10):e0240402.
10. Widmer B, Gerhardt RE, Harrington JT, Cohen JJ. Serum electrolyte and acid base composition: the influence of graded degrees of chronic renal failure. Archives of internal medicine. 1979 Oct 1;139(10):1099-102.
11. Xue JL, Ma JZ, Louis TA, Collins AJ. Forecast of the number of patients with end-stage renal disease in the United States to the year 2010. Journal of the American Society of Nephrology. 2001 Dec 1;12(12):2753-8.
12. Zhang R, Wang S, Zhang M, Cui L. Hyponatremia in patients with chronic kidney disease. Hemodialysis International. 2017 Jan;21(1):3-10.
13. Luo J, Brunelli SM, Jensen DE, Yang A. Association between serum potassium and outcomes in patients with reduced kidney function. Clinical Journal of the American Society of Nephrology. 2016 Jan 1;11(1):90-100.
14. Obrador GT, Rubilar X, Agazzi E, Estefan J. The challenge of providing renal replacement therapy in developing countries: the Latin American perspective. American Journal of Kidney Diseases. 2016 Mar 1;67(3):499-506.