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CLINICAL CORRELATES OF HYPONATREMIA AMONG HOSPITALIZED HEART FAILURE PATIENTS AT JAKAYA KIKWETE CARDIAC INSTITUTE, DAR ES SALAAM

BY

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CERTIFICATION

The undersigned certifies that she has read and at this moment recommended for submission a dissertation titled "***CLINICAL CORRELATES OF HYPONATREMIA AMONG HOSPITALIZED HEART FAILURE PATIENTS AT JAKAYA KIKWETE CARDIAC INSTITUTE, DAR ES SALAAM***" in partial fulfillment of the requirements for the degree of Master of Medicine in Internal Medicine.

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I, BILQIS S. NASSOR, hereby declare that this dissertation is my own effort and original work, and that it has not been presented and will not be presented to any other university for a similar degree or any other academic award.

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ACKNOWLEDGEMENT AND DEDICATION

In the Name of Allah, the Most Gracious, the Most Merciful.

I prostrate in humble gratitude first and foremost to Almighty Allah, who blessed me with perseverance and the intellectual capacity to undertake this research journey.

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ABSTRACT

Background:

Hyponatremia is a frequent electrolyte disturbance in patients with heart failure (HF), associated with prolonged hospitalization, increased morbidity, and higher mortality. It results from hemodynamic alterations, neurohormonal activation, and medication effects, particularly diuretics. In sub-Saharan Africa, including Tanzania, data on its prevalence and clinical correlates remain limited. Understanding its magnitude among HF patients at JKCI is crucial for early identification and routine monitoring of serum sodium levels to prevent complications and improve outcomes.

Objective:

To determine the clinical correlates of hyponatremia among hospitalized adult HF patients at JKCI, Dar es Salaam.

Methodology:

A hospital-based cross-sectional study was conducted among adult HF patients admitted to JKCI. Sociodemographic characteristics, medical history, medication use, volume status, laboratory findings, and echocardiographic parameters were collected using a structured tool. Serum sodium was categorized into normal, mild, moderate, and severe hyponatremia, and volume status was used to classify hypovolemic, euvolemic, and hypervolemic hyponatremia. Data were analyzed using SPSS version 25. Descriptive statistics summarized participant data, chi-squared tests assessed associations, and Spearman's correlation evaluated the relationship between ejection fraction (EF) and sodium levels.

Results:

Of 133 HF patients, 67.6% had hyponatremia, mostly mild to moderate. Males had a slightly higher prevalence (68.1%) than females (67.2%). Common symptoms included fatigue (62.4%), nausea (42.1%), and headache (34.6%), with severity correlating significantly with sodium levels. Hyponatremia was more severe in single patients, and unexpectedly higher among those with higher education. Prevalence increased with older age (>60 years) and was more common in patients using diuretics, restricting salt, and those with reduced EF (HFrEF), where hypervolemic hyponatremia predominated. Hypertension was the most frequent comorbidity (91%) but was not statistically associated. Hyponatremia severity correlated strongly with NYHA functional class and chronicity of HF.

Conclusion:

Hyponatremia is a common and under-recognized electrolyte imbalance among hospitalized HF patients at JKCI. Its occurrence was strongly linked to advanced NYHA class, diuretic use, salt restriction, comorbidities, older age, and reduced EF. Early recognition and management can reduce HF complications, hospital stay, and improve quality of life

Recommendation:

Routine sodium monitoring, individualized dietary advice, detailed volume assessment, and further longitudinal research are recommended to improve HF outcomes

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LIST OF ABBREVIATIONS

ACEIs	Angiotensin Converting Enzyme Inhibitors)
ARBs	Angiotensin Receptor Blockers)
AVP	Arginine Vasopressin
AHF	Acute Heart Failure
CCBs	Calcium Channel Blockers
CKD	Chronic Kidney Disease
CHF	Congestive Heart Failure
EF	Ejection Fraction
ESRD	End Stage Renal Disease
HNa	Hyponatremia
HF	Heart Failure
NSAIDs	Nonsteroidal Anti-inflammatory Drugs
NYHA	New York Heart Association
RAAS	Renin Angiotensin Aldosterone System
SSRIs	Selective Serotonin-Reuptake Inhibitors
SNS	Sympathetic Nervous System
SIADH	Syndrome of Inappropriate Antidiuretic Hormone Secretion.

OPERATIONAL DEFINITIONS

Hyponatremia: Hyponatremia is defined as a low sodium concentration below the acceptable range of 135–145 mmol/L [1]

Heart failure: Heart failure is a clinical syndrome characterized by the heart's inability to pump blood effectively, resulting in inadequate cardiac output to meet the body's metabolic demands and causing reduced tissue perfusion [2]. It is a clinical syndrome consisting of cardinal symptoms (e.g. breathlessness, ankle swelling, and fatigue) that may be accompanied by signs (e.g., elevated jugular venous pressure, pulmonary crackles, and peripheral edema).[3]

Clinical correlates: Refers to the clinical signs, symptoms, or findings that vary with or are related to a specific medical condition, disease, or disorder[4] They are the observable or measurable factors that help in diagnosing or understanding the relationship between a condition and its effects on the body or mind.

Acute hyponatremia: Hyponatremia occurring less than 48 hours [5]

Chronic hyponatremia: Hyponatremia of equal to or more than 48 hours [5]

DDAVP: or desmopressin acetate, is a synthetic derivative of the natural hormone vasopressin, which plays a key role in maintaining fluid balance. Clinically, it is used to manage central diabetes insipidus and nocturnal enuresis by decreasing excessive urination and thirst.[6]

Total osmolality: is defined as the concentration of all solutes in a given weight of water (mOsm/kg), regardless of whether or not the osmoles can, move across biological membranes[5]. Effective osmolality or tonicity: refers to the number of osmoles that contribute water movement between the intracellular and extracellular compartment[5]

CHAPTER ONE

1.0 INTRODUCTION

Heart failure is a common clinical syndrome resulting from any abnormality of cardiac structure or function that impairs the ventricle's ability to eject or fill with blood, leading to reduced cardiac output [7].Heart failure poses a significant global health concern and is the leading cause of morbidity and mortality in older adults worldwide[8]. It accounts for roughly 497,000 hospital admissions and 4,825,000 hospital days annually in the United States[9]. Interestingly, heart failure is the only cardiovascular condition that is increasing in incidence, prevalence, and mortality, having a poor prognosis, with less than 50% of patients surviving 5 years after diagnosis. [10,11]. In sub-Saharan Africa, the prevalence of heart failure is rising as a result of the shift towards non-communicable diseases and the growing population of elderly individuals, accounting for 9.6% of all hospital admissions[12,13]. Hyponatremia emerges as a critical clinical marker in adult heart failure patients, significantly influencing their medical outcomes both during hospitalization and in long-term follow-up[14]. It is a prevalent electrolyte disturbance in heart failure patients, occurring in 15-30% of hospitalized cases, a condition closely linked to more severe heart failure stages and less favorable patient prognoses[15]. It involves complex neurohumoral dysregulation that contributes to water retention and sodium dilution[16]. It can lead to a wide spectrum of clinical symptoms, from subtle to severe or even life-threatening, and is associated with increased mortality, morbidity, and length of hospital stay in patients presenting with a range of conditions. Despite this, the management of patients remains problematic.[5] Studies consistently demonstrate that hyponatremia serves as a significant prognostic marker, associated with increased hospitalization and mortality risks in heart failure patients [17].

1.1 BACKGROUND

1.1.1 HEART FAILURE

Heart failure is a clinical syndrome consisting of cardinal symptoms (e.g. breathlessness, ankle swelling, and fatigue) that may be accompanied by signs (e.g. elevated jugular venous pressure, pulmonary crackles, and peripheral oedema) which can be due to structural or functional abnormality in the heart, that can lead to reduced cardiac output or increased intracardiac pressures [3]

Classification of Heart Failure by the European Society of Cardiology

Heart failure (HF) is classified into different categories based on various factors, including the onset of symptoms and the underlying cardiac function.[3]

Classification by onset of symptoms

Chronic Heart Failure (CHF): Is defined as a life-limiting syndrome marked by the heart's impaired ability to circulate blood effectively. This dysfunction manifests through clinical features including breathlessness, reduced exercise tolerance, and fluid accumulation, and is frequently associated with comorbidities such as coronary artery disease and systemic hypertension [18]. This classification refers to patients who have an established diagnosis of heart failure or those who experience a gradual onset of symptoms that can be managed but not completely cured[3].

Acute Heart Failure (AHF): Is defined as a sudden worsening of heart failure symptoms such as dyspnea, orthopnea, and lower limb swelling[19] . This can occur in patients with previously stable CHF or can present as a new diagnosis. AHF may require immediate medical attention and often leads to hospitalization[3].

Decompensated Heart Failure: This is defined as a sudden or gradual worsening of heart failure symptoms. Patients may require hospitalization or intravenous diuretic therapy to manage their symptoms during this phase[3].

Classification by Ejection Fraction: Heart failure can also be classified based on the left ventricular ejection fraction (LVEF): Heart Failure with Reduced Ejection Fraction (HFrEF): Typically defined as HF with an LVEF of less than 40%. Heart Failure with Preserved Ejection Fraction (HFpEF): Defined as HF with a LVEF of 50% or higher. Heart Failure with mildly reduced Ejection Fraction (HFmrEF): Defined as HF with an LVEF between 41% and 49%. [3]

The Framingham criteria are widely used for the clinical diagnosis of heart failure (HF) and are based on a combination of major and minor clinical signs. Established from the Framingham Heart Study, these criteria require the presence of either two major criteria or one major and two minor criteria to confirm a heart failure diagnosis.

Table 1: Framingham Criteria for Heart Failure Diagnosis[20]

Category	Criteria
Major Criteria	Paroxysmal nocturnal dyspnea
Major Criteria	Neck vein distension
Major Criteria	Rales (lung crackles)
Major Criteria	Radiographic cardiomegaly (enlarged heart on chest X-ray)
Major Criteria	Acute pulmonary edema
Major Criteria	S3 gallop (third heart sound)
Major Criteria	Increased central venous pressure (>16 cm H_2O at right atrium)
Major Criteria	Hepatojugular reflux (neck vein distension upon pressing the liver)

Major Criteria	Weight loss of more than 4.5 kg in 5 days in response to treatment
Minor Criteria	Bilateral ankle edema
Minor Criteria	Nocturnal cough
Minor Criteria	Dyspnea on ordinary exertion
Minor Criteria	Hepatomegaly (enlarged liver)
Minor Criteria	Pleural effusion (fluid around the lungs)
Minor Criteria	Decrease in vital capacity by one-third from maximum recorded
Minor Criteria	Tachycardia (heart rate >120 beats/min)

1.1.2 EPIDEMIOLOGY OF HEART FAILURE

The global burden of heart failure (HF) affects approximately 64 million people, with increasing prevalence due to population aging and improved survival rates. HF is associated with high mortality, morbidity, and significant healthcare system challenges worldwide. [21]

In 2021, there were 56.5 million prevalent cases of heart failure globally, with ischemic heart disease, hypertensive heart disease, and other cardiomyopathy accounting for most cases[22.] Heart failure is a significant public health issue in Sub-Saharan Africa, accounting for 12.23% mortality among 2976 patients studied. Contributing factors include high blood pressure, infections, and socioeconomic barriers, necessitating prevention and education programs to alleviate the burden[23.]

The overall mortality rate for heart failure patients in the INTER-CHF study was 16.5%, with the highest rates in Africa (34%) and India (23%), and the lowest in China (7%), South America (9%), and the Middle East (9%).[24]

A study done in Cameroon highlights that nearly 50% of heart failure patients die within 36 months, emphasizing the urgent need for improved preventive strategies.[25]

The burden of heart failure in Tanzania is significant, with a 26.2% prevalence among emergency department patients with a high thirty-day mortality rates (25.4%) and poor uptake of evidence-based therapies.[26]

1.1.3 HYPONATREMIA

Hyponatremia defined as a serum sodium ion concentration below 135 mmol/L is the most encountered and important electrolyte imbalance that can be seen in isolation or as in most often the case, as a complication of other medical illnesses (e.g. heart failure, liver failure, kidney failure, pneumonia, cancer) [27].

Classification of hyponatremia according to the European journal of endocrinology. According to biochemical severity: Mild hyponatremia as a biochemical finding of a serum sodium ion concentration between 130 and 135 mmol/l (as measured by ion-specific electrode). Moderate hyponatremia is a biochemical finding of a serum sodium concentration between 125 and 129 mmol/l as measured by ion specific electrode. Profound (severe) hyponatremia is a biochemical finding of a serum sodium concentration >125 mmol/l as measured by ion-specific electrode[5]. According to the time of development: Acute hyponatremia as hyponatremia that is documented to exist < 48 h. Chronic hyponatremia as hyponatremia that is documented to exist for at least > 48 h. If hyponatremia cannot be classified, it is considered as chronic, unless there is clinical or anamnestic evidence of the contrary[5]

Classification of Hyponatremia can be further classified depending on its underlying pathophysiology and the relationship between total body water and sodium levels[28]: Dilutional Hyponatremia: This is the most common form of hyponatremia, characterized by excess water retention relative to sodium levels. It occurs when total body water is in excess compared to sodium stores, which may be low, normal, or increased. The primary cause is excessive renal retention of water, often due to increased activity of arginine vasopressin (AVP) in response to various stimuli[28].

Types of Dilutional Hyponatremia: Hypervolemic Hyponatremia: This occurs when both body sodium and water are in excess, but the increase in total body water exceeds the total body sodium level, leading to edema. Common causes include congestive heart failure, liver cirrhosis, and renal diseases. Euvolemic Hyponatremia: Characterized by normal or near-normal total body sodium and increased total body water without signs of volume depletion or overt hypervolemia. It is often associated with elevated AVP levels.[28]

Deletional Hyponatremia: This type is usually hypovolemic, indicating an absolute deficiency of water but a relative excess of body water compared to sodium concentration. In this case, total body water decreases, but total body sodium decreases to a greater extent. Causes may include renal solute losses (e.g., diuretic use, salt-wasting nephropathy) or nonrenal solute losses (e.g., gastrointestinal losses from diarrhea or vomiting)[28.]

Clinical management of hyponatremia is based on treating the underlying causes (Table 2) however, accurately determining the etiology of hyponatraemia is difficult, especially in elderly individuals[29]. Expert physicians' clinical judgement is the most often recognized method of getting an accurate diagnosis[30]; however, as few clinicians are particularly interested in hyponatremia, this may not be feasible. Multiple possible causes of

hyponatremia may co-exist, and cognitive or sensory impairment may make it difficult to establish a clinical history. Accurately determining volemic state is essential for diagnosing underlying reasons.

A thorough understanding of the causes of hyponatremia is necessary for both preventing its onset and for proper therapeutic therapy. There are currently few high-quality research describing the causes of hyponatremia in the elderly. The majority of findings come from retrospective studies that rely on diagnoses made by non-specialist clinicians looking back at case notes, which often don't contain enough information to enable an accurate diagnosis (i.e., investigation of volemic state, reporting of necessary investigations)[31].

1.1.4 EPIDEMIOLOGY OF HYPONATREMIA

Hyponatremia is the most common electrolyte abnormality found in clinical settings worldwide. It affects a significant number of hospitalized patients, with mild to moderate cases occurring in approximately 15-30% of these patients. Severe cases of hyponatremia are less common, affecting about 1-4% of hospitalized individuals[28].

The prevalence of hyponatremia can vary depending on the underlying causes and the patient population being studied. For instance, patients with conditions that lead to fluid imbalance, such as heart failure or liver cirrhosis, may have higher rates of hyponatremia due to the body's inability to regulate sodium and water properly[32].

In the USA, the prevalence of hyponatremia (<135 mEq/l) is approximately 4.3% for patients over 65 years old, with 0.14% having sodium levels lower than 126 mEq/l. In the ICU, prevalence is around 15%[33].

A large retrospective analysis (N= 20667) of patients who presented to the emergency department of the university hospital-Bern (in Switzerland) between 1st January 2009 and

31st December 2010 returned an estimated prevalence of hyponatremia of around 8.9%, 13.5%, 15.2% and 16.9% for seniors aged 51-60, 61-70, 71-80 and > 80 years respectively[34].

In Asia, Intisar Hamoud et al, observed that within 736 patients who met the inclusion criteria, 377 patients (51.2%) had hyponatremia upon admission to the hospital. This prevalence increased significantly during hospitalization, with 562 patients (76.35%) experiencing hyponatremia at some point during their stay.[14]

Another cross-sectional study as part of the ongoing Rotterdam prospective program found the prevalence of hyponatremia was ranging between 5.9% and 11.6% for seniors in age >55 years with females being more affected than male by 60.6% [35].

In 2016, it was noted that there was increasing prevalence of hyponatremia reaching up to 25%, particularly in vulnerable populations like the elderly in Uganda.[36]

1.1.5 RISK FACTORS OF HYPONATREMIA

The risk factors of hyponatremia include age, diabetes mellitus, cardiovascular complications (e.g. heart failure), consumption of certain medications (e.g. thiazide diuretics, benzodiazepine, antiepileptics) as well as gender (female) [37] have been reported to be important risk factors in the etiopathogenesis of hyponatremia in humans 31. By far, age had been consistently considered as the strongest risk of all towards development of hyponatremia in adults[35,37]. Uncontrolled case series have suggested that women are at greater risk of hyponatremia than men; however, a controlled study suggests that this association is due to low body weight rather than gender [38]. It's crucial to emphasize the role of multiple medication use in causing hyponatremia in people, particularly among older adults. While loop diuretics alone are rarely linked to hyponatremia in the elderly, the risk significantly increases when these medications are taken alongside other drugs[39.]

This combination effect highlights the complex nature of drug interactions in the development of hyponatremia, especially in adult populations.

In addition, hyponatremia is associated with several disease states (Table 1)[27,40,41].

Elevated antidiuretic hormone (ADH) levels are characteristic of several of these states, including circulating volume depletion, congestive heart failure, cirrhosis, and SIADH.[16].

Table 2: Summary of causes of hyponatremia in patients with heart failure[42,43]

Causes of Hyponatremia in Patients with Heart Failure
1. Continued release AVP despite a reduction in osmolality due to the following reasons: • Low cardiac output • Decreased renal blood flow • Reduced baroreceptor stimulation mediated by low blood pressure
2. Low cardiac output leads to activation of RAAS and an increase in angiotensin II levels, potent stimuli to thirst, resulting in enhanced water intake
3. Medications used to treat heart failure, hypertension, or cardiac-related conditions a. Diuretics (especially thiazides, less commonly aldosterone antagonists, amiloride, loop diuretics)
4. Hyponatremia in the setting of advanced CKD/ESRD due to Cardiorenal syndromes
5. Hypotonic hyponatremia due to increased free water intake in the setting of low GFR

1.1.6 HYPONATREMIA IN HEART FAILURE

Hyponatremia has been considered as an important prognostic predictor for worsening heart failure as highlighted in different studies[17,43–45]. Approximately 20–30% of patients with chronic heart failure New York Heart Association (NYHA) classes III and IV have hyponatremia [46]. It is associated with more severe heart failure and an increased risk of death, independent of other comorbid conditions[46 47.] It remains uncertain whether this is due to an unrecognized level of disease severity or if it has a causative impact. Although renal sodium retention tends to increase the extracellular volume, the effective circulating blood volume is generally reduced due to impaired cardiac output. [5] Baroreceptor mediated neurohumoral activation commonly results in increased secretion of vasopressin by the pituitary. The concurrent activation of the renin-angiotensin system and enhanced vasopressin secretion leads to decreased sodium elimination in urine and elevated urine osmolality. Although simultaneous use of diuretics may contribute to the development of hyponatremia, loop diuretics have less potential for causing hyponatremia than thiazides[5]. Moreover, dietary sodium restriction in heart failure patients may also contribute to hyponatremia [48]

1.1.7 EPIDEMIOLOGY OF HYPONATREMIA IN HEART FAILURE

Hyponatremia is a common electrolyte disturbance among heart failure patients globally, with the prevalence varying across different regions and clinical settings. Studies conducted in the United States have reported a prevalence ranging from 10-15% in outpatient heart failure patients to as high as 15-30% in those hospitalized. The prevalence tends to be even higher, up to 40%, in patients with advanced stages of heart failure, particularly those classified as New York Heart Association (NYHA) class III or IV.

Results from the international collaborative of NT-proBNP study on the relationship between hyponatremia and outcomes in patients with acutely decompensated heart failure (ADHF), revealed that hyponatremia occurs in about 24% of patients presenting with acutely decompensated heart failure and is linked to severe symptoms and higher NT-proBNP levels. A U-shaped association exists between serum sodium levels and 1-year mortality rates in patients with heart failure. Hyponatremia was found as an independent predictor of 1-year mortality in acutely decompensated heart failure, with a hazard ratio of 1.72 [49.]

Looking at the continental perspective in sub-Saharan Africa, hyponatremia affects 28.9% of heart failure patients in Ethiopia, linked to increase in-hospital mortality and longer stays. The study highlights a significant burden in low-income settings, emphasizing the need for routine sodium assessments and management strategies in such populations.[50]

A study in Uganda found that 24.2% of hospitalized heart failure patients experienced hyponatremia, highlighting the substantial clinical challenge posed by this electrolyte disturbance in resource-limited settings.[12]

While comprehensive data on the national prevalence of hyponatremia in Tanzanian heart failure patients is currently lacking, the available evidence from sub-Saharan Africa suggests that this condition may also be a significant concern in the country.

1.1.8 PATHOPHYSIOLOGY OF HYPONATREMIA IN HEART FAILURE

The development of Hyponatremia in heart failure patients is often related to various etiological factors and pathophysiological mechanisms. These may include fluid overload, impaired renal function, and the effects of neurohormonal activation, which are common in heart failure[51,52.] The reduced cardiac output in heart failure leads to arterial

underfilling, which triggers a series of compensatory mechanisms. The body responds with increased sympathetic stimulation, raising heart rate and promoting vasoconstriction to maintain blood pressure. Simultaneously, decreased renal tubular flow reduces the kidney's ability to excrete sodium and water. This activates the Renin-Angiotensin-Aldosterone System (RAAS), which further promotes sodium and water retention, decreasing renal blood flow (RBF). Additionally, non-osmotic vasopressin (AVP) release promotes water reabsorption and stimulates thirst, leading to excessive water intake. These combined effects dilute sodium levels, resulting in hyponatremia.

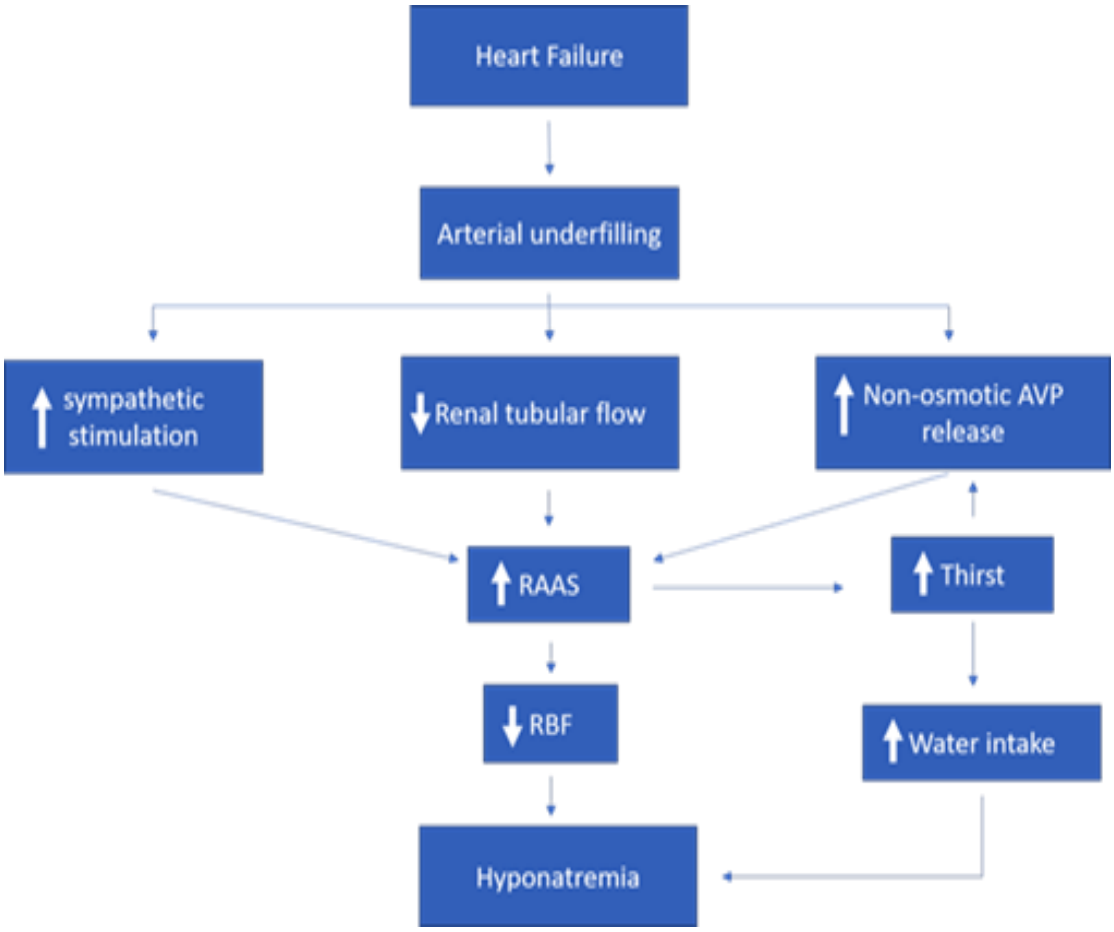


Figure 1: The pathophysiology of dilutional hyponatremia in heart failure

1.1.9 CLINICAL FEATURES OF HYPONATREMIA IN HEART FAILURE

Clinical features of hyponatremia in heart failure include confusion, seizures, muscle cramps, weakness, and fatigue. These symptoms can vary based on the severity and duration of hyponatremia, impacting the patient's overall prognosis and complicating heart failure management.[53]

Hyponatremia in heart failure is also linked to reduced myocardial contractility, leading to circulatory blood volume increase, edema, and multiorgan derangements. It predicts worsening clinical outcomes, including increased cardiac death and rehospitalization rates in affected patients.51

It often presents with mild symptoms which include non-specific signs such as headache, nausea, and fatigue, which arise as the brain starts to adapt to lower sodium levels and increased water retention which can then lead to hyponatremic encephalopathy if serum sodium levels decrease acutely [5,55.]

As hyponatremia worsens, patients may experience moderately severe symptoms like irritability, confusion, lethargy, and muscle cramps, indicating a more significant impact on brain function due to increased intracranial pressure[5,55]. This occurs because the rapid influx of water into brain cells leads to brain edema, which can compromise neurological function.

In severe cases, life-threatening symptoms such as seizures, loss of consciousness and/or coma, or respiratory arrest may develop, reflecting critical brain swelling and the body's inability to compensate for the drastic changes in osmotic pressure[5,56.] The severity of symptoms is closely linked to the rate of sodium decline and the brain's capacity to adapt, with acute changes posing a higher risk for severe outcomes[56.]

Chronic hyponatremia can impair quality of life, highlighting its clinical significance during hospitalizations and post-discharge[51]. Chronic hyponatremia in heart failure is associated with attention deficit, dizziness, tiredness, gait disturbance, falls, sarcopenia, bone fractures, and osteoporosis. It reflects the severity of the underlying disease and contributes to increased morbidity and mortality.[57]

Table 3: Classification of hyponatremia by severity with clinical features

Severity	Na serum concentration (mmol/l)	Symptoms
Mild	135–130	Usually asymptomatic
Moderate	129–125	Nausea without vomiting
		Confusion
		Headache
Severe	< 125	Vomiting
		Cardiorespiratory failure
		Abnormal and deep drowsiness
		Convulsions
		Coma (≤ 8 GCS scale)

1.1.10 DIAGNOSIS OF HYPONATREMIA IN HEART FAILURE

Hyponatremia, defined as a serum sodium level below 135 mEq/L, is a common electrolyte disorder in patients with heart failure, particularly in those who are decompensated and fluid overloaded. The diagnosis begins with determining plasma tonicity to exclude other causes of hyponatremia, which can be achieved by measuring plasma osmolality to classify it into either hypotonic, isotonic or hypertonic by using the following formula [5]:

This formula accounts for the major contributors to serum osmolality, which include sodium, glucose, and urea.

Once hypotonic hyponatremia is identified (plasma osmolality < 285 mOsm/L), it is crucial to differentiate between dilutional and depletional hyponatremia, as these conditions require different management approaches. This differentiation can be made by reviewing the patient's medical history, assessing volume status, and measuring urine osmolality[51].

Dilutional hyponatremia is often associated with conditions like congestive heart failure (CHF), where excess water retention occurs, while depletional hyponatremia typically indicates a loss of sodium[28].

Assessing the patient's volume status is crucial. This can be done through physical examination and laboratory tests to determine whether the patient is hypovolemic, euvolemic, or hypervolemic. For instance, in CHF patients, the presence of edema may indicate hypervolemic hyponatremia, which is characterized by both sodium and water excess, but with a greater increase in water27. If urine osmolality is ≤100 mOsm/kg, the likely causes include primary polydipsia, low solute intake, or beer potomania.

If urine osmolality is >100 mOsm/kg, the next step involves measuring urine sodium concentration. If urine sodium is ≤30 mmol/L, the cause may be related to low effective arterial blood volume. If extracellular fluid (ECF) is expanded, consider conditions such as heart failure, liver cirrhosis, or nephrotic syndrome. If ECF is reduced, causes like diarrhea, vomiting, or third spacing are likely. If urine sodium is >30 mmol/L, the algorithm evaluates for diuretic use or kidney disease. If these are present, the likely cause is diuretics or kidney dysfunction5,26

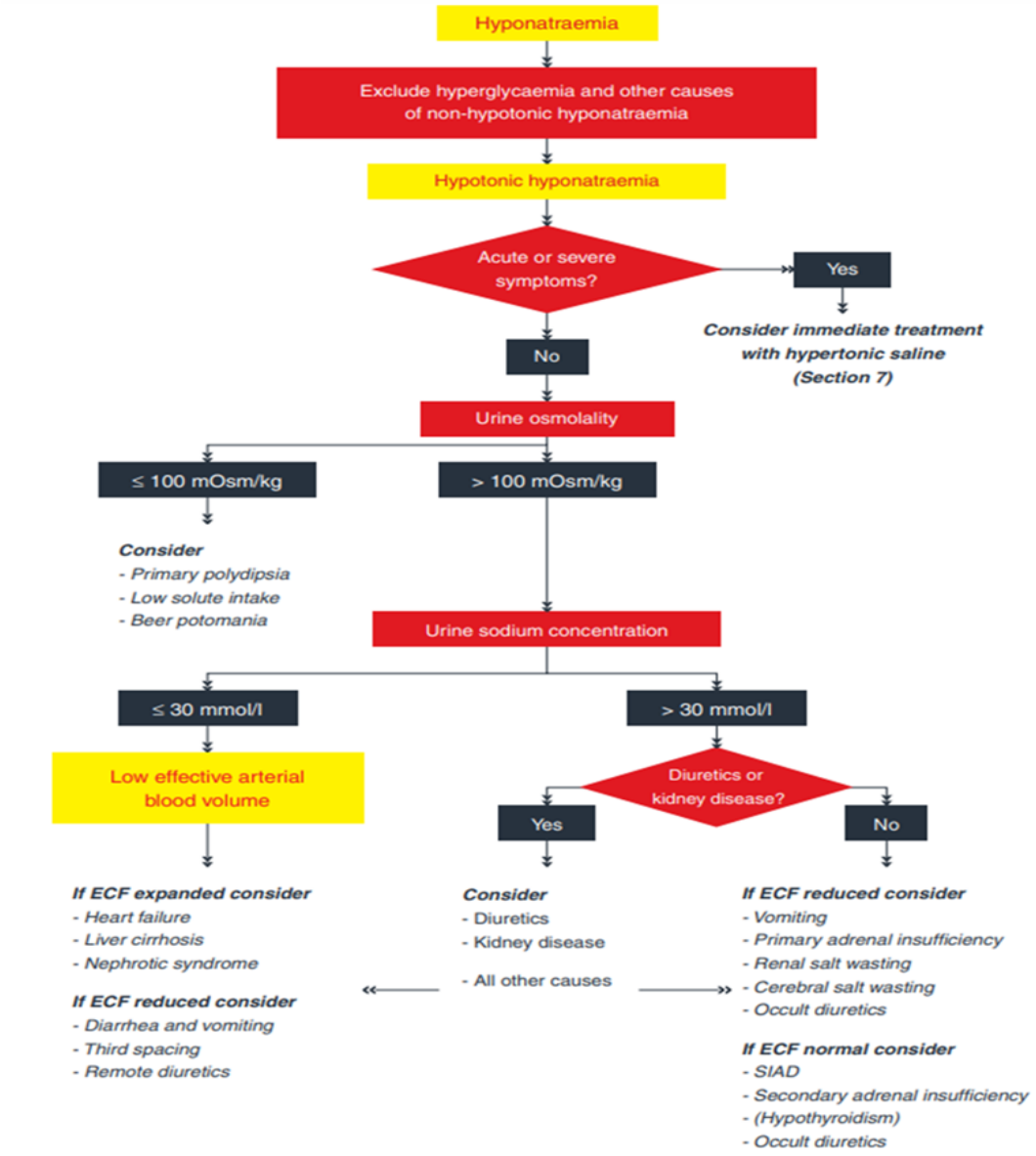


Figure 2: Algorithm for the diagnosis of hyponatremia; derived from the European journal of endocrinology[5]

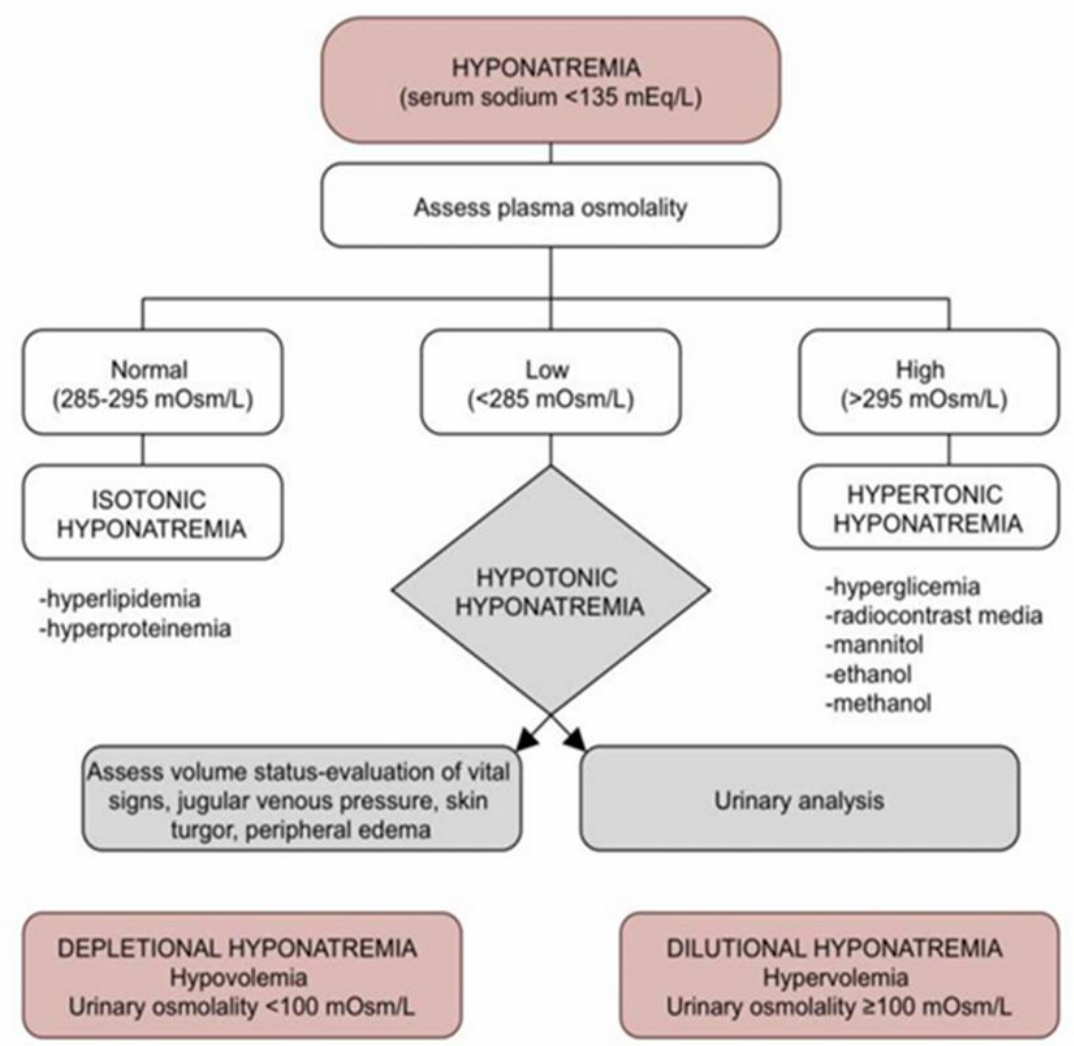


Figure 3: Diagnostic algorithm in heart failure associated with hyponatremia[27]

1.1.11 TREATMENT OF HYPONATREMIA IN HEART FAILURE

In cases of dilutional hyponatremia, which is the most common mechanism in heart failure, the management focuses on promoting free water excretion. This can be achieved through fluid restriction (less than 800–1000 mL/day) [5] and the use of hypertonic saline in conjunction with loop diuretics. The main beneficial effects of association between loop diuretics and hypertonic saline solutions are represented by improvements in serum sodium levels with a low/no risk of overcorrection, increased diuretic efficiency, fluid and weight loss, improvement in renal function, shorter hospitalization, and lower mortality rates48. In cases of severe or acute hyponatremia, prompt administration of hypertonic saline can be lifesaving48. On the other hand, depletional hyponatremia is treated with saline administration to replenish sodium levels[51].

Vaptans, such as tolvaptan, are also utilized as they promote free water excretion, helping to correct hyponatremia without significantly affecting renal function.[58] Additionally, inotropic agents can be employed to improve cardiac output in patients with severe heart failure, which may enhance renal blood flow and aid in correcting hyponatremia[59].

It is important to note that inappropriate correction of hyponatremia can lead to serious complications, such as osmotic demyelination syndrome, which can result in severe neurological symptoms[51].

The management of hyponatremia in heart failure patients is further complicated by factors such as increased thirst due to fluid restriction which can reduce compliance with treatment [51]. Additionally, chronic hyponatremia can significantly impair the quality of life and is associated with poor short- and long-term outcomes, making timely and appropriate management essential[51,57]

1.2 PROBLEM STATEMENT

Hyponatremia has been reported as the commonest electrolyte imbalance among hospitalized patients worldwide, affecting about 1-4% hospitalized patients, especially adults as they are the most at-risk population group towards development of comorbidities55,56. It has been considered as an important prognostic predictor for worsening heart failure as highlighted in different studies[16,34–36]. Approximately 20–30% of patients with chronic heart failure New York Heart Association (NYHA) classes III and IV have hyponatremia [37] However, it remains largely underdiagnosed, highlighting the need for improved awareness among medical professionals.57

Hyponatremia represents a critical and often underestimated electrolyte disturbance in heart failure patients, presenting a significant clinical challenge that demands comprehensive investigation and treatment[53,61]. The problem stems from the complex pathophysiological mechanisms underlying heart failure, where neurohumoral activation and compensatory physiological responses lead to sodium and water retention, ultimately resulting in an imbalanced electrolyte profile that can dramatically compromise patient outcomes.[5]

The potential consequences of untreated or inadequately managed hyponatremia in heart failure patients are profound, encompassing increased mortality rates, prolonged hospital stays, higher readmission frequencies, reduced quality of life, and substantial economic burdens on both individual patients and the healthcare system[62].

In Sub-Saharan Africa, existing literature reveals a significant knowledge gap regarding the prevalence, specific clinical manifestations, and prognostic implications of hyponatremia among adult heart failure patients, highlighting an urgent need for a targeted, comprehensive investigation that can provide evidence-based insights to improve clinical practice.[12]

In Tanzania, this electrolyte disorder remains inadequately studied and often overlooked due to various factors that are not typically considered in the evaluation process. Conditions such as pseudohyponatremia and hypertonic hyponatremia are often misidentified as they tend to mask the true electrolyte imbalances in heart failure leading to misdiagnosis and subsequent inappropriate treatment decisions[63]. Such misdiagnosis may exacerbate fluid overload and worsen heart failure symptoms, complicating patient management and outcomes.

Drug-induced hyponatremia is another factor that can be easily missed, as it is often asymptomatic and may resolve with water restriction and medication monitoring[42.] By systematically examining the clinical manifestations and laboratory findings of hyponatremia in heart failure patients, there will be a better understanding of how this electrolyte disorder manifests and progresses in the local population.

There is scarce evidence from online retrieved peer reviewed platforms on the magnitude/burden, risk factors as well as prognosis of hyponatremia among adults with heart failure in Tanzania. Thus, the need for the study is highly warranted as low levels of sodium in blood are highly correlated with significant morbidity and mortality among adults with heart failure.[62]

1.3 RATIONALE

Hyponatremia is a clinical feature in 15–20% of emergency admissions to hospital which is associated with increased mortality, morbidity and length of hospital stay in patients [5]. Currently, hyponatremia is one of the top five causes of sudden death in adults worldwide[15], making it crucial to study.

Despite its clinical significance, hyponatremia remains underdiagnosed and undertreated, particularly in Tanzania, where data on its prevalence and impact in heart failure patients are

scarce. This study aims to bridge this knowledge gap by providing evidence-based insights into the burden and clinical correlates of hyponatremia in hospitalized heart failure patients. By identifying prevalence, risk factors, and prognostic implications, the findings can contribute to earlier detection, better treatment strategies, and improved patient outcomes. Recognizing and managing hyponatremia effectively can help optimize fluid balance, guide appropriate therapy adjustments, and ultimately reduce hospital-related complications and mortality.

This research will serve as a foundation for improving clinical protocols and so contribute to the development of locally relevant clinical guidelines, ensuring that

electrolyte imbalances are routinely evaluated as part of standard heart failure care. By addressing this often-overlooked condition, this research has the potential to reduce avoidable complications, strengthen heart failure management and improve the overall quality of life for heart failure patients in Tanzania.

1.4 RESEARCH QUESTIONS

I. What is the prevalence of hyponatremia among hospitalized HF patients at JKCI?

II. What is the distribution of levels of hyponatremia (mild, moderate, and severe) by sociodemographic factors such as age, gender, and alcohol use among hospitalized heart failure patients at JKCI?

III. What is the distribution of levels of hyponatremia by clinical characteristics such as diabetes mellitus (DM), hypertension (HTN), chronic kidney disease (CKD), diuretic use, and salt intake among hospitalized heart failure patients at JKCI?

IV. What is the distribution of the types of hyponatremias (hypovolemic, hypervolemic, and euvolemic) by age, gender, and chronicity of heart failure among hospitalized heart failure patients at JKCI?

V. What is the distribution of levels of hyponatremia by the functional status of heart failure among hospitalized heart failure patients at JKCI?

VI. What is the distribution of levels of hyponatremia by the ejection fraction among hospitalized heart failure patients at JKCI?

1.5 0BJECTIVES

1.5.1 BROAD OBJECTIVES

To determine the clinical correlation of hyponatremia with heart failure among hospitalized adult patients in Dar es salaam.

1.5.2 SPECIFIC OBJECTIVES

I. To determine the prevalence of hyponatremia among hospitalized HF patients at JKCI

II. To determine the distribution of levels of hyponatremia (mild, moderate and severe) by sociodemographic factors (such as age, gender, alcohol use) among hospitalized HF patients at JKCI.

III. To determine the distribution of levels of hyponatremia by clinical characteristics such as (DM, HTN, CKD, diuretics use and salt intake) among hospitalized HF patients JKCI.

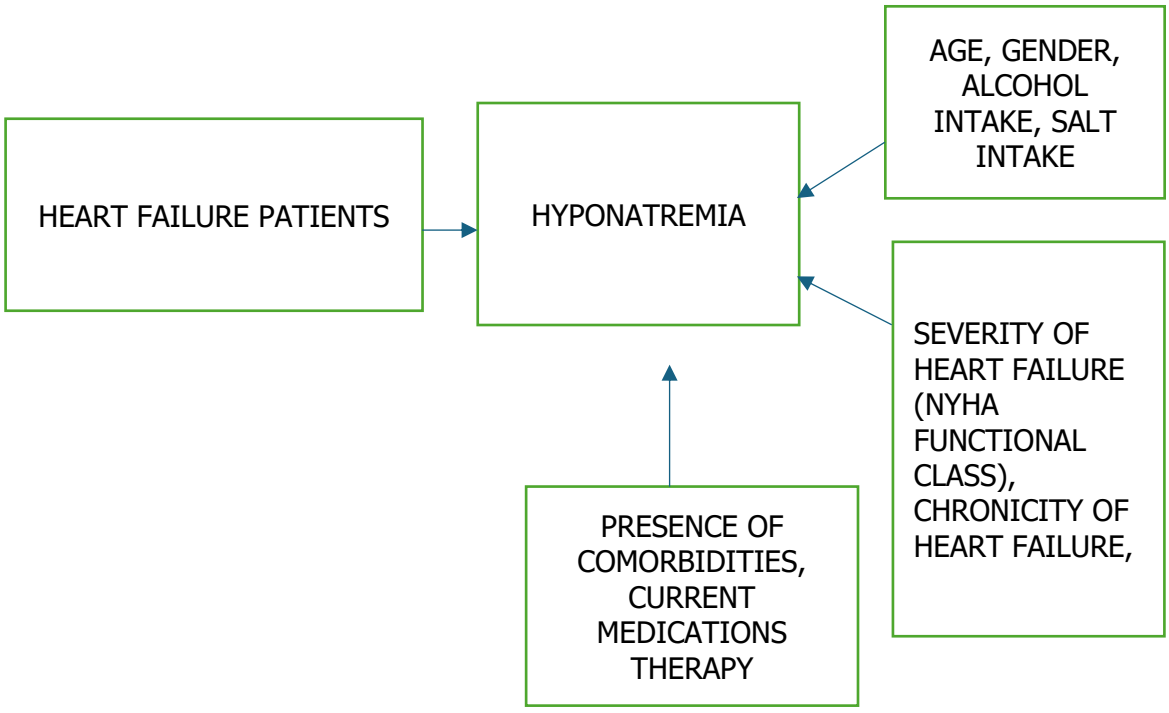
IV. To determine the distribution of the types of hyponatremias (Hypovolemic, hypervolemic and euvolemic) by age, gender, chronicity of HF among hospitalized HF patients at JKCI.

V. To determine the distribution of levels of hyponatremia by functional status of heart failure among hospitalized HF patients at JKCI.

VI. To determine the distribution of levels of hyponatremia by the ejection fraction among hospitalized HF patients at JKCI.

1.6 CONCEPTUAL MODEL

Figure 4: Conceptual framework for Clinical correlates of hyponatremia with heart failure among hospitalized adults.



CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 BURDEN OF HYPONATREMIA IN ADULTS WITH HEART FAILURE

A cohort study by CS Kang et al in the US, which aimed to reassess the association between hyponatremia and in-hospital outcomes in patients with acute decompensated heart failure (ADHF) using a National Inpatient Sample (NIS) database collected between 2016 and 2018 to identify patients with a primary diagnosis of HF, found that among 727,629 hospital admissions for HF, 72,824 (10%) of them had an additional diagnosis of hyponatremia.

Mohan and his colleagues from New York in the United States published their findings on population prevalence of hyponatremia and its association to mortality via a population based cross-sectional analysis of 14697 adults back in 2013[62]. They reported the prevalence of hyponatremia to range between 1.74% and 3.86% for males aged 50-89 years [62.] Likewise, the prevalence of hyponatremia for females was 1.52% to 4.09% for age ranges 50-89. With Females having significantly higher prevalence of hyponatraemia compared to males with (P =0.004)59

In large retrospective cohort study by Donze et al done in the US that included all adult patients admitted with a diagnosis of congestive heart failure to a tertiary-care hospital between July 2003 and October 2009. Among the 4295 with congestive heart failure and hyponatremia at admission, 1799 (41.9%) did not have their sodium level corrected at discharge. Overall, 1269 patients (29.5%) had a 30-day unplanned readmission or died.

Among patients with persistent hyponatremia, those with more severe hyponatremia at discharge (<130 mm/L) had a 50% risk of having a 30-day readmission or a 2-fold increased risk of death than those with less severe hyponatremia at discharge (130-134 mm/L).

Study by F. Aliyeva et al in Switzerland investigated the impact of hyponatremia on the development of acute kidney injury (AKI) in patients with acute decompensated heart failure (ADHF). Conducted with a sample of 100 patients, it found that 45 had hyponatremia, and among these, 63.5% developed AKI during their hospital stay, compared to only 36.5% of those without hyponatremia. This difference was statistically significant (P = 0.001), indicating that hyponatremia is a strong predictor of AKI, with affected patients having a 5.21-fold increased risk. The study also highlighted that comorbidities could influence the presence of hyponatremia, and the length of hospital stays, emphasizing the need for careful monitoring and management of sodium levels in heart failure patients to prevent complications like acute cardiorenal syndrome[64].

In a Japanese study by Sato et al on 4,837 hospitalized patients with HF enrolled in the Acute Decompensated Heart Failure Syndromes (ATTEND) registry in 2013, Hyponatremia (sodium <135 mEq/L) was observed in 11.6% of patients. Patients with hyponatremia were of similar age, included fewer men, and had a higher proportion of previous hospitalizations for HF compared to those with normonatremia. During hospitalization, inotrope levels and mechanical device use were significantly higher in patients with hyponatremia. Rates of all-cause and cardiac death were significantly higher in patients with hyponatremia, 15.0% and 11.4%, respectively, compared to 5.3% and 3.6%, respectively, in those with normonatremia. In hyponatremic hospitalized patients with HF, cardiac death accounted for 76.2% of all-cause death [15].

This study highlights that mineral abnormalities are a common complication of heart failure (HF). In particular, hyponatremia, which was prevalent in 11.6% of heart failure patients, and misdiagnosis, including drug-induced hyponatremia, can complicate management. Accurate identification is crucial to avoid exacerbating fluid overload and worsening heart failure[15].

In the COAST Study done in South Korea, Taiwan, China and other eight centers on The Clinical Characteristics and Outcomes in the Relation with Serum Sodium Level in Asian Patients Hospitalized for Heart Failure) conducted among 1470 hospitalized patients with systolic HF (ejection fraction < 45%). The relationship between admission sodium level and clinical outcomes was analyzed and found that 247 patients (16.8%) had hyponatremia defined as Na+ < 135 mmol/L. The 12-month mortality was higher in hyponatremic patients (27.9% vs. 14.6%) and hyponatremia was an independent predictor of 12-month mortality and Underuse of optimal medical treatment was more pronounced in hyponatremic patients [44].

The SHOUT-PREDICTION prospective, observational study conducted in a single-center setting in India, involved the observation of 130 consecutive patients admitted with Acute Decompensated Heart Failure (ADHF) investigated the relationship between serum sodium levels and clinical outcomes in patients hospitalized with Acute Decompensated Heart Failure (ADHF). It was found that hyponatremia, a condition characterized by low sodium levels, is prevalent among these patients and is associated with high in-hospital mortality rates indicating that lower serum sodium levels correlate with poorer functional status and worse clinical outcomes during hospitalization and follow-up. Specifically, both hyponatremia and systolic blood pressure (SBP) were identified as independent predictors of mortality during hospitalization[65].

A retrospective study by Renato De Vecchis et al, which centered on medical records of patients hospitalized for ADHF in the period April 2013 to April 2016, was performed aiming to evaluate

the effect of the normalization of serum sodium on the composite endpoint of short-term rehospitalization and mortality. One hundred and sixty CHF patients with various degrees of functional impairment were enrolled in the study. Among them, 56 (35%) had persistent hyponatremia over the course of hospitalization. The length of stay of the index admission (p = 0.0015) and the New York Heart Association (NYHA) class III at discharge (p = 0.0022) were identified as risk factors associated with the composite endpoint of 30-day unplanned readmission or death [66].

In Africa, Ali K et al conducted a descriptive, prospective cohort study at Jimma University Hospital in Ethiopia, spanning from November 1, 2013, to July 31, 2014. This hospital-based research involved 152 patients admitted with heart failure, of whom 44 (28.9%) were diagnosed with hyponatremia. Specifically, 43.6% of those with hyponatremia were discharged with New York Heart Association (NYHA) functional classes III and IV, indicating more severe heart failure symptoms. Patients on salt restriction, on chronic diuretic treatment (furosemide and spironolactone), and with impaired renal function at admission were found to be highly affected. Hyponatremia was found to be associated with increased hospital mortality and longer hospital stay (16.6 vs 12 days). Patients with hyponatremia also had lower blood pressure and poor functional status at discharge[50].

Nankabirwa and her colleagues reported a cross-sectional study from Uganda that focused on determining the prevalence of hyponatremia among 211 >60 years' patients of heart failure attending Mulago hospital in Kampala, Uganda between August 2013 and March 2014[12]. They found a prevalence of hyponatremia of around 24.2% (n=51)[12]. Of the patients with hyponatremia (n=51), 52.9% (n=27) had mild hyponatremia, while 24 (47.1%) had moderate to severe (Na+ = 125-10 mmol/L) hyponatraemia[12].

Table 4: Literature review: Hyponatremia with functional status of HF [47,64-66]

AUTHOR (S),YEAR OF PUBLICATION AND COUNTRY	METHODOLOGY	FINDINGS
Hisham et al., 2017-INTER-CHF study aim to measure mortality for 1 year	Prospective analytical study from 6 countries N= 2105	• overall mortality was 16·5%: highest in Africa-34% • NHYA class III or IV
Yan Huang et al. 2009-2012 China Aim to investigate the prevalence and prognostic value	Cross sectional study N=1048	• 9.2 % prevalence • NHYA class II-IV
Renato De Vecchis et al., 2013-2016 Italy Aim to evaluate the effect of the normalization of serum sodium	Retrospective study N=160	• 56 (35%) had persistent hyponatremia • NYHA) class III
Ali K *et al.*, 2014 Ethiopia Aim to assess patterns of hyponatremia	Cross sectional study N=152	• 44 (28.9%) had hyponatremia • 43.6% NHYA class III -IV

CHAPTER THREE

3.0 METHODOLOGY

3.1 STUDY DESIGN

A descriptive cross-sectional study was conducted in a hospital setting.

3.2 STUDY AREA

The study was conducted in the Jakaya Kikwete Cardiac Institute (JKCI), as it is the largest and most specialized facility dedicated to cardiovascular diseases in Dar es Salaam, which serves patients from all regions of Tanzania and neighboring countries, providing comprehensive cardiovascular care. It is in Upanga West, Ilala District, Dar es Salaam. It is unique in being a tertiary-level, government-owned, specialized, and university teaching hospital offering exclusively advanced cardiac care, including heart failure management, training, and research services. The institute has a bed capacity of 157, attending over 1,800 outpatients and 100 inpatients weekly. The facility is well equipped with a Biplane Catheterization Laboratory and 3 ultra-modern operating theatres, an Intensive Care Unit, and patient rooms. With diagnostic facilities, experienced cardiologists, and a large and diverse population of heart failure patients from all over Dar es Salaam, JKCI becomes an ideal study site, a representation of Dar es Salaam, leading to high-quality data collection.

3.3 STUDY DURATION

The research spanned eight months, from December 2024 to July 2025, during which proposal development, data collection, data entry, data analysis, and report writing were carried out.

3.4 GENERAL POPULATION

All adult patients diagnosed with heart failure.

3.5 TARGET POPULATION

Patients above 18 years with heart failure admitted at JKCI

3.6 STUDY POPULATION

All hospitalized adult patients admitted with heart failure at JKCI

3.7 ELIGIBILITY CRITERIA

3.7.1 INCLUSION CRITERIA

I. All adults aged 18 years and above with heart failure.

II. All hospitalized adult patients with diagnosed heart failure admitted to JKCI consent to participate in the study.

3.7.2 EXCLUSION CRITERIA

I. Acute Kidney Injury, End stage renal disease patient or on dialysis

II. Recent Surgery

JUSTIFICATION FOR EXCLUSION CRITERIA

Individuals who have undergone recent surgery were excluded due to the potential impact on fluid balance and sodium levels [27].

Patients with acute renal failure or significant renal impairment were excluded, as these conditions can independently affect sodium levels and complicate the interpretation of results[27].

3.8 SAMPLE SIZE ESTIMATION

The sample size was calculated using Slovin's formula for sample size calculation:

$$n = \frac{N}{1+N.e^2}$$

Variables:

N = 200 (total population size)

ε=0.05 (margin of error)

n = required sample size

The calculated sample size was approximately **133 participants**.

Justification of the formula

According to JKCI data from hospital records (2022-2024), an estimated number of 1200 of heart failure patients are admitted annually. This study was expected to run for a maximum of 2 months; hence, the accessible population is about 100 participants per month. A similar study was done by Karanga et.al in 2016 in Kenya [67] ; Prevalence of Hyponatremia in patients admitted with heart failure at Kenyatta National Hospital, and the same formula was used. Since the studies are conducted in sub-Saharan African settings with similar healthcare challenges and demographic profiles, adopting the same validated formula maintains methodological consistency while minimizing risks of under- or oversampling.

3.9 SAMPLING PROCEDURE

A purposive sampling technique was employed to select participants who met clearly defined inclusion criteria. This approach ensured that only relevant cases of heart failure with potential hyponatremia were studied, allowing for a focused analysis.

For this study on the clinical correlates of hyponatremia with heart failure among hospitalized adult patients in Dar es Salaam, the Jakaya Kikwete Cardiac Institute (JKCI) was chosen as the study site. It was an ideal choice due to its status as a specialized tertiary cardiac center and the primary referral hospital for heart-related conditions in Tanzania. JKCI handled a high volume of heart failure cases, ensuring a large and diverse patient population representative of

Dar es Salaam. Additionally, its advanced diagnostic facilities, well-maintained patient records, and experienced healthcare professionals made it a resource-rich environment for data collection. The institute's centralized location also enhanced logistical feasibility, making JKCI a strategic and representative study site for this research. Purposive selection involved screening hospitalized adult heart failure patients at JKCI based on specific eligibility criteria. Patients meeting the inclusion criteria were consecutively recruited, ensuring that all eligible participants during the study period were considered and minimizing selection bias.

3.9.1 SCREENING AND RECRUITMENT

A consecutive recruitment technique was employed to enroll patients admitted with heart failure at JKCI until the required sample size was achieved. The list of patients admitted was obtained from the nursing register, and patients were invited to participate in the study. Heart failure patients were identified by the diagnosis made by the cardiologist at JKCI, following the Standard Treatment Guidelines and National Essential Medicine List Tanzania (NEMLIT) [20] .These guidelines recommended using the Framingham criteria, which required the presence of either two major criteria or one major and two minor criteria for a heart failure diagnosis (Table 1). Consent was sought from the patients. Those who consented were then screened for the inclusion and exclusion criteria to identify individuals to be enrolled in the study.

3.10 STUDY VARIABLES

3.10.1 Independent variables

Age, Gender, alcohol intake, Salt intake (yes or no), Severity of heart failure (NYHA functional class), chronicity of heart failure, Presence of comorbidities (e.g., diabetes, hypertension, kidney disease), current medication therapy (diuretics, antipsychotics, antiepileptics), ejection fraction.

3.10.2 Dependent variables

Serum sodium levels -Presence of hyponatremia (defined as serum sodium level < 135 mmol/L) -Normonatremia (defined as serum sodium level 135-145 mmol/L)

3.11 DATA COLLECTION

Data collection comprised socio-demographics, clinical characteristics, and laboratory variables.

3.11.1 DATA COLLECTION PROCEDURES

The principal investigator, as well as a trained research assistant, collected data from study participants at the selected hospital using a structured questionnaire, which had closed and open-ended questions, physical examination, and laboratory investigations. Codes were used in all study materials, such as questionnaires, lab results, and analytic files, making sure that names, initials, and other private information were not included. The questionnaire was sent to internal medicine experts to review it for relevance, clarity, and completeness, guiding necessary revisions.

QUESTIONNAIRE

The questionnaire included the following items:

1. Sociodemographic and clinical variables

Sociodemographic data included age, gender, and residence. The participants or their caregivers were inquired whether a doctor had ever informed them of having diabetes mellitus, a stroke, chronic kidney disease, or hypertension, or if they needed to limit salt intake in their diet. The caregiver was also questioned about any recent changes in the patient's behavior and other clinical signs indicative of hyponatremia, for instance vomiting., headache, generalized body weakness, altered mentation, seizures, and falls. Together with the history of any current or previous medication use by the patient, such as diuretics or anti psychotics. Heart failure symptoms were evaluated, including fatigue, dyspnea on exertion, paroxysmal nocturnal dyspnea, persistent cough, and palpitations. Patients were then classified based on their functional status and chronicity of heart failure. Functional status was evaluated using the New York Heart Association (NYHA) Functional Classification system. This classification evaluated the severity of symptoms and their impact on a patient's daily activities as follows:

Class I: No symptoms with ordinary activity.

Class II: Mild symptoms with ordinary activity.

Class III: Marked symptoms with less than ordinary activity.

Class IV: Symptoms present even at rest, worsening with any activity

The chronicity of heart failure was determined as follows: patients experiencing their initial episode were categorized as having acute heart failure, while those with a pre-existing heart failure diagnosis prior to the current episode were classified as having decompensated heart

failure. The echo results were sought from the patients or the database, and the ejection fraction was recorded in order to determine the severity of the heart failure.

2. Physical examination

A research assistant, who is a trained nurse, recorded a participant's body weight using a Secco weighing scale, accurate to 0.5 kg. The measurement was taken with the participant wearing light clothing and no shoes. Participants stood with their feet together and arms at their sides while the reading was noted. Height was assessed using a height measuring rod. Participants were instructed to stand barefoot on the floor, aligned with the height measuring rod, and to look straight ahead while standing. For those who were very sick or unable to stand, supine length measurements were taken. Participants were instructed to lie on their backs. A flexible tape measure was used to determine the distance from the top of the head to the heel. The height was then measured and noted to the nearest 0.5 cm.

Body Mass Index

The Body Mass Index was determined by a person's height and weight, using the formula:

BMI = weight in kg/Height in m2.

According to the 2023 WHO guideline, the BMI criteria utilized were detailed in the table.

Table 5: The Table shows Body Mass Index parameters

WEIGHT STATUS	BODY MASS INDEX (BMI) Kg/ m^2
Under weight	Less than 18.5
Healthy weight	18.5-24.9
Excess weight	25.0-29.9
Obese	30.0 and above

3. Blood Pressure

Blood pressure was measured to determine hypertension by the standard method in sitting position or lying down, depending on the functional status of the participant, using an automatic BP machine (China,2002). It was taken after the participant had rested for at least 5 minutes in a sitting position with the participant's arm supported at the level of the heart, using an appropriate cuff size. Pressure above 139 systolic and 89 diastolic was considered high blood pressure.

Signs of heart failure and hyponatremia

The principal investigator also performed a physical examination to assess various health indicators of hyponatremia and heart failure, such as the presence of pallor, oedema, and mental status using the Glasgow Coma scale, and dehydration Status, raised jugular venous pressure, hepatojugular reflux, rales, gallop rhythm, third heart sound and hepatomegaly.

Patients were classified according to the type of hyponatremia as follows

Hypovolemic hyponatremia: hypotension, tachycardia, dry skin and mucus membranes, decreased skin turgor, mental status changes, and oliguria.

Hypervolemic hyponatremia: hypertension, peripheral edema, lung crackles, jugular venous distention, weight gain, ascites, cold extremities, rapid weight gain due to fluid retention, confusion, and irritability.

Euvolemic hyponatremia: absence of overt signs of volume depletion or hypervolemia, mild to moderate mental status changes without significant fluid retention or loss.

4. Laboratory investigations.

Biochemical analysis of Serum sodium was done after collecting a venous blood sample by a research assistant (trained phlebotomist) using (Beckman Coulter AU480 clinical chemistry analyzer Laboratory machine, USA) at a hospital-based laboratory. Participants in the study had a venous blood sample drawn, and a 5CC syringe was used to draw at least 2.5 mL of blood. Samples were taken to the laboratory at JKCI. The sample was left to clot for about 30 minutes before being spun in a centrifuge to separate the clear serum. The analyzer automatically recorded and displayed the sodium concentration. Results were printed for interpretation. Serum sodium concentration was reported with normal sodium levels ranging from 135-145 mmol/L. Any fall in sodium concentration below 135 mmol/L was classified as hyponatremia.

3.12 DATA ANALYSIS

Data collected were cleaned and analyzed using SPSS version 24. Data cleaning and verification were performed weekly to ensure completeness, accuracy, and validation of information. Statistical methods were tailored to each study objective. Descriptive statistics including means, medians, standard deviations, frequencies, and percentages were used to summarize continuous and categorical variables, particularly in determining the prevalence of hyponatremia. Chi-square tests were used to assess associations between categorical variables, including levels of hyponatremia (mild, moderate, severe) and sociodemographic factors;

hyponatremia severity and clinical characteristics (such as comorbidities and medication use); types of hyponatremia (hypovolemic, euvolemic, hypervolemic) by age, gender, and chronicity of heart failure; and levels of hyponatremia by NYHA functional class. A p-value of <0.05 was considered statistically significant. Where applicable, results were reported with odds ratios (OR), adjusted odds ratios (aOR), and 95% confidence intervals (CI). To assess the association between levels of hyponatremia and ejection fraction (EF), Chi-square tests were used for categorical comparisons, while Spearman's rank correlation was applied to evaluate the strength and direction of the relationship between continuous EF values and serum sodium levels.

3.13 DISSEMINATION OF RESULTS

The research findings will be distributed to the KU Library, the Ministry of Health, and the Tanzania Cardiac Society via research reports and scientific conferences held locally and globally.

CHAPTER FOUR

4.0 ETHICAL CONSIDERATIONS

The KU Institutional Research and Ethics Committee was consulted for ethical approval. The JKCI Head of Research, Training, and Consultancy gave permission to carry out the study.

Prior to data collection, study participants received a thorough explanation of the study's goals, procedures, and purpose. Each participant was given a voluntary informed consent form to read and sign. The next of kin present read the consent forms to those who could not read and write, and a thumbprint was used in place of a signature for those who couldn't. The participants in the study experienced no significant harm as a result of the study. Participants were informed of minimal discomfort during sample withdrawal, which would resolve immediately after the procedure.

Confidentiality was maintained. Instead of utilizing personal identifiers, each study participant was assigned a unique alphanumeric number (such as P001 or P002) to protect participant confidentiality. Only authorized research staff had secure access to a password-protected, private document that links codes to participant information. Only these codes were used in all study materials, such as questionnaires, lab results, and analytic files, making sure that names, initials, and other private information were not included. Only de-identified data were used for data analysis and reporting, and to preserve anonymity, the documents that link identities to codes were completely erased after the study was finished. Participants were not compelled to participate in the study, and they were free to leave at any time if they chose not to. The lead investigator addressed and responded to any inquiries from the research participants.. The results of the laboratory findings were communicated back to the patient and inserted in the patient’s file for use by the medical team managing the patient in the wards.

The study did not interfere with the institution's already established management; however, those with severe hyponatremia were contacted by the attending physician immediately for correction and were managed using standard hospital protocol.

CHAPTER FIVE

5.0 RESULTS

5.1 Baseline characteristics of the study participants.

This study was carried out over a period of 8 months from December 2024 to July 2025, where a total of 133 patients diagnosed with heart failure were recruited at the Jakaya Kikwete Cardiac Institute (JKCI), Dar es Salaam.

Table 6 shows the distribution of social demographics and clinical characteristics of heart failure patients. The mean age of participants was 58.2 ± 16.9 years, with age ranging 21 to 94. With males being slightly higher than females 54.1% and 45.9% respectively, and the majority aged sixty and above. Most of the participants were married 93 (69.9%). In terms of education, 44(33.1%) had completed secondary education, while a significant proportion, 39(29.3%) had no formal education, and only 18 (13.5 %) had higher education. Over half of the participants, 76 (57.1%), were unemployed, with 57(42.1%) employed. The majority of participants were non-smokers, with 105 individuals (78.9%) reporting no history of smoking, while 28 (21.1%) were smokers. Furthermore, 103 participants (77.4%) reported abstaining from alcohol consumption, while 30 (22.6%) admitted to alcohol intake. Based on the distribution of comorbidities among the study participants, Hypertension (HTN) alone represented the most prevalent comorbidity among the study participants, affecting 81 individuals (60.9%). Moreover, a concurrent diagnosis of hypertension and diabetes mellitus (HTN + DM) was identified in 30 participants (22.6%). In addition, other comorbid conditions were documented in 22 participants (16.5%).

In regard to salt restrictions, the majority of participants were restricting salt, about 87 (65.4%), with non-restricting about 46 (34.6%).

The mean BMI was 27.1 ± 5.51 standard deviation with the lowest being 17, while the highest was 51.4. The majority of participants, however, were within the BMI range of 18.5-29.9, and over two-thirds, 90 (67.7%), were found to be hyponatremic, with the mean Serum Na level of 131.095 ± 7.04 standard deviations. Among those with hyponatremia, 7 (14.6%) were asymptomatic, while 85 (63.9%) were symptomatic, with 83 (62.4%) reporting fatigue as the most common symptom. Nausea was experienced by 56 (42.1%) patients. Twenty-eight people (21.1%) had muscle cramps, and 46 (34.6%) experienced headaches. Vomiting was reported by 19 (14.3%) patients, and confusion by 6 (4.5%), though it was less common. Only 4 (3.0%) individuals reported frequent falls, making it the least common symptom.

Table 6: Social demographic and clinical characteristics of Heart failure patients at Dar es salaam. (N=133)

Variable	**Categories**	**Frequen**	**Percen**
Gender	Male	72	54.1
	Female	61	45.9
Marital status	Single	13	9.8
	Married	93	69.9
	Widowed/ Widower	20	15.0
	Divorced/ Divorcee	7	5.3
Education	No formal education	39	29.3
	Primary	32	24.1
	Secondary	44	33.1
	Higher education	18	13.5
Employment	Unemployed	76	57.1
	Employed	57	42.9
Residence	DSM	80	60.2
	Outside DSM	53	39.8
Chronicity	< 6 months	44	33.1
	6 m - 1 year	42	31.6
	>1 year	47	35.3
Comorbidities	HTN	81	60.9
	HTN+ DM	30	22.6
	Others	22	16.5
Medications	Diuretic based	121	91.0
	Non-diuretic based	12	9.0

Salt restriction	Not restricted	46	34.6
	Restricted	87	65.4
Smoking	No	105	78.9
	Yes	28	21.1
Alcohol intake	No	103	77.4
	Yes	30	22.6
Headache	No	87	65.4
	Yes	46	34.6
Frequent fall	No	129	97
	Yes	4	3
Muscle cramps	No	105	78.9
	Yes	28	21.1
Confusion	No	127	95.5
	Yes	6	4.5
Fatigue	No	50	37.6
	Yes	83	62.4
Vomiting	No	114	85.7
	Yes	19	14.3
Nausea	No	77	57.9
	Yes	56	42.1
Age (years) *			58.2 ± 16.
Body mass index (Kg/m^2)*			27.1 ± 5.5
Ejection fraction *			41.47 ± 14

*, data are expressed in mean ± standard deviation; HTN, Hypertension; DM, diabetes mellit

DSM, Dar es Salaam.

5.2 The prevalence of hyponatremia among hospitalized heart failure patients at JKCI.

Figure 1 illustrates the prevalence of hyponatremia among hospitalized heart failure patients at JKCI. The prevalence of hyponatremia among hospitalized heart failure patients at JKCI was found to be 67.6%. The mean serum sodium level was 131.10 ± 7.04 mmol/L, ranging from a minimum of 107.0 mmol/L to a maximum of 145.0 mmol/L. Among the 133 study participants, 20 (15.0%) were classified as having severe hyponatremia, 29 (21.8%) had moderate hyponatremia, and 41 (30.8%) had mild hyponatremia, whereas 43 (32.3%) exhibited Normonatremia.

Table 7 shows the distribution of Symptom Status and levels of hyponatremia among hospitalized heart failure patients at JKCI. Of the total participants, 48 were asymptomatic. Among these, 7 (14.6%) presented with mild hyponatremia, while the majority, 41 (85.4%), maintained normal serum sodium levels. Conversely, 85 participants exhibited symptoms, with the highest proportion, 34 (40.0%), experiencing mild hyponatremia. This was followed by 29 participants (34.1%) with moderate hyponatremia and 20 participants (23.5%) with severe hyponatremia, and this association was statistically significant(p-value<0.05).

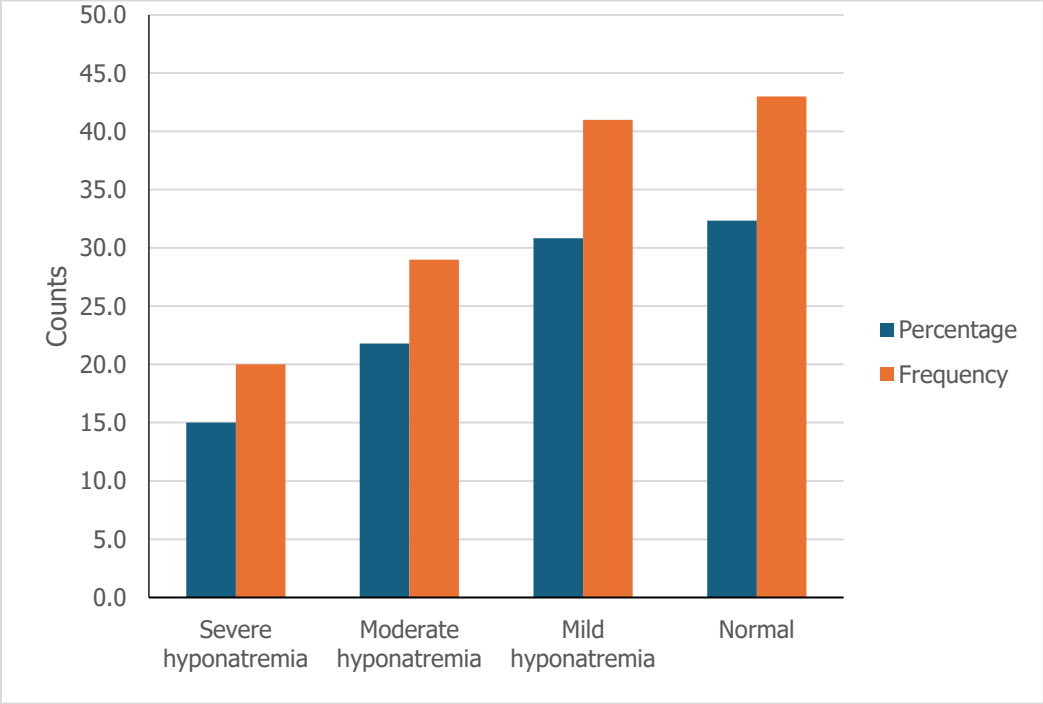


Figure 4: Prevalence of hyponatremia among HF patients according to the severity of hyponatremia.

Table 7: Distribution of levels of hyponatremia by symptom status among Heart failure patients at JKCI (N=133)

	Levels of hyponatremia					
Symptom status	Severe hyponatremia	Moderate hyponatremia	Mild hyponatremia	Normal	**χ2**	P-value
Asymptomatic	0(0.0)	0(0.0)	7(14.6)	41(85.4)	99	**0.0001***
Symptomatic	20(23.5)	29(34.1)	34(40.0)	2(2.4)		

5.3 Distribution of levels of hyponatremia by sociodemographic characteristics such as age, gender, alcohol use, smoking, and obesity among hospitalized heart failure patients at JKCI.

Table 8 displays the distribution of social demographic characteristics by hyponatremia levels. Participants under 40 had the highest proportion of mild hyponatremia, at 40.9% (9/22), while those aged 40 to 59 were more common in moderate hyponatremia, at 25.6% (10/39). At this age group, Severe and mild hyponatremia were observed at equal proportions, each accounting for 17.9%. Meanwhile, 38.5% of patients in this age category maintained normal serum sodium levels, representing the highest proportion of normonatremic across all age groups. Severe hyponatremia was notably prevalent among those under 40, with a proportion of 27.3% (6/22), and was least observed in adults over 60, at 11.1% (8/72). Although this age group did not have the highest proportion of severe hyponatremia, they showed a significant burden of hyponatremia overall, with more than two-thirds affected by some level of sodium imbalance, although the association was statistically insignificant (p-value >0.05).

With regard to Gender, Hyponatremia was more prevalent among males than females across all levels of hyponatremia majority being 33.3%(24/72) in mild hyponatremia, although

females,39.3%(24/61), were more normonatremic compared to males, 26.4%(19/72), despite this the association was statistically insignificant (p-value >0.05).

Alcohol intake did not show statistical significance (p-value > 0.05) with the level of hyponatremia, as only 30 participants who drank alcohol were found to have severe, moderate, and mild hyponatremia, with proportions of 16.7%, 26.7%, and 30.0%, respectively, compared to 103 non-drinkers who were normonatremic, with 26.7%.

A minority of the participants, 28, were smoking; of these, 14.3% had severe hyponatremia, 25.0% moderate hyponatremia, and 32.0% mild hyponatremia, while the majority, 105 non-smokers had Normonatremia of 33.3%. The association was statistically insignificant (p>0.05).

In patients with a body mass index (BMI) exceeding 24.9, severe hyponatremia was observed in 17.0% of cases, while normal sodium levels were present in 32.1%. Similarly, within the BMI range of 25 to 29.9, the incidence of severe hyponatremia decreased to 9.8%, with mild hyponatremia being most prevalent at 39.2%, indicating a trend towards milder forms. Conversely, among patients with a BMI of 30 or higher, there was a higher prevalence of severe (20.7%), and moderate (24.1%) hyponatremia compared to mild cases (17.2%), although the proportion of patients with normal sodium levels remained relatively high at 37.9%, the association was statistically insignificant (p>0.05).

In terms of marital status, a statistically significant association was observed between marital status and hyponatremia severity among heart failure patients (p<0.05). Single patients had the highest incidence of severe hyponatremia (53.8%) and the lowest proportion with normal sodium levels (15.4%). Married patients demonstrated a more balanced distribution, with severe hyponatremia in only 11.8% of cases, while 34.4% had normal sodium levels—the highest among all groups. Widowed patients also showed a low incidence of severe

hyponatremia (10.0%), with the majority having normal sodium levels (35.0%), while 30.0% had moderate and 25.0% had mild hyponatremia. Divorced patients did not present with any severe or moderate hyponatremia; instead, 71.4% exhibited mild hyponatremia, and 28.6% maintained normal sodium levels.

Regarding education level, those without formal education had the highest proportions of mild hyponatremia (38.5%) and moderate cases (28.2%), with severe hyponatremia in 15.4%, while only 17.9% had normal sodium levels. In contrast, individuals with primary education had the lowest rate of severe hyponatremia (3.1%) and the highest proportion of normal sodium levels (46.9%). Among patients with secondary education, the distribution was more balanced, with 13.6% experiencing severe, 25% moderate, and 25% mild hyponatremia, while 36.4% had normal levels. However, patients with higher education showed a surprisingly high prevalence of severe hyponatremia (38.9%) and lower frequencies of moderate (5.6%) and normal (27.8%) levels. The (p-value < 0.05) suggests that education level is statistically associated with hyponatremia severity. Concerning employment status, the distribution of hyponatremia severity among unemployed patients was more balanced, with 13.2% having severe, 22.4% moderate, and 28.9% mild hyponatremia, while 35.5% had normal sodium levels. In contrast, employed patients had a much higher proportion of severe (34.8%) and moderate (42.1%) hyponatremia, with fewer falling in the normal range (55.5%), although the association was statistically insignificant (p-value >0.05).

Table 8: Distribution of levels of hyponatremia by sociodemographic factors among Heart failure patients at JKCI (N=133)

Variable		Levels of hyponatremia				χ2	P-value
		Severe hyponatremia	Moderate hyponatremia	Mild hyponatremia	Normal		
Age range	Less than 40	6 (27.3)	2 (9.1)	9 (40.9)	5 (22.7)		
	40 to 59	6 (15.4)	11 (28.2)	7 (17.9)	15 (38.5)	9.	0.144
	60 +	8 (11.1)	16 (22.2)	25 (34.3)	23 (31.9)		
Gender	Male	11 (15.3)	18 (25.0)	24 (33.3)	19 (26.4)	2.	0.428
	Female	9 (14.8)	11 (18.0)	17 (27.9)	24 (39.3)		
Alcohol	No	16 (15.5)	20 (19.4)	32 (31.1)	35 (34.0)	1.	0.646
	Yes	4 (3.3)	9 (30.0)	9 (30.0)	8 (26.7)		
Smoking	No	17 (16.2)	21 (20.0)	32 (30.5)	35 (33.3)	1.	0.715
	Yes	3 (10.7)	8 (28.6)	9 (32.1)	8 (28.6)		
BMI Range	>24.9	9 (17.0)	11 (20.8)	16 (30.2)	17 (32.1)		
	25 to 29.9	5 (9.8)	11 (21.6)	20 (39.2)	15 (29.4)	5.:	0.531
	30 +	6 (20.7)	7 (24.1)	5 (17.2)	11 (37.9)		
Marital status	Single	7(53.8)	1(7.7)	3(23.1)	2(15.4)		
	Married	11(11.8)	22(23.7)	28(30.1)	32(34.4)	24	**0.004****
	Widowed	2(10.0)	6(30.0)	5(25.0)	7(35.0)		
	Divorced	0(0.0)	0(0.0)	5(71.4)	2(28.6)		
Education	No formal edu	6(15.4)	11(28.2)	15(38.5)	7(17.9)		
	Primary	1(3.1)	6(18.8)	10(31.3)	15(46.9)	19	**0.022****
	Secondary	6(13.6)	11(25.0)	11(25.0)	16(36.4)		
	Higher educati	7(38.9)	1(5.6)	5(27.8)	5(27.8)		
Employment	Unemployed	10(13.2)	17(22.4)	22(28.9)	27(35.5)	5.	0.486
	Employed	10(34.8)	12(42.1)	19(66.5)	16(55.5)		

*BMI, Body mass Index

5.4 Distribution of levels of hyponatremia by clinical characteristics among Heart failure patients at JKCI.

Table 9 outlines the distribution of levels of hyponatremia by clinical characteristics among Heart failure patients at JKCI. Despite the lack of statistical significance (p-value >0.05), regarding comorbidities, HTN was the most prevalent among all patients 91%(121/133), whereby the HTN alone constitute 60.9%(81/133) of cases ,with the majority having normal sodium levels (32.1%), followed by mild hyponatremia (28.4%) and moderate hyponatremia (22.2%), and 17.3% presented with severe hyponatremia. In comparison, patients with HTN and diabetes mellitus (DM) comprised 22.5% (30/133). This group showed slightly higher proportions of moderate (26.7%) and mild (26.7%) hyponatremia, with 36.7% maintained normal sodium levels and only 10.0% had severe hyponatremia.

The Others comorbidities category comprising patients with RHD (Rheumatic Heart Disease), cardiomyopathies, cor pulmonale and congenital heart disease, represented 16.5% of the study cohort. Within this group, RHD was the most common, and the majority of patients presented with mild hyponatremia (40.0%), while 24.0% maintained normal sodium levels, and smaller proportions had with severe (12.0%) or moderate (12.0%) hyponatremia.

In examining the distribution of hyponatremia severity relative to medication type, it was observed that among patients on diuretics-based regimens, the majority exhibited either mild (32.2%) or normal (31.4%) sodium levels, followed by moderate (21.5%) and severe (14.9%) hyponatremia. In contrast, patients on non-diuretic-based medications predominantly fell within the normal range (41.7%), while an equal proportion experienced severe (16.7%) and mild (16.7%) hyponatremia, with 25.0% presenting with moderate levels. However, no statistically significant association was identified (p-value > 0.05). The distribution of salt

restriction exhibited a statistical significance (p-value < 0.05) across the levels of hyponatremia. Specifically, among patients who did not restrict salt, the majority (52.2%) had normal sodium levels, while only 15.2% had severe hyponatremia. In contrast, those who practiced salt restriction had a higher proportion of moderate (29.9%) and mild (33.3%) hyponatremia, with only 21.8% maintaining normal sodium levels. Notably, although the percentage of severe cases was similar in both groups (15.2% vs 14.9%), overall, hyponatremia of any grade was more prevalent among those with salt restriction

Table 9: Distribution of levels of hyponatremia by clinical characteristics among Heart failure patients at JKCI (Comorbidities, Medications, Salt restriction) (N=133)

Variable		Levels of hyponatremia				χ2	P-value
		Severe Hyponatremia	Moderate Hyponatremia	Mild Hyponatremia	Normal		
Comorbidities	HTN	14 (17.3)	18 (22.2)	23 (28.4)	26 (32.1)	4.012	0.675
	HTN+ DM	3 (10.0)	8 (26.7)	8 (26.7)	11 (36.7)		
	Others	3 (12.0)	3(12.0)	10 (40.0)	6 (24.0)		
Medications	Diuretics based	18 (14.9)	26 (21.5)	39 (32.2)	38 (31.4)	1.299	0.729
	Non-diuretics based	2 (16.7)	3 (25.0)	2 (16.7)	5 (41.7)		
Salt restriction	Not restricted	7 (15.2)	3 (6.5)	12 (26.1)	24 (52.2)	16.61	**0.001****
	Restricted	13 (14.9)	26 (29.9)	29 (33.3)	19 (21.8)		

HTN, Hypertension; DM, diabetes mellitus

5.5 Distribution of the types of hyponatremias (Hypovolemic, hypervolemic, and euvolemic) by age, gender, and chronicity of HF among hospitalized HF patients at JKCI.

Table 10 highlights the distribution of the types of hyponatremias among hospitalized HF patients. The distribution of hyponatremia types showed significant variation across different age groups (p-value < 0.05), indicating a statistically significant link between age and hyponatremia type. Among patients under 40 years old, most (81.8%) had hypervolemic hyponatremia, while 13.6% had hypovolemic and 4.5% had euvolemic types. In the 40 to 59 age group, hypervolemic hyponatremia remained the most common (82.1%), with no cases of hypovolemic hyponatremia and 17.9% showing euvolemic type. Notably, in individuals aged 60 and older, hypervolemic hyponatremia increased to 91.7%, with only 1.4% presenting hypovolemic and 6.9% euvolemic types.

The distribution of hyponatremia types between males and females was not statistically significant (p-value > 0.05). Among males, 90.3% had hypervolemic hyponatremia, while 4.2% had hypovolemic and 5.6% euvolemic types. Females showed a slightly lower rate of hypervolemic hyponatremia (83.6%), with only 1.6% hypovolemic and a higher proportion (14.8%) euvolemic compared to males. Regarding chronicity, most (79.5%) of patients with acute heart failure had hypervolemic hyponatremia, followed by euvolemic (15.9%) and hypovolemic (4.5%) forms. Similarly, patients with chronic heart failure mainly presented with hypervolemic hyponatremia (87.1%), with significantly fewer cases of euvolemic (6.5%) and hypovolemic (2.2%) types. Among those with acute-on-chronic

heart failure, hypervolemic hyponatremia remained the most common (87.2%), with a slight increase in euvolemic cases (10.6%). This association was not statistically significant (p-value > 0.05).

Table 10: Distribution of types of hyponatremias (age, gender, and chronicity) among Heart failure patients at JKCI. (N=133)

		Hyponatremia type				
Variable		Hypervolemic	Hypovolemic	Euvolemic	χ^2	P-value
Age range	< 40	18 (81.8)	3 (13.6)	1 (4.5)		
	40 to 59	32(82.1)	0(0.0)	7(17.9)	14.292	**0.006****
	60 +	66(91.7)	1(1.4)	5(6.9)		
Gender	Male	65(90.3)	3(4.2)	4(5.6)	3.728	0.155
	Female	51(83.6)	1(1.6)	9(14.8)		
Chronicity	Acute	35(79.5)	2(4.5)	7(15.9)		
	Chronic	40(95.2)	1(2.4)	1(2.4)	5.207	0.267
	Acute on chronic	41(87.2)	1(2.1)	5(10.6)		

5.6 Distribution of levels of hyponatremia by functional status (NYHA Grade I-IV) of heart failure among hospitalized Heart failure patients at JKCI.

Table 11 depicts the distribution of levels of hyponatremia by functional status of HF among hospitalized Heart failure patients. A statistically significant association was seen between the NYHA functional classification of heart failure and the severity of hyponatremia (p-value <0.05). In NYHA Grade I, no patients had severe or moderate hyponatremia, while 50.0%

had mild hyponatremia, and the remaining 50.0% were normonatremic. As the functional class worsened, the burden of hyponatremia increased. In Grade II, mild hyponatremia remained most common (40.0%), but moderate and severe forms began to appear, 13.3% and 3.3% respectively. By Grade III, both moderate and mild hyponatremia were equally prevalent (31.0%), with 12.1% having severe cases. In Grade IV, the highest level of functional impairment, 30.8% had severe hyponatremia, and 20.5% were mild, showing a clear trend of increasing severity with worsening heart failure status.

Table 11: Distribution of levels of hyponatremia by functional status of HF(NYHA Grade I-IV) among hospitalized Heart failure patients at JKCI.(N=133)

		Levels of hyponatremia					
Variable		Severe hyponatremia	Moderate hyponatremia	Mild hyponatremia	Normal	χ2	P-value
NYHA Grade	GRADE I	0(0.0)	0(0.0)	3(50.0)	3(50.0)	20.585	**0.015***
	GRADE II	1(3.3)	4(13.3)	12(40.0)	13(43.3)		
	GRADE III	7(12.1)	18(31.0)	18(31.0)	15(25.9)		
	GRADE IV	12(30.8)	7(17.9)	8(20.5)	12(30.8)		

NHYA, New York Heart Association

5.7 Distribution of levels of hyponatremia by Left ventricular Ejection Fraction (HFrEF, HFmrEF, and HFpEF) of heart failure among hospitalized Heart failure patients at JKCI.

Table 12 displays the distribution of hyponatremia severity across different left ventricular ejection fraction (LVEF) categories: HFrEF (≤40%), HFmrEF (41–49%), and HFpEF (≥50%). Although the association between ejection fraction and hyponatremia severity was not statistically significant ($p>0.05$), some trends were noted. As seen in figure 2 below, A positive but weak correlation was observed, with a Spearman correlation coefficient (r) of 0.198 and a p-value of 0.022, indicating a statistically significant association. Among patients with HFrEF, mild hyponatremia was most common (37.0%), followed by moderate (24.7%) and severe (15.1%), while only

23.3% had normal sodium levels. In the HFmrEF group, more than half (54.5%) had normal sodium levels, and only 9.1% had severe hyponatremia, suggesting a milder profile. Among those with HFpEF, there was a slightly higher proportion of severe (18.4%), and moderate (21.1%) hyponatremia compared to HFmrEF, with 36.8% maintaining normal sodium levels.

Table 12: Distribution of levels of hyponatremia by Left ventricular ejection fraction (HFmrEF, HFmrEF, and HFpEF) of heart failure among hospitalized Heart failure patients at JKCI. (N=133)

		Levels of hyponatremia					
Variable		Severe hyponatremia	Moderate hyponatremia	Mild hyponatremia	Normal	χ2	P-value
LVEF	≤ 40 (HFrEF)	11(15.1)	18 (24.7)	27(37.0)	17(23.3)		
	41-49 (HFmrEF)	2(9.1)	3 (13.6)	5(22.7)	12(54.5)	9.2	0.163
	≥50 (HFpEF)	7(18.4)	8 (21.1)	9(23.7)	14(36.8)		

HFrEF, heart failure with reduced ejection fraction; HFmrEF, heart failure with mildly reduced ejection fraction; HFpEF, heart failure with preserved ejection fraction

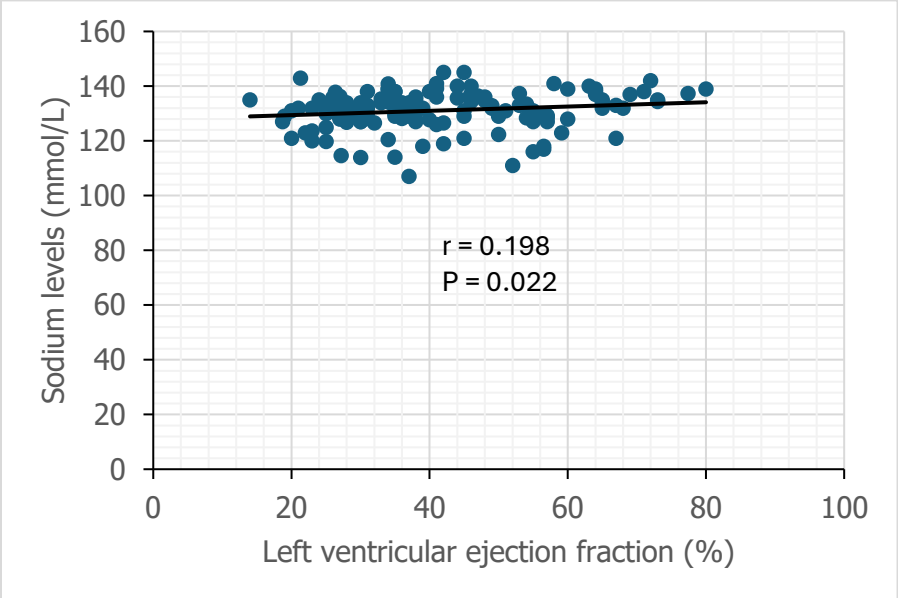


Figure 5: Correlation Between Left Ventricular Ejection Fraction (LVEF) and Serum Sodium Levels Among Heart Failure Patients at JKCI

CHAPTER SIX

6.0 DISCUSSION

This study determined the clinical correlation of hyponatremia among hospitalized heart failure patients at JKCI in Dar es Salaam. The prevalence of hyponatremia among hospitalized heart failure patients at JKCI was found to be 67.6%. This finding was slightly lower compared to a study done in Kenya at Kenyatta National Hospital, which had a prevalence of 79.8%[67]. This can be explained by better fluid and electrolyte monitoring or earlier clinical intervention at the JKCI.

