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SERUM ELECTROLYTE LEVELS IN HEART FAILURE PATIENTS WITH A HYPERTENSION HISTORY

KADAR SERUM ELEKTROLIT PADA PASIEN GAGAL JANTUNG DENGAN RIWAYAT HIPERTENSI

Original Research Article
Penelitian

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ABSTRACT

Background: *Knowing the description of serum electrolytes in those with a history of hypertension and congestive heart failure is critical.* ***Purpose:*** *The purpose of this study is to look into the estimation of serum electrolytes, the correlation between serum electrolytes (sodium (Na^+), potassium (K^+), chlorine (Cl^-)) levels with blood pressure, and the demographic characteristics of heart failure patients with a history of hypertension.* ***Method:*** *A retrospective design was used in this study, which used progress records (e.g., participant demographic data, medical history, and clinical laboratory tests such as serum electrolytes and blood chemistry) from patients with hypertension and Heart Failure (HF) who were hospitalized.* ***Result:*** *The present study established no correlation between serum electrolyte levels and blood pressure. The highest of Na^+ levels were 169 mEq/L, K^+ 6.4 mEq/L, and Cl^- 119 mEq/L. Most participants had the habit of not smoking (87 people, 79.8%) and not consuming alcohol (91 people, 83.5%). Demographic characteristics such as gender, smoking habits, and alcohol consumption had no significant impact on serum electrolyte levels, except for a history of alcohol consumption on sodium levels, which had a significant effect (p-value = 0.014). Furthermore, an absence of correlation was observed between demographic factors and blood pressure.* ***Conclusion:*** *A lack of relationship between serum electrolyte levels and blood pressure. Similarly, demographic characteristics were not correlated with blood pressure. HF patients with a history of hypertension show normal serum electrolyte levels, but a significant relationship between alcohol consumption habits and sodium levels was found.*

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ABSTRAK

Latar belakang: Mengetahui gambaran elektrolit serum pada mereka yang memiliki riwayat hipertensi dan gagal jantung kongestif sangatlah penting. **Tujuan:** Penelitian ini bertujuan untuk melihat estimasi elektrolit serum, korelasi antara elektrolit serum (Natrium (Na^+), Kalium (K^+), Klorida (Cl^-)) dengan tekanan darah, dan karakteristik demografi pasien gagal jantung dengan riwayat hipertensi. **Metode:** Desain retrospektif digunakan dalam penelitian ini menggunakan catatan kemajuan (misalnya, data demografi peserta, riwayat kesehatan, dan tes laboratorium klinis seperti elektrolit serum dan kimia darah) dari pasien hipertensi dan gagal jantung yang dirawat di rumah sakit. **Hasil:** Tidak menemukan korelasi antara kadar elektrolit serum dengan tekanan darah. Kadar Na^+ tertinggi sebesar 169 mEq/L, kadar K^+ 6.4 mEq/L, dan kadar Cl^- 119 mEq/L. Sebagian besar partisipan memiliki kebiasaan tidak merokok (87 orang, 79.8%) dan tidak mengonsumsi minuman beralkohol (91 orang, 83.5%). Karakteristik demografi seperti jenis kelamin, kebiasaan merokok, dan konsumsi alkohol tidak mempunyai dampak yang signifikan terhadap kadar elektrolit serum, kecuali riwayat konsumsi alkohol terhadap kadar natrium, yang mempunyai pengaruh signifikan (*p-value* = 0.014). Selain itu, tidak ditemukan korelasi antara karakteristik demografis dan tekanan darah. **Kesimpulan:** Tidak adanya hubungan antara kadar elektrolit serum dengan tekanan darah. Demikian pula, karakteristik demografis tidak berkorelasi dengan tekanan darah. Sebagian besar pasien yang terdiagnosis hipertensi dan gagal jantung mempunyai kadar elektrolit serum yang tidak seimbang, sehingga menjadi salah satu penanda utama munculnya diagnosis penyakit gagal jantung. Pasien gagal jantung dengan riwayat hipertensi menunjukkan kadar elektrolit serum normal. Namun, ditemukan hubungan yang signifikan antara kebiasaan konsumsi alkohol dengan kadar natrium.

