UNIVERSITY OF GHANA

SCHOOL OF PUBLIC HEALTH

DIALYSIS ADEQUACY AND ASSOCIATED FACTORS FOR END-STAGE RENAL DISEASE AT KORLE BU TEACHING HOSPITAL, ACCRA-GHANA IN 2018

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, COLLEGE OF HEALTH SCIENCES, UNIVERSITY OF GHANA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER'S DEGREE IN PUBLIC HEALTH.

DECLARATION

I, Amewu Etornam Kojo, declare that except for other works which have been duly acknowledged, this work is the result of my original research, and that as far as I am aware, this dissertation, either in whole or in part, has not been presented elsewhere for another degree.

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ABSTRACT

Background: Globally, achieving dialysis adequacy is a major concern for hemodialysis patients and clinicians. Dialysis adequacy measures the dose of dialysis required for a patient to obtain a long-term good prognosis. However, demographic, clinical, biochemical factors, and treatment characteristics affect this goal. Although several studies have been done around the world, no study has been done in Ghana to assess dialysis adequacy and associated factors for end-stage renal disease (ESRD).

Objective: This study evaluates dialysis adequacy and associated factors for ESRD at Korle Bu Teaching Hospital.

Method: A retrospective cross-sectional study of one hundred and sixty-seven (167) participants receiving hemodialysis at the Korle Bu Teaching Hospital was enrolled in the study. Data was collected, coded, and cleaned with Microsoft Excel 2016, and analyzed using Stata (version 18). Dialysis adequacy was determined using the urea reduction ratio (URR). URR was calculated as pre–urea–post–urea/pre-urea. URR values <0.65 and ≥0.65 were labeled as inadequate dialysis and adequate dialysis, respectively. The independent variables were categorized as socio-demographic, clinical, biochemical factors, and treatment characteristics. After the univariate logistic regression, variables found to be statistically significant at 0.05 were subjected to a multivariate logistic regression. Crude and adjusted odds ratios (OR) were reported with their p-values and corresponding 95% confidence intervals (CI).

Results: Among 167 hemodialysis patients, the prevalence of dialysis adequacy was 31.1% (95% CI: 24.6%–38.5%). Low hemoglobin (anemia) showed the strongest association with

reduced adequacy; patients with anemia had 93% lower odds of achieving adequacy in univariate analysis (cOR = 0.07, 95% CI: 0.03–0.19, p<0.001) and 87% lower odds after adjustment (aOR = 0.13, 95% CI: 0.04–0.42, p=0.001). Hypoalbuminemia was also associated with lower adequacy (cOR = 0.43, 95% CI: 0.22–0.85, p=0.016; aOR = 0.37, 95% CI: 0.15–0.87, p=0.023). Conversely, undergoing more than three dialysis sessions per week was linked to higher adequacy (cOR = 7.22, 95% CI: 3.38–15.42, p<0.001; aOR = 2.84, 95% CI: 1.11–7.27, p=0.030). Age, biochemical phosphate and calcium levels, vascular access type, and duration of dialysis were not significantly associated with adequacy.

Conclusion: In this study, only one-third (31.1%) of the patient population achieved dialysis adequacy at KBTH. This is a result of suboptimal clinical management, driven by anemia, hypoalbuminemia, and limited session frequency. Addressing these modifiable factors through targeted interventions, coupled with systemic improvements in healthcare service delivery, can enhance outcomes and reduce mortality risks. Collaborative efforts between clinicians, policymakers, and international partners are crucial to overcoming existing systemic barriers.

DEDICATION

To the Almighty God who granted me divine love and wisdom to produce this piece of work. To my parents, Mr. and Rev. Mrs. Amewu, and siblings, Esq John Mark Bekui, Nana Yaw Amewu, and Makafui Amewu, for their immense support throughout the journey. Also, to my dedicated supervisor, Professor Ernest Kenu, for his robust guidance and for inspiring me to pursue greater heights.

ACKNOWLEDGEMENT

I am grateful to the Almighty God, who granted me the strength and knowledge to produce this research work.

The quality of this work was through the rich guidance of my academic supervisor Professor Ernest Kenu.

I would like to thank Professor Vincent Boima and Dr. Adomako at the Korle Bu Teaching Hospital for their immense contributions to this work and throughout the MPH journey.

I am also very grateful for the support and care I received from my family.

I am grateful to the Korle Bu Teaching Hospital Renal and Dialysis Unit for their support and assistance.

Lastly, I am grateful to all who contributed in diverse ways to make this study a success.