The current study found that many patients presented with fatigue (62.4%), nausea (42.1%), headache (34.6%), muscle cramps (21.1%), vomiting (14.3%), confusion (4.5%), and frequent falls (3%). This was in comparison to a study done in Uganda, which showed similar symptoms present in patients with hyponatremia[12]. The resemblance can be due to the use of the same study population, where both studies used heart failure patients, and most of the patients were elderly and common underlying pathophysiology of hyponatremia, which tends to produce similar clinical manifestations regardless of geographical or demographic differences. The clinical presentation was similar across all classes of hyponatremia (mild, moderate, and severe), whereby most of the patients with mild hyponatremia were asymptomatic, with few presenting with fatigue, while moderate hyponatremia presented with nausea, fatigue, muscle cramps and headache and severe hyponatremia presented with vomiting, confusion and frequent falls.

The association was statistically significant (p-value <0.05). This was comparable to a study done in Ireland [68], which showed corresponding symptom profiles since the observed symptoms correspond to the impact of hyponatremia on the central nervous system.

In this study, those with and those without formal education had the highest proportions of mild hyponatremia (38.5%). In contrast, individuals with primary education have the highest proportion of normal sodium levels (46.9%). However, patients with higher education showed a surprisingly high prevalence of severe hyponatremia (38.9%) and lower frequencies of moderate (5.6%) and normal (27.8%) levels, which was statistically significant in contrast to a meta-analysis study, which showed lower education levels correlated to poor health literacy and impacted management of HF leading to delayed diagnosis and treatment of hyponatremia [69].

This study found a significant association between marital status and hyponatremia severity among heart failure patients ($\chi^2 = 24.11$, $p = 0.004$), with severe hyponatremia more common in single patients (53.8%), while married patients tended to have milder forms of hyponatremia or were more likely to be normonatremic (34.4%). These findings suggest that marital status, possibly through the proxy of social support, may influence the severity of electrolyte derangements in heart failure. Although direct studies are lacking, existing research supports the protective role of social support in heart failure. Rutledge et al showed that emotional and social support improve outcomes in heart failure patients, likely through better medication adherence and fluid regulation—factors that may reduce hyponatremia [70]. Coyne et al similarly found that poor marital support predicted higher mortality in heart failure, implying that social isolation may worsen clinical and physiological status [71]. The absence of studies directly linking marital status to hyponatremia likely reflects a research gap, as social factors are often underexplored in relation to specific biochemical abnormalities. Future studies should

consider integrating social determinants into clinical research frameworks to better understand their impact on electrolyte balance.

This study found that hyponatremia becomes more prevalent with advancing age, particularly among patients over 60 years old, where hypervolemic hyponatremia was the most common type, followed by hypovolemic and euvolemic hyponatremia, respectively. This aligns with a study conducted in Greece[61], which also reported that hyponatremia is frequently observed in the elderly population. The similarity between these findings may be attributed to age-related physiological changes, such as increased antidiuretic hormone (ADH) secretion, as well as the widespread use of medications linked to hyponatremia, particularly diuretics. Consistent with this, the current study revealed that patients on a diuretic-based regimen were more likely to develop moderate to severe hyponatremia, whereas those not taking diuretics mostly remained normonatremic.

The distribution of hyponatremia severity showed no statistically significant association (p-value>0.05) with gender, alcohol use, smoking status, employment status, and BMI range.

Low salt intake predisposes to hyponatremia. In the current study, Hyponatremia was more prevalent among those restricting salt, 52.6% of participants, in contrast to a study done in Uganda, where 91% of participants with hyponatremia were adding salt to their food and was statistically insignificant [12]. This discrepancy may be due to the compounded effect of diuretics and volume depletion.

In this study, most patients (91%) were hypertensive, which is consistent with observations made in other study done in Uganda[12] . Hyponatremia was also seen in patients with Diabetes mellitus, and other comorbidities (Rheumatic Heart disease, cardiomyopathies, Cor pulmonale, and congenital heart disease), but was less common in patients with no comorbidities. This

was a similar finding to a study done by the National Health and Nutrition Examination Survey in the United States, which had similar findings, which may be due to the combined effects of neurohormonal activation, renal dysfunction, and medical therapy. Although the association was not statistically significant (p-value >0.05).

The study revealed a significant association between the severity of hyponatremia and the functional status of heart failure as assessed by the NYHA. As the NYHA grade increased, indicating worsening functional impairment, there was a progressive shift toward more severe forms of hyponatremia. Specifically, severe hyponatremia was more frequent among patients in Grade IV (30.8%) and Grade III (12.1%), while moderate hyponatremia peaked in Grade III (31.0%). This finding resembles the study done in Ethiopia, which observed that hyponatremia was more common among patients with advanced NYHA functional classes, reporting 43.6% in class III and IV[50]. The resemblance can be explained by shared patient characteristics and settings, similar pathophysiological mechanisms, and clinical patterns of HF.

In this study, although the severity of hyponatremia appeared to differ across the three LVEF categories (HFrEF, HFmrEF, and HFpEF), the variation was not statistically significant ($p > 0.05$). A weak but statistically meaningful positive correlation was, however, observed between serum sodium and LVEF ($r = 0.198$, $p = 0.022$). These findings highlight that hyponatremia in heart failure is unlikely to be determined by ejection fraction alone but rather reflects a combination of overlapping influences. Diuretic therapy, especially at higher doses, can directly lower sodium levels; dietary salt restriction may further accentuate the imbalance regardless of cardiac function; and coexisting conditions such as chronic kidney disease contribute independently to disordered sodium handling. In addition, age-related physiological changes in renal and hormonal regulation of water and electrolytes may help explain why the relationship

between EF and sodium was not more pronounced. In support of this, a large cardiac surgery cohort demonstrated only a marginal correlation between preoperative serum sodium and LVEF ($r^2 = 0.04$), reinforcing the notion that left ventricular function is not the predominant driver of sodium imbalance[72] .

CHAPTER SEVEN

7.0: STUDY STRENGTHS, LIMITATIONS, AND MITIGATIONS

Strengths included that the study was conducted at the Jakaya Kikwete Cardiac Institute (JKCI), a national referral and high-volume tertiary center, making it an ideal setting for capturing a broad range of advanced heart failure cases and enhancing the clinical richness of the data. Furthermore, the categorization of hyponatremia by both severity (mild, moderate, and severe) and type (hypervolemic, hypovolemic, and euvolemic) provided detailed insights into the distribution patterns.

Absence of confirmatory tests was a limitation in this study. Confirmatory tests like serum and urine osmolality were not included in the study due to cost. This may have affected the accuracy of further hyponatremia classification. However, the study mitigated this by using standardized clinical criteria and routine lab tests to guide diagnosis. Future studies should consider including these tests to enhance diagnostic precision.

CHAPTER EIGHT

8.0: CONCLUSION

This study demonstrated that hyponatremia is a major but under-recognized electrolyte imbalance among hospitalized heart failure patients at the Jakaya Kikwete Cardiac Institute (JKCI), with a prevalence of 67.6%. This rate, although slightly lower than the 79.8% reported at Kenyatta National Hospital in Kenya[67], still reflects a substantial clinical burden in our setting. The difference may be attributable to better fluid and electrolyte monitoring or earlier intervention practices at JKCI. Similar to previous literature, the severity of hyponatremia was strongly linked to advanced New York Heart Association (NYHA) functional classes, likely due to greater neurohormonal activation, higher diuretic use, and reduced renal perfusion seen in severe heart failure[50].

A key contribution of this study is the identification of clinical correlations not well-documented in prior regional research. Specifically, we observed that salt restriction was associated with a higher prevalence of hyponatremia, a finding contrary to some studies, such as one from Uganda, where most hyponatremic patients were adding salt to food[12]. This difference may be explained by the compounded effects of diuretic use and volume depletion in our study population. Diuretic therapy, particularly at higher doses, was also linked to an increased risk of moderate to severe hyponatremia, reinforcing existing evidence on the role of medication-induced sodium loss[50,62]. Additionally, comorbidities such as hypertension and diabetes were more common in hyponatremic patients, in line with findings from Ethiopia and the NHANES data in the United States[50,62]. The type of hyponatremia also varied by age, with hypervolemic hyponatremia being most prevalent among elderly patients, reflecting age-related physiological changes and polypharmacy.

These findings underscore that the development and severity of hyponatremia in heart failure are influenced by both disease-specific and modifiable factors, including dietary practices and treatment regimens. As one of the few studies in Tanzania to comprehensively examine the prevalence, severity, types, and clinical correlates of hyponatremia in hospitalized heart failure patients, this research provides essential evidence to guide local clinical practice. Early recognition and targeted management of hyponatremia could improve patient outcomes, reduce hospital stays, and enhance the overall quality of heart failure care in similar resource-limited settings.

8.1: RECOMMENDATIONS

The findings of this study highlight the need for targeted strategies to improve the detection, prevention, and management of hyponatremia in heart failure patients. Given its high prevalence (67.6%) and significant association with disease severity, routine screening for serum sodium levels should be an integral part of the clinical evaluation of all hospitalized heart failure patients. This aligns with the recommendation by Nankabirwa et al.[12], who emphasized that early identification and classification of hyponatremia can serve as a valuable prognostic marker in heart failure and enable timely intervention.

Clinicians should maintain a high index of suspicion in patients with comorbidities like hypertension, diabetes, and ischemic heart disease, as these were common among hyponatremic patients in the study and have been consistently reported in other studies from Ethiopia and the United States[50,62]. Management strategies for these high-risk groups should include tighter control of blood pressure and blood glucose, careful use and monitoring of diuretic therapy, and regular reassessment of volume status.

Dietary counseling should also be individualized. Findings from the study suggest that strict salt restriction, particularly in combination with high-dose diuretics, may increase the risk of hyponatremia. Therefore, salt restriction policies should be applied cautiously, balancing the benefits of sodium control in hypertension and heart failure with the risks of exacerbating electrolyte imbalance.

Finally, this study provides locally relevant evidence that can inform the development of Tanzanian clinical guidelines for heart failure management, ensuring that electrolyte imbalances particularly hyponatremia are routinely evaluated and appropriately managed. By addressing this often-overlooked complication, healthcare providers can reduce morbidity, prevent hospital readmissions, and improve the quality of life for heart failure patients in Tanzania.

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APPENDICES

APPENDEX I: CONSENT FORM- ENGLISH VESRSION

TITLE: CLINICAL CORRELATES OF HYPONATREMIA AMONG HOSPITALIZED HEART FAILURE PATIENTS AT JKCI, DAR ES SALAAM.

I, Dr. Bilqis S. Nassor, a resident in the Department of Internal Medicine, am undertaking the above-mentioned study as part of the requirements for the completion of my postgraduate training. Your participation is requested in order to provide important health-related information that will serve as data for this study. The main objective of this research is to assess the clinical correlates of hyponatremia in hospitalized adults diagnosed with heart failure. The outcomes are expected to guide recommendations for routine screening of hyponatremia in such patients, enabling early intervention to prevent further complications.

Eligible participants will include adult patients with heart failure who meet the study's inclusion criteria. Those enrolled will be interviewed using a structured questionnaire to capture sociodemographic details and undergo a physical examination. Laboratory investigations will include blood test for serum sodium levels. Blood sampling will involve venipuncture, which may cause mild discomfort. All collected data will be kept strictly confidential and will not be disclosed to any unauthorized party. Participation in this study is voluntary, with no payment charges to the participant, and withdrawal will be allowed at any stage without any consequences.

For further clarification or in case of any issues, participants may contact:

Prof. Y. Mgonda, Chairperson, Department of Internal Medicine

Director of Postgraduate Studies and Research, Hubert Kairuki Memorial University (HKMU)

I …… confirm that I have read, or the contents of this form have been explained to me, and I fully understand what it means. I therefore give my consent to take part in this study

Signature ……... (Participant), Date……...

Signature…….. (Researcher), Date……...

APPENDIX II: FOMU YA IDHINI (SWAHILI VERSION)

UHUSIANO WA UPUNGUFU WA SODIAMU KWENYE DAMU NA SHINIKIZO LA MOYO KWA WAGONJWA WATU WAZIMA WALIOLOAZWA KATIKA HOSPITALI YA JKCI, DAR ES SALAAM

Mimi, Dkt. Bilqis S. Nassor, mtafiti katika Idara ya Tiba ya Ndani, ningependa kufanya utafiti ulioainishwa hapo juu kama sehemu ya mahitaji muhimu ya kukamilisha masomo yangu ya uzamili. Ushiriki wako unahitajika ili kupata taarifa muhimu kuhusu hali yako ya afya zitakazotumika kama data kwenye utafiti huu.

Lengo la utafiti huu ni kubaini uhusiano wa upungufu wa sodiamu kwenye damu kwa wagonjwa watu wazima walioloazwa na shinikizo la moyo. Matokeo ya utafiti huu yatasaidia katika kutoa mapendekezo ya uchunguzi wa mapema wa upungufu wa sodium katika damu kwa wagonjwa waliogundulika kuwa na shinikizo la moyo, hivyo kuwezesha hatua za mapema kabla ya maendeleo ya matatizo zaidi.

Watu wazima waliogundulika kuwa na shinikizo la moyo na ambao watakidhi vigezo vya ushiriki watajumuishwa katika utafiti huu na watahojiwa kwa kutumia dodoso litakalojumuisha taarifa zao za kijamii na kimazingira pamoja na uchunguzi wa mwili.

Vipimo vya damu kwa ajili ya sukari ya damu ya haraka na kiwango cha sodiamu kwenye damu vitafanyika. Mkojo utaangaliwa kwa osmolality ya mkojo na mkusanyiko wa sodiamu. Kutakuwa na maumivu kidogo wakati wa kuchukuliwa sampuli ya damu kwenye mishipa ya damu.

Matokeo ya utafiti hayatatolewa kwa mtu yeyote asiyeidhinishwa. Mshiriki hatahitajika kulipa ada yoyote na atakuwa na uhuru wa kujiondoa wakati wowote ndani ya kipindi cha utafiti.

Watu wa Kuwasiliana nao kwa Maswali au Matatizo

- Prof. Y. Mgonda, Mwenyekiti wa Idara ya Tiba ya Ndani
- Mkurugenzi wa Masomo ya Uzamili na Taasisi ya Utafiti ya HKMU

Mimi, ... nimesoma/nimeelezwa yaliyomo kwenye fomu hii na nimeelewa maana yake. Hivyo, nakubali kushiriki katika utafiti huu.

Sahihi ..... (Mshiriki), Tarehe.....

Sahihi..... (Mtafiti), Tarehe.....

APPENDEX III: QUESTIONNAIRE (ENGLISH VERSION)

Title: CLINICAL CORRELATES OF HYPONATREMIA AMONG HOSPITALIZED HEART FAILURE PATIENTS AT JKCI, DAR ES SALAAM.

1. Date _____
2. Identity _____

Section A: Sociodemographic Information

1. Age: _____
2. Gender: Male [] Female [ ]

3. Marital Status: Single [] Married [ ] Divorced [ ] Widowed [ ]
4. Level of Education:

No formal education [] Primary [ ] Secondary [ ] higher education []

5. Occupation: _____
6. Employment status:

Employed [ ] Unemployed [ ] self-employed [ ]

7. Residence:

Dar es salaam [ ] Outside DAR [ ]

Section B: Medical History

8. Have you been diagnosed with heart failure? Yes [ ] No [ ]
9. If yes, when were you diagnosed? (Year/Month): _____
10. Is the echocardiogram available? Yes [ ] no[ ]
11. What is the ejection fraction? _____
12. Have you ever been told by a doctor that you have:
    - Hypertension? Yes [ ] No [ ]
    - Diabetes Mellitus? Yes [ ] No [ ]
    - Kidney disease? Yes [ ] No [ ]
    - Stroke? Yes [ ] No [ ]

13. Are you currently on medications for:

- Diuretics [ ]
- CCBs [ ]
- ARBs [ ]
- ACEIs [ ]
- Anti psychotics[ ]
- Anticonvulsants [ ]
- Other (specify): _____

Section C: Lifestyle and Risk Factors

14. Have you been advised to restrict salt in your diet? Yes [ ] No [ ]
15. If not, how often do you consume salty foods? Frequently [ ] Occasionally [ ] Rarely [ ] Never []
16. Do you smoke? Yes [ ] No [ ]
17. If yes- how many?
18. Do you consume alcohol? Yes [ ] No [ ]
19. How many years? < 10 yrs or >10 y
20. How frequent ? Every day ☐ Every week ☐ sometimes ☐

Section D: Clinical Symptoms

21. Have you experienced any of the following recently? (Tick all that apply)

- Nausea [ ]
- Vomiting [ ]
- Headache []
- Confusion [ ]
- Muscle weakness [ ]

- Seizures [ ]
- Fatigue [ ]
- Frequent falls [ ]

Section E: physical examination and Laboratory findings

22. Mental status assessment: GCS-E-…… V…….M…….
23. Pulse rate: _____(b/min)
24. Blood Pressure: _____(mmHg)
25. Weight: ____kg, Height: ____cm BMI-_____,
26. Edema presence (legs/ankles): Yes [ ] No [ ]
27. Ascites presence: YES [ ] NO [ ]
28. Dry skin and mucus membranes: YES [] NO []
29. Decreased skin turgor: YES [ ] NO [ ]
30. Decreased Urine output: YES [ ] NO [ ]
31. Lung crackles: PRESENT [ ] ABSENT [ ]
32. Jugular venous distention YES [ ] NO [ ]

Laboratory Tests

33. Serum Sodium (Na+):
    result: _____ mmol/L

    Classification (Tick one):

    Normal (135–145 mmol/L) [ ]

    Mild Hyponatremia (130–134 mmol/L) [ ]

    Moderate Hyponatremia (125–129 mmol/L) [ ]

    Severe Hyponatremia (<125 mmol/L) [ ]

Section F: Heart Failure Assessment

34. NYHA Classification (Tick one):

- Class I: No limitation of physical activity [ ]
- Class II: Mild limitation of physical activity [ ]
- Class III: Marked limitation of physical activity [ ]
- Class IV: Symptoms at rest [ ]

APPENDEX IV: DODOSO (KISWAHILI)

UHUSIANO WA UPUNGUFU WA SODIAMU KWENYE DAMU KWA WAGONJWA WATU WAZIMA WALIOLOAZWA NA SHINIKIZO LA MOYO KATIKA HOSPITALI YA JKCI, DAR ES SALAAM

1. Tarehe _____

2. Utambulisho_____

Sehemu A: Habari ya Kijamii

1. Umri: _____
2. Jinsia: Kiume [ ] Kike [ ]
3. Hali ya Ndoa: nimeolewa/nimeoa [ ] mtalaka [ ] Mjane [ ] sjaolewa/ sijaoa
4. Kiwango cha Elimu: Sijasoma [ ] Msingi [ ] Sekondari [ ] Chuo kikuu [ ]
5. Kazi anayofanya: _____
6. Hali ya Ajira:

Nimeajiriwa [ ] Sina ajira [ ] Nimejiari mwenyewe [ ]

7. Makazi:

Dar [ ] Nje ya DAR []

Sehemu B: Historia ya Matibabu

8. Je, umeshagundulikana kuwa na shinikizo la moyo? Ndiyo [ ] Hapana [ ]
9. Kama ndiyo, ulitambuliwa lini? (Mwaka/Mwezi): _____
10. Je, ECHO ya moyo inapatikana? Ndiyo [ ] Hapana [ ]
11. Je sehemu ya ejection ilikua ngapi kwenye ekokadiogramu? _____
12. Je, daktari aliwahi kukuambia kuwa una:
    - Shinikizo la damu? Ndiyo [ ] Hapana [ ]
    - Kisukari? Ndiyo [ ] Hapana [ ]
    - Matatizo ya figo? Ndiyo [ ] Hapana [ ]
    - Mlipuko wa damu? Ndiyo [ ] Hapana [ ]

13. Je, sasa unakunywa dawa za:

- Diuretics [ ]
- CCBs [ ]
- ARBs [ ]
- ACEIs [ ]
- Anti psychotics[ ]
- Anticonvulsants [ ]
- Nyinginezo : _____

Sehemu C: Dalili za Kikliniki

14. Je, ulikuwa na dalili zifuatazo hivi karibuni? (Chagua zote zinazohitajika)

- Kichefuchefu [ ]
- Kutapika [ ]
- Kuumwa kichwa [ ]
- Kuhangaika [ ]
- Udhaifu wa misuli [ ]
- Kutetemeka [ ]
- Ukakasi [ ]
- Kuanguka mara kwa mara [ ]

Sehemu D: Mtindo wa Maisha na Vidra vya Hatari

15. Je, umepewa ushauri wa kupunguza chumvi kwenye chakula? Ndiyo [ ] Hapana[]

16. Kama hapana, unakula vyakula vya chumvi mara ngapi? Mara kwa mara [ ] Mara chache [ ] Nadra [ ] Kamwe [ ]

17. Je, unavuta sigara? Ndiyo [ ] Hapana [ ]

18. Kama ndiyo- kiasi gani?

19. Je, unakunywa pombe? Ndiyo [ ] Hapana [ ]

20. Kama ndiyo kwa muda gani? chini ya miaka 10 [ ] au zaidi ya miaka 10[ ]

21. kila mda gani? Kila siku[ ] kila wiki [ ] au mara chache [ ]

Sehemu E: Uchunguzi wa Mwili na Matokeo ya Maabara

22. Tathmini ya Hali ya Akili: GCS-E-…… V…….M…….

23. Kiwango cha mpigo wa moyo: _____ (mpigo kwa dakika)

24. Shinikizo la damu: _____ (mmHg)

25. Uzito: ___*kg, Urefu: cm BMI-*

26. Uwepo wa uvimbe (miguu/vifundoni): IPO [ ] HAPANA [ ]

27. Uwepo wa maji tumboni (ascites): IPO [ ] HAPANA [ ]

28. Ngozi kavu na utando wa ute (mucus membranes): IPO [ ] HAPANA [ ]

29. Kupungua kwa unyumbufu wa ngozi (skin turgor): IPO [ ] HAPANA [ ]

30. Kupungua kwa mkojo: IPO [ ] HAPANA [ ]

31. Kelele za mapafu (lung crackles): IPO [ ] HAPANA [ ]

32. Kuvimba kwa mishipa ya shingo (jugular venous distention): IPO [ ] HAPANA [ ]

Vipimo vya Maabara

46. Sodiamu kwenye Seramu (Na+):

Matokeo: _____ mmol/L

Uainishaji (Chagua moja):

- Kawaida (135–145 mmol/L) [ ]
- Upungufu wa Sodiamu wa Kiwango cha Chini (130–134 mmol/L) [ ]

- Upungufu wa Sodiamu wa Kati (125–129 mmol/L) [ ]
- Upungufu Mkubwa wa Sodiamu (<125 mmol/L) [ ]

Sehemu F: Tathmini ya Kushindwa kwa Moyo

47. Uainishaji wa NYHA (Chagua moja):

- Daraja I: Hakuna kikomo cha shughuli za mwili
- Daraja II: Kikomo kidogo cha shughuli za mwili
- Daraja III: Kikomo kikubwa cha shughuli za mwili
- Daraja IV: Dalili zipo hata ukiwa umepumzika

APPENDIX V: KAIRUKI UNIVERSITY INSTITUTION REVIEW ETHICAL COMMITTEE REPORT

KAIRUKI UNIVERSITY (KU)

70 Chwaku Street,
Mikocheni,
P.O BOX 65300,
Dar es Salaam,
Tanzania.

Tel: +255-22-2700021/4
Fax: +255-22-2775591
Email: irec@ku.ac.tz
Website: www.ku.ac.tz

Ref. No. KU/IREC/27.10/562 **16 April, 2025**

Dr. Bilqis Salim Nassor,
Kairuki University,
70 Chwaku Street,
Mikocheni,
P. O. Box 65300.
Dar es Salaam, Tanzania.

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING HEALTH RESEARCH

I am pleased to inform you that the research titled: **Clinical Correlates of Hyponatremia among Hospitalized Patients with Heart Failure at JKCI, Dar es Salaam (Nassor, B. S., 2025)** has been granted ethical approval.

This approval is in effect for one year from the above date.

- Any changes in the procedures should be reported to the Institutional Research Ethics Committee.
- Significant changes will require the submission of a revised request for ethical approval.
- You will be required to submit **a study progress report** every six months.

Permission to publish your findings should be sought from the National Institute for Medical Research (NIMR) before submission to a publisher and not concurrently.

CHAIR PERSON

Name: Prof. Frederick Kaijage

Signature:

SECRETARY

Name: Prof. Columba Mbekenga

Signature:

DIRECTOR POSTGRADUATE ST... KAIRUKI UNIV... P. O. Box 653... AND RESEARCH INSTI...

APPENDIX VI: PERMISSION LETTER FOR DATA COLLECTION FROM JKCI HOSPITAL

UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH

JAKAYA KIKWETE CARDIAC INSTITUTE (JKCI)

JAKAYA KIKWETE CARDIAC INSTITUTE

In reply please quote;
Ref No: AB.123/307/01L/63 09/04/2025

Dr. Bilqis S. Nassor
MMed – Kairuki University

RE: PERMISSION TO CONDUCT RESEARCH AT JKCI

Reference is made to your letter requesting to do a research study entitled **"Clinical Correlates of Hyponatremia among Heart Failure Patients at Jakaya Kikwete Cardiac Institute, Dar es Salaam, Tanzania."** here at JKCI.

This letter serves as an official document that permits you to do the above-mentioned task as requested. However, the institution also requires you to have JKCI local co-supervisor

It is our sincere hope that you will adhere strictly to the rules and regulations governing good clinical practice. Your compliance with these standards will ensure the integrity and ethical conduct of your study.

JAKAYA KIKWETE CARDIAC INSTITUTE
P. O. Box 65141
Dar-es-Salaam
JKCI

Best Regards,

Dr. Pedro Pallangyo
Head of Research, Training and Consultancy.
CC: ALL DIRECTORATES & Head of Units

Jakaya Kikwete Cardiac Institute (JKCI); Upanga East Plot No. 1048, Kalenga Street, Malik Road, P. O. Box 65141 - Dar es Salaam; Telephone Number + 255 -22- 2152392Email:info@jkci.or.tz, Website: ww.jkci.or.tz.

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SCHOOL OF MEDICINE

DEPARTMENT OF INTERNAL MEDICINE

CLINICAL CORRELATES OF HYPONATREMIA AMONG HOSPITALIZED HEART FAILURE PATIENTS AT JKCI, DAR ES SALAAM.

BY

DR. BILQIS S NASSOR

REG. NO: HK/PG/DM/22/9022

SUPERVISOR: PROFESSOR YASSIN MGONDA

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF MEDICINE IN INTERNAL MEDICINE AT KAIBUKI UNIVERSITY.

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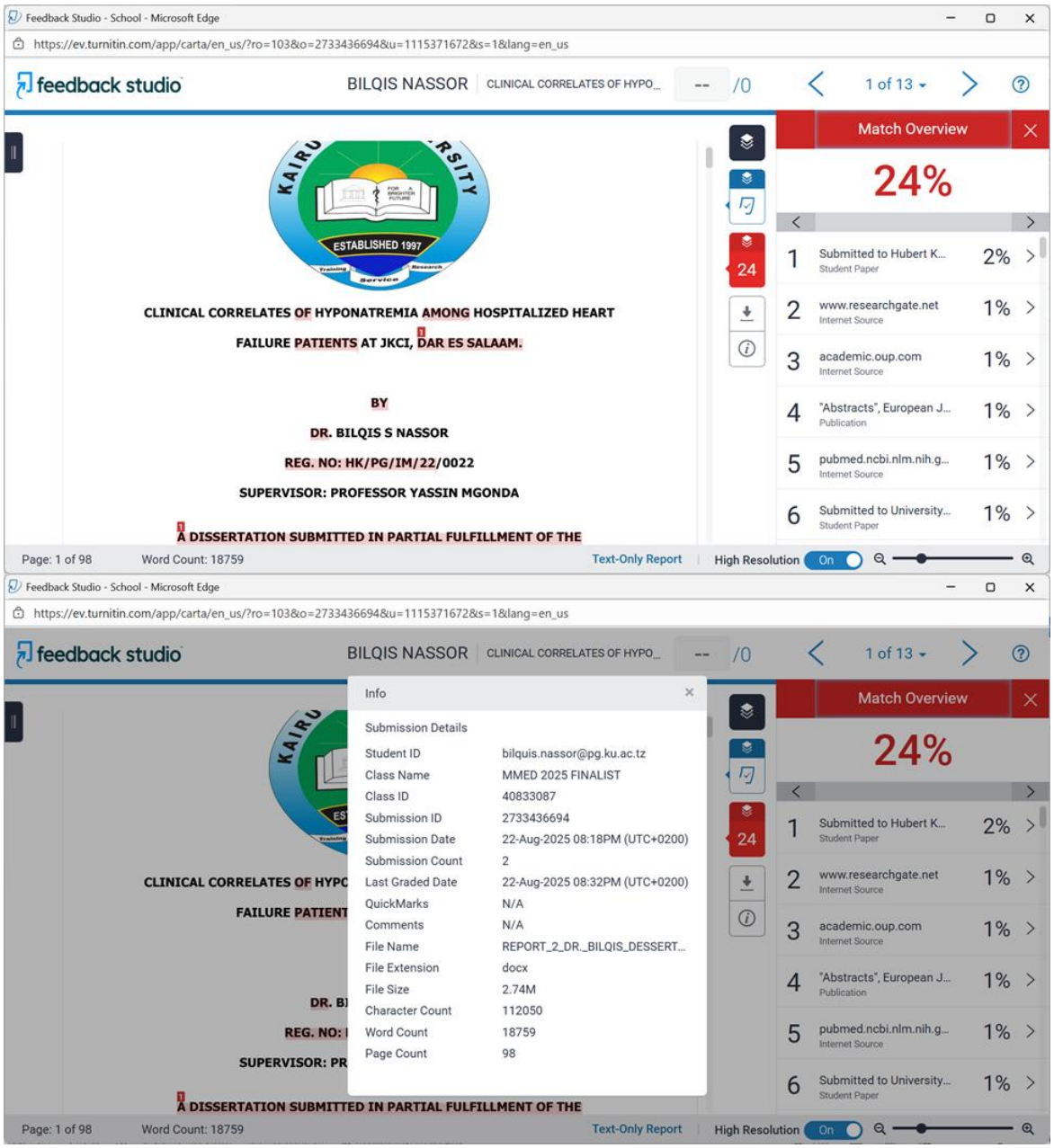
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