Kata kunci:
Gagal jantung, Hipertensi, Elektrolit serum

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INTRODUCTION

Heart failure (HF) is a common disease with a significant risk of morbidity and mortality worldwide (Zhang *et al*., 2018). During the study period, 15.084 women and 15.822 men died from heart failure, women and men were equally likely to die from heart failure (Taylor *et al*., 2021). HF patients' outcomes are known to be predicted by their serum sodium levels (Tanai and Frantz, 2015). A consensus meeting was held by the Heart Failure Association on the topic of physiological monitoring of the complex multi-morbid HF patient, with one important aspect being monitoring of the related features of congestion status, renal function, and electrolyte levels, particularly potassium (Rossignol *et al*., 2019). Electrolyte imbalances are common in heart failure. Diuretics, renal impairment, neurohormonal activation, and a combination of these factors can all cause them.

Sodium (Na^+) and potassium (K^+) are the most commonly tampered with electrolytes (Verbrugge *et al*., 2015). Chloride (Cl^-) is also harmed (Ter Maaten *et al*., 2016). Na^+, K^+, and Cl^- are interested in the clinical course of HF because their changes may necessitate intervention or adaptation of HF therapies, and they appear to be related to prognosis (Kammerlander, 2019). Patients whose serum sodium levels fall below 125 mEq/L solely due to heart failure are usually nearing the end of their lives. Patients with heart failure with this hyponatremia level are also prone to hyperkalemia. In advanced cardiac disease, distal sodium and water delivery are so low that potassium excretion (primarily dependent on distal potassium secretion) falls below the intake level (Sterns and Gottlieb, 2024).

The segmentation regression model identified a turning point value of serum sodium levels (137.5 mmol/L) for all-cause death. Lower serum sodium levels (<137.5 mmol/L) were linked to a higher risk of all-cause mortality across 30, 90, 365 days, and 4 years, according to the fully adjusted cox proportional hazard model (Peng *et al*., 2022). Advanced heart failure patients often experience hyponatremia, the most prevalent electrolyte disorder. Hyponatremia is characterized by a serum sodium concentration below 136 mEq/L (Adrogué, 2017). Hyponatremia is a key clinical concern during and after hospitalization for patients with heart failure, as it is associated with poor short- and long-term outcomes (Şorodoc *et al*., 2023). Another study found no correlation between discharge hyponatremia and post-discharge morbidity or mortality, indicating that hyponatremia is not the sole cause of poor HF outcomes (Omar *et al*., 2017). The study revealed that Atrial Fibrillation (AF) in HF was more common in outpatients with Heart Failure with Reduced Ejection Fraction (HFrEF) and hyponatremia than in those with HFrEF and normonatremia. These findings further indicate that hyponatremia is independently linked to the development of AF (Cavusoglu *et al*., 2019). Cl^- is a better predictor of outcomes than sodium in HF, and the current debate over the beneficial versus detrimental effects of salt restriction in HF patients may be related, in part, to its impact on chloride homeostasis. Changes in plasma volume, vasopressin secretion, and the Renin Angiotensin Aldosterone Systems (RAAS) that occur with worsening HF are thought to be primarily mediated by serum chloride rather than serum sodium levels (Kataoka, 2017).

Decreased serum chloride concentrations were independently associated with increased all-cause mortality, Cardiovascular Disease (CVD) mortality, cancer mortality, and respiratory disease mortality (Hou *et al*., 2023), while another study found that chloride, Blood Urea, and Nitrogen (BUN) were inversely linked with diastolic blood pressure (Ríos-González *et al*., 2024). Both chloride and sodium are powerful ions found in extracellular fluid. Several studies have claimed that serum sodium abnormalities predict poorer outcomes in acute or chronic HF patients (Cuthbert *et al*., 2018; Grodin *et al*., 2015; Rossignol *et al*., 2019; Zandijk *et al*., 2021). However, almost none of them have considered chloride levels in their analyses. Serum electrolytes, measured routinely, have been suggested as a marker of (de)congestion and associated with cardiovascular disease. The most major risk factor is Hypertension (HTN), while other risk factors include advanced age, female gender, and diabetes (Ziaeian and Fonarow, 2016). As a result, knowing the description of serum electrolytes in those with a history of HTN and congestive heart failure is critical. This study aims to look into the estimation of serum electrolytes, the correlation between serum electrolytes (Na^+, K^+, and Cl^-) and blood pressure, and the demographic characteristics of heart failure patients with a history of hypertension.

MATERIAL AND METHOD

Material

A retrospective design was used in this study, which used progress records (e.g., participant demographic data, medical history, and clinical laboratory tests such as serum electrolytes and blood chemistry) from patients with hypertension and heart failure who were hospitalized. The procedure for taking samples and test materials is by the electrolyte test (electrolyte panel). Blood is drawn from a vein in the arm using a tiny needle. After inserting the needle, a small amount of blood is collected into a test tube or vial. When the needle is inserted or removed, the patient may experience a minor sting. This operation normally takes less than five minutes. The test materials (Na^+, K^+, and Cl^- serum) were examined using an electrolyte analyzer with an Ion-emitting or Selective Electrode (ISE). This tool contains four electrodes, namely Na^+, K^+, Cl^-, and reference. An electrolyte analyzer can detect inorganic salt ions and calcium ions in small material samples.

Method

The data taken and analyzed are first filtered through two stages, namely (1) Phase I, identifying all patients with a diagnosis of hypertension and heart failure who underwent treatment in the period March - May 2023, and (2) Phase II, identifying and collecting demographic data related to smoking history and alcohol consumption, which is considered to influence serum electrolyte levels in patients with hypertension and HF. Then it was found that the number of samples which met the criteria was 109. Respondent data met criteria such as having been diagnosed with HF with a history of hypertension for more than three months and undergoing inpatient treatment in the period March to May 2023. This study will adjust the number of samples that are willing and meet the criteria (purposive sampling) using binomial proportions using the cross-sectional sample formula, Snedecor, Cochran, and Lemeshow, as shown in Formula (1).

$$n = \frac{Z^2\ 1 - \alpha_{2}\ _{p\,(1-p)\ N}}{d^2\,(N-1) + Z^2\ 1 - \alpha_{2}\ _{p\,(1-p)}}$$

$$\Leftrightarrow \frac{Z^2\,\alpha\, p\, q}{d^2}$$

$$\Leftrightarrow \frac{Z^2\, p\,(1-p)}{d^2} \quad \text{............... (1)}$$

Annotation: n = minimum sample size required, α = degree of freedom, p = proportion of hypertensive patients whose serum electrolyte levels were measured, q = 1 - p (proportion of hypertensive patients whose serum electrolyte levels were measured), d = limit of error or absolute precision; if set = 0.05 or Z1- /2 = 1.96 or Z2 1- /2 = 1.962 or rounded to 4, then the formula (Formula 2 and Formula 3) for the known size of N simplified.

$$n = \frac{4\,p\,q}{d^2} = \frac{4 \times 0.935 \times 0.065}{0.05^2} = 97.24 \quad \text{.................(2)}$$

$$n = \frac{n}{1 - f} = \frac{97.24}{1 - 0.1} = 108.044 \quad \text{...............(3)}$$

Then it is obtained p = 93.5% -> 0.935 then q = 1– p ->1 – 0.935 = 0.065 then d = 0.05 (5%). The minimum number of participants that will be used in this study is 97.24 (98), 10% added to anticipate someone dropping out (not completing the measurement or failing the study). The number of participants used was 108.044 (109) participants.

Analysis data in this research for categorical data, use the binomial x^2 or chi-square statistical test analysis, and for associations, use the Pearson product-moment correlation. The study was conducted at Prof. R.D. Kandou Manado General Teaching Hospital in North Sulawesi, Indonesia.

RESULT

Table 1 shows the demographic characteristics of the participants, with the average age falling into the older age category (63.10 years). The highest height is 190 cm, and the heaviest weight is 123 kg. The highest systolic pressure reached 205 mmHg, and the diastolic pressure was 115 mmHg. The highest Na^+ levels were 169 mEq/L, K^+ 6.4 mEq/L, and Cl^- 119 mEq/L. The study found estimated values for serum electrolytes, Na^+ was 132.51 mEq/L, K^+ was 3.70 mEq/L, and Cl^- was 95.49 mEq/L. The estimated average Na^+ of respondents was below the normal range (hyponatremia, normal range: 136 - 145 mEq/L), while K^+ was still in the normal range 3.70 (normal range: 3.5 - 5.0 mEq/L), and Cl^- was slightly below the standard value (normal range: 96 - 106 mEq/L) (Shrimanker and Bhattarai, 2024; Relias and Nurse, 2024).

Table 2 shows the participants' habits, with the majority being male, 63 people (57.8%). Most participants had the habit of not smoking 87 people (79.8%) and not consuming alcohol 91 people (83.5%). Smoking and alcohol consumption habits are among the citizens' demographic and habits in Minahasa (Manado).

Statistically, there was no significant relationship between demographic characteristics and systolic blood pressure (p-value > 0.05). However, a positive correlation was identified between the direction of the relationship between demographic characteristics and Systolic Blood Pressure (SBP). The relationship with Diastolic Blood Pressure (DBP) is also insignificant and positive except for age demography, potassium, and chloride levels, which have a negative correlation direction, as shown in Table 3. The direction of the positive correlation between the characteristics of the participants and systolic pressure indicates a correlation between variables in the same direction (if one variable increases the other variable will also increase), while in variables with a negative correlation between the characteristics of the participants such as age, potassium, and chloride levels with diastolic pressure (if one variable decreases then the other variable increases). The findings are not statistically significant, but clinically and conceptually show that age and serum electrolytes play a role in blood pressure regulation. Table 4 shows that there is no significant correlation between gender, smoking, and alcoholic habits with systolic and diastolic blood pressure (p-value > 0.05).

Table 1. Demographic characteristics of the participants

Characteristics	n	Percentage (%)
Sex		
Male	63	57.8
Female	46	42.2
	$\bar{x}$ (min - max)	Standard of Deviation (SD)
Age (years)	63.10 (37 - 91)	10.06
Height (cm)	160.14 (140 - 190)	7.78
Weight (kg)	66.89 (42 - 123)	13.54
Systolic Blood Pressure (SBP)* (mmHg)	136.54 (90 - 205)	22.18
Diastolic Blood Pressure (DBP)* (mmHg)	80.76 (45 - 115)	11.87
Sodium (Na^+) (mEq/L)	132.51 (97 - 169)	9.83
Potassium (K^+) (mEq/L)	3.70 (1.8 - 6.4)	1.09
Chloride (Cl^-) (mEq/L)	95.49 (53 - 119)	11.58

Table 2. Participants' habits

Variabels	n	Percentage (%)
Habits of smoking		
Yes	22	20.2
No	87	79.8
Alcohol consumption		
Yes	18	16.5
No	91	83.5

Table 3. Correlation between demographic characteristics with Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP)

Variabels	Systolic Blood Pressure (SBP)			Diastolic Blood Pressure (DBP)		
	$\bar{x}$	SD	p*	$\bar{x}$	SD	p*
Sex						
Male	138.7	22.56	0.223	81.9	10.88	0.236
Female	133.5	22.53		79.1	13.06	
	Systolic Blood Pressure (SBP)			**Diastolic Blood Pressure (DBP)**		
	n	r	p*	n	r	p*
Age	109	0.053	0.587	109	- 0.155	0.108
Height	109	0.054	0.576	109	0.154	0.110
Weight	109	0.107	0.270	109	0.113	0.242
Sodium (Na^+)	109	0.099	0.307	109	0.015	0.876
Potassium (K^+)	109	0.043	0.656	109	- 0.004	0.965
Chloride (Cl^-)	109	0.007	0.942	109	- 0.027	0.779

SD = Standard of Deviation, $\bar{x}$ = mean, p* = significancy, r = product - moment

Table 4. Correlation between participant habits with Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP)

Variabels	Systolic Blood Pressure (SBP)			Diastolic Blood Pressure (DBP)		
	$\overline{x}$	SD	p*	$\overline{x}$	SD	p*
Habits of smoking						
Yes	137.8	22.56	0.754	81.59	15.55	0.770
No	136.2	22.53		80.55	10.85	
Alcohol consumption						
Yes	18	29.70	0.064	84.22	16.39	0.315
No	91	20.54		80.08	10.75	

$\overline{x}$ = mean, p*= significancy (chi-square)

Table 5. Correlation between participants' habits with Na^+, K^+, and Cl^-

Variabels	Sodium (Na^+)			Potassium (K^+)			Chloride (Cl^-)		
	$\overline{x}$	SD	p*	$\overline{x}$	SD	p*	$\overline{x}$	SD	p*
Sex									
Male	132.3	9.75	0.779	3.74	1.06	0.670	95.68	12.02	0.835
Female	132.8	10.05		3.66	0.915		95.22	11.06	
Habits of smoking									
Yes	135.5	12.88	0.202	3.64	0.704	0.658	95.00	12.59	0.838
No	131.7	8.83		3.72	1.06		95.61	11.38	
Alcohol consumption									
Yes	138.3	10.31	0.014†	3.84	0.868	0.485	92.56	12.59	0.284
No	131.4	9.37		0.368	1.02		96.07	11.35	

$\overline{x}$ = mean, p* = significancy, p† = significancy < 0.05

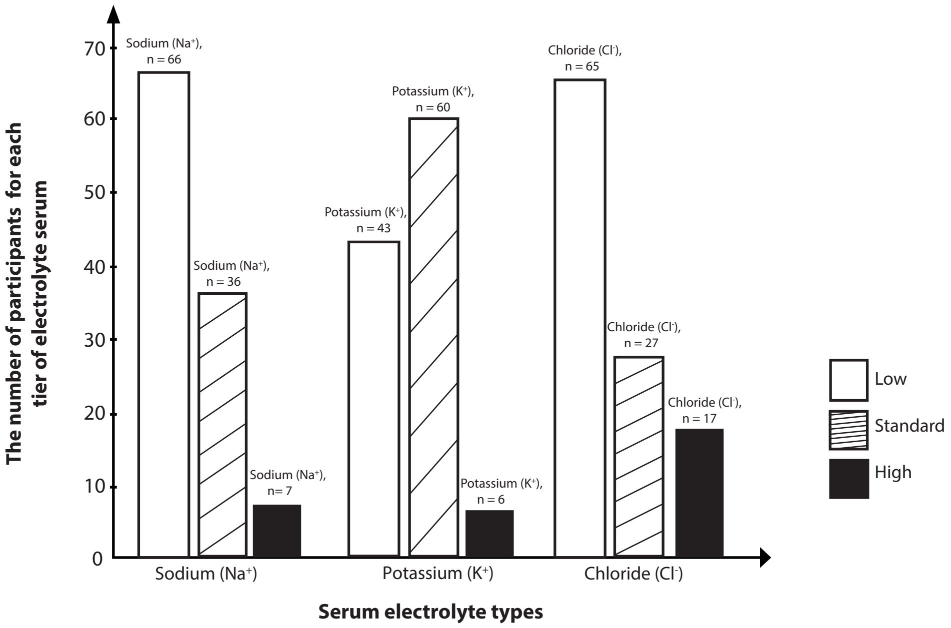

Figure 1. Data set presents the number of participants in each tier of electrolyte serum in patients with Heart Failure (HF)

Sex demographics, smoking habits, and alcohol consumption had no statistically significant impact on serum electrolyte levels as be seen in Table 5, except for a history of alcohol consumption on Na^+ levels, which had a significant effect (p-value = 0.014). Figure 1 shows the following data set, which presents the number of participants in each tier of electrolyte serum in patients with heart failure (n = 109). The majority of participants had low sodium levels 66 people (60.55%), normal potassium levels 60 people (55.04%), and low chloride levels 65 people (59.63%).

DISCUSSION

This study discovered that most HF participants were elderly (i.e., older than 60 years) and had more incidents in men than women. Related research has revealed that HF is far more common in older age groups, reaching 4.3% among people aged 65 to 70 in 2012, and is expected to rise steadily until 2030, when the prevalence of HF may reach 8.5% (Van Nuys *et al*., 2018). Another study has reported that in developed countries the prevalence of 'all types' heart failure is around 11.8% in those aged 65 and up (Fonseca, 2017). A similar study reported that women with HF were diagnosed at a younger age of 8.1% and older age of 34.4%, compared to 17.8% of men diagnosed at a younger age of 65 years and 18.4% at an age older than 85 years (Taylor *et al*., 2021). Comorbid Cardiovascular Disease (CVD) was expected, with women being more likely to have hypertension (Taylor *et al*., 2021; Usman *et al*., 2022), and men being more likely to have ischemic heart disease, a previous myocardial infarction, diabetes, or smokers (Taylor *et al*., 2021). Another study reported that even when no Coronary Artery Disease (CAD) or ischemic heart disease is present, hypertension can cause HF (Ziaeian and Fonarow, 2016). Therefore, physician evaluation, laboratory tests, sophisticated cardiovascular imaging, or invasive hemodynamic catheterization are all possible diagnostic criteria for heart failure.

The Framingham Heart Study, conducted in 1971, established clinical criteria for HF diagnosis based on physical examination and physician assessment (Mahmood and Wang, 2013). High blood pressure generates mechanical stress due to increased afterload and neurohormonal changes that increase ventricular mass. HTN is also highly related with other comorbidities for HF development, and aggressively treating hypertension has been proven to decrease the occurrence of HF (Ziaeian and Fonarow, 2016; Malik *et al*., 2024). The condition of increased blood pressure exposes cardiac myocytes to mechanical stress, leading to left ventricular hypertrophy and Heart Failure with Preserved Ejection Fraction (HFpEF) or HFrEF, even without occluded coronary arteries (Ziaeian and Fonarow, 2016). Atrial myocyte functional remodelling may contribute to the transition from compensated LV hypertrophy to HF in advanced Hypertension Heart Disease (HHD), as well as an increased risk of atrial arrhythmias in HF (Pluteanu *et al*., 2018). In a cohort study, it was found that 73.6% of patients with HFrEF had hypertension, compared with 89.3% of patients with HFpEF (Gerber *et al*., 2015).

The Left Ventricular Ejection Fraction (LVEF) is used to classify HF, namely (1) HFrEF (LVEF ≤ 40%), (2) HF with modestly reduced ejection fraction (LVEF 41% to 49% with signs of HF (raised cardiac biomarkers or elevated filling pressures), (3) HFpEF (LVEF ≥ 50% with indications of HF, elevated cardiac biomarkers or filling pressures), and (4) HF with enhanced ejection fraction (LV EF > 40% or previously recorded LVEF below 40%) (Heidenreich *et al*., 2022).

The American College of Cardiology (ACC) and the American Heart Association (AHA) heart failure stages, namely (1) Stage A, at risk of HF. There are no symptoms, structural heart disease, or signs of increased cardiac biomarkers, although risk factors exist. Hypertension, diabetes, metabolic syndrome, cardiotoxic medicines, and cardiomyopathy-related genetic variation are all risk factors. (2) Stage B, pre-HF. Patients have no indications or symptoms of heart failure but have structural heart disease, evidence of elevated filling pressures (by invasive or non-invasive examination), or chronically raised cardio-markers in the absence of other causes, such as chronic renal disease or myocarditis. (3) Stage C, patients having structural heart disease and a current or previous history of heart failure symptoms. (4) Stage D, patients who have refractory symptoms that interfere with everyday living or require recurring hospitalization despite focused, guideline-directed medical treatment (Heidenreich *et al*., 2022; Malik *et al*., 2024).

Another finding in this study was that participants' blood pressure, on average, fell into the category of stage 1 hypertension (136.54 mmHg systolic and 80.76 mmHg diastolic). This finding is consistent with a related previous study, which reported that participants' blood pressure was in the stage 1 hypertension category (130 – 139 mmHg systolic or 80 – 89 mmHg diastolic) (Whelton *et al*., 2018; Flack and Adekola, 2020). According to findings, the workload on the heart is increased by hypertension, causing structural and functional changes in the myocardium. Hypertrophy of the left ventricle is one of these changes, which can lead to heart failure (Tackling and Borhade, 2024). According to previous research, long-term hypertension eventually leads to HF. Thus, most HF patients have a history of hypertension (Messerli *et al*., 2017), and poor dietary management practices are a contributing factor to the issue (Usman *et al*., 2019). The diagnosis of hypertension-elevated Blood Pressure (BP) is linked to an increased risk of CVD (e.g., CVD death or heart failure, myocardial infarction, ischemic and hemorrhagic stroke) (Hermida *et al*., 2018). One of the causes and early indicators of heart failure is hypertension.

Electrolyte imbalances are common in the HF clinical course. Clinicians are particularly interested in potassium and sodium levels because changes may necessitate immediate action to prevent harm and most commonly affected, However, Cl^- is also impacted. This study found that the average estimated Na^+ of respondents was below normal (hyponatremia), in line with previous studies which reported that hyponatremia (lower than 135 mEq/L) is the most common electrolyte disorder in hospitalized patients in general and is common in acute and chronic HF (Verbrugge *et al*., 2015; Ter Maaten *et al*., 2016; Kammerlander, 2019). Furthermore, the rising prevalence of HF and emerging knowledge about chloride as a prognostic marker in HF have heightened interest in the pathophysiology and interactions of chloride abnormalities with HF-related factors and treatments (Zandijk *et al*., 2021).

The study found that the average potassium level was still within normal limits (3.6 - 5.3 mEq/L). Nonetheless, the number of participants with low potassium levels (hypokalemia) was quite high (43; 39.44%). Severe hypokalemia must be thoroughly monitored and the reason explored as soon as possible due to the increased risk of cardiac compromise (Casey *et al*., 2023). According to other studies, dyskinesia (hypokalemia and hyperkalemia) in heart failure is expected due to the disease, associated comorbidities, and medications (Ferreira *et al*., 2020). Low potassium levels are linked to increased morbidity and mortality in patients with heart failure. The risk increases as potassium levels fall below approximately 4.0 mmol/L, with a steep risk increase above 3.5 mmol/L. Higher potassium levels or hyperkalemia (levels greater than 5.5 mmol/L) has also been linked to an increased risk of adverse events (Ferreira *et al*., 2020; Shrimanker and Bhattarai, 2024). Other studies have found that hypochloremia, regardless of sodium level, is associated with a higher risk of morbidity and mortality or hospitalization for heart failure than isolated hyponatremia (Cuthbert *et al*., 2018).

The study also discovered that smoking and alcohol consumption had no statistically significant relationship with blood pressure or serum electrolytes. In line with the findings of previous studies, there was no statistically significant difference in age, complete blood count parameters, liver functions, serum electrolyte levels, or blood sugar levels between the smoker and non-smoker groups (Eid *et al*., 2022). There were no significant differences in serum electrolyte, potassium, sodium, magnesium, or calcium levels between men and volunteers smoking 10 - 25 or 26 - 40 cigarettes per day for three years (Rebat *et al*., 2020). This study also discovered a significant relationship between alcohol and sodium electrolytes. This is in line with related studies, the survey reveals a meaningful relationship between alcohol and sodium electrolytes, hyponatremia in 46%, hypochloremia in 24%, and hypokalemia in 67% of alcohol-dependent individuals, with significant differences between levels (Chandini *et al*., 2017). A previous study has reported that various factors can cause electrolyte imbalances in alcoholic patients (Palmer and Clegg, 2017), such as hyponatremia, hypokalemia, hypomagnesemia, hypocalcemia, hypochloremia, hypophosphatemia with elevated blood glucose, and metabolic alkalosis with a standard anion gap were discovered during the evaluation (Meenashi Sundaram *et al*., 2023). The effect of alcohol on serum electrolyte levels is also determined by how often and how much alcohol is consumed.

This study found no correlation between serum electrolyte levels and blood pressure nor between the participants' demographics. Most patients diagnosed with hypertension and heart failure have imbalanced serum electrolyte levels (Na^+, K^+, and Cl^-). The limitations of this study are the sampling of small-scale treatment effects and the need to evaluate the effects of treatment on serum electrolyte levels.

CONCLUSION

The present investigation established no correlation between serum electrolyte (Na^+, K^+, and Cl^-) levels and blood pressure. Furthermore, no correlation was established between participant demographics and blood pressure in heart failure patients with a history of hypertension. The majority of patients diagnosed with hypertension and heart failure exhibit imbalanced serum electrolyte levels (Na^+, K^+, and Cl^-). The study revealed no statistically significant correlation between demographic characteristics and systolic blood pressure. However, a positive correlation was identified with diastolic blood pressure.

The findings indicated a negative correlation between age, potassium, and chloride levels, suggesting a potential relationship between these variables. However, research has demonstrated a correlation between age and serum electrolytes on one hand, and blood pressure regulation on the other. The present study found no significant correlation between gender, smoking, and alcohol consumption on the one hand, systolic, and diastolic blood pressure on the other. The analysis revealed a substantial impact of alcohol consumption on sodium levels, with the majority of subjects exhibiting low sodium, normal potassium, and low chloride levels. The impaired serum electrolyte balance condition is one of the main markers of the emergence and diagnosis of heart failure. Both sodium, potassium, and chloride each have a role in maintaining the circulatory system, ejection fraction and heart muscle pump in distributing blood throughout the body. Future studies are recommended to investigate the comparison of serum electrolytes between those who received care and treatment and those who were not controlled.

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AUTHOR CONTRIBUTION

The contributions of each author include ideas, data generation, data analysis, manuscript preparation, and funding. Please use initials to refer to each author's contribution in this section, S. U. and M. N. analyzed and interpreted the patient data regarding the disease. S. U., C. Z. T., I. S., and M. N. conceived the study, contributed to sample preparation, language editing, and designed the study. All authors discussed the results and contributed to the final manuscript.

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DATA AVAILABILITY

It is evident that the datasets generated and/or analysed during the present study are not subject to public disclosure due to their sensitive nature and the confidential nature of the clinical data they contain. However, these datasets are available to interested parties upon request, with the necessary conditions being met by the corresponding author.

CONFLICT OF INTEREST

The authors state there is no conflict of interest with the parties involved in this study.

ETHICAL APPROVAL

This research has been approved by the ethics committee with number 083/EC/KEPK-KANDOU/VI/2023 issued on 23rd June 2023 by the research ethics committee of the General Hospital, Prof. Dr R.D. Kandou Manado. This declaration of ethics applies during the period June 23rd, 2023 until June 23rd, 2024.

INFORMED CONSENT

An informed consent form was obtained from the respondents prior to their participation in the study, and it was explained to them that they were free to withdraw at any point.

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