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aOR	Adjusted odds ratio
BUN	Blood, Urea, and Nitrogen
CGN	Chronic glomerulonephritis
CI	Confidence interval
CKD	Chronic Kidney Disease
cOR	Crude odds ratio
DA	Dialysis Adequacy
DM	Diabetes Mellitus
ESRD	End Stage Renal Disease
GFR	Glomerular Filtration Rate
Hb	Hemoglobin
HIV	Human Immunodeficiency Virus
Kt/v	Clearance ratio
N	Frequency

NSAID	Non-Steroidal Anti-inflammatory Drug
RRT	Renal Replacement Therapy
UF	Filtration Volume
URR	Urea Reduction Rate
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1.1 Background

Globally, kidney diseases have remained a significant global public health concern. According to a World Health Organization (WHO) 2024 report, kidney diseases have moved from the 13th to the 10th leading cause of death globally, with a staggering mortality rate of 813,000 in 2000 to 1.3 million in 2019 (world health organisation, 2024) . In Africa, it is estimated that 1.4 million (1.3–1.5 million) cases and 127,158(113,401–142,425 cases) deaths were a result of kidney diseases in 2019. In 2015, the mortality figure was 116,436 [105,243 - 128,891], indicating a 10% rise in deaths. However, there were varying numbers of deaths in the different sub-regions. In West Africa, approximately 53,920 (41,737–68,749) kidney disease-related deaths occurred, and 54,265 deaths [45,468–64,685] occurred in East and Southern Africa. At the national levels in 2023 in Africa, Cape Verde, Sao Tome and Principe, and Seychelles recorded the lowest prevalence of kidney disease with 105 (92–118), 50 (39–59), and 44 (39–49), respectively. Nigeria recorded the highest prevalence of 20,045 (15,894 - 25,087), which is demographically like Ghana. Ethiopia and South Africa recorded a prevalence of 9, 860 (8,583 - 11,286), and 12,353 (11,414 - 13,224), respectively (*Noncommunicable Diseases | WHO | Regional Office for Africa*, 2023). In Ghana, the prevalence is 13% (Adjei et al., 2019). Chronic Kidney Disease (CKD) is a progressive condition characterized by a steady loss of kidney function over time, leading to a range of complications that can significantly influence a person's quality of life. The kidneys filter waste products, balance fluids and electrolytes, and control blood pressure. As CKD advances, these functions become hindered, causing the accumulation of waste products and fluids in the body, electrolyte imbalances, and hypertension (Thurlow et al., 2021) . End-stage kidney disease is expected to increase in prevalence in the next decade due to the increasing aging population, with increasing prevalence of diabetes and hypertension(Liyanage et al., 2015)

Dialysis or kidney transplantation are the two main Renal replacement therapies (RRT) widely used worldwide to manage people with end-stage kidney disease (Liyanage et al., 2015). About 2.62 million people globally were undergoing dialysis in 2010. In sub-Saharan Africa, there were 1.3 per million population on hemodialysis in Nigeria. Rwanda recorded the lowest prevalence of 1.2 per million population, with South Africa as the highest with 125 per million population on hemodialysis in 2013 (Naicker, 2013) . In Ghana, there were 652 patients on hemodialysis in 2018 (Tannor et al., 2018) . By 2030, the demand for dialysis is expected to double (Luyckx et al., 2018) . This is due to the increasing prevalence of non-communicable diseases (NCDs) such as hypertension and diabetes, and infectious conditions like human immunodeficiency virus (HIV) and malaria. Hemodialysis is the preferred form of dialysis by many clinicians in many countries as it performs vital kidney functions such as electrolyte and fluid balance, and waste removal (Tannor et al., 2023) . The effectiveness of hemodialysis is directly translated into patients' quality of life, survival rate, and returning to a point where dialysis is no longer needed. This is greatly dependent on dialysis adequacy.

Dialysis adequacy refers to the minimum dose of dialysis needed for a good prognosis in the long term (Owen et al., 1993). According to (Hothi, 2023) dialysis adequacy is assessed by urea clearance, quantified as urea reduction ratio (URR), single-pool, or equilibrated Kt/V. This quantifies the effectiveness of hemodialysis in clearing waste substances such as urea. Adequate dialysis has been proven to help avert uremic complications(Vadakedath & Kandi, 2017).

Countries such as Japan, Malaysia, the United Kingdom (UK), the United States of America(USA), Brazil, and Australia have over 75% of their patients achieve dialysis adequacy whereas 50-70% of patients on hemodialysis in China and The Cooperation Council for the Arab States of the Gulf (GCC) which consists of The Kingdom of Bahrain, the State of Kuwait, the Sultanate of Oman, the State of Qatar, the Kingdom of Saudi Arabia and the United Arab Emirates (*Gulf Cooperation Council (GCC) and the EU | EEAS*, 2023) are achieving dialysis adequacy. India and Tanzania have less than 50% of their patients on hemodialysis achieving dialysis adequacy(Bharati & Jha, 2020).

However, several factors can influence the effectiveness of hemodialysis. Studies in Iran and Tanzania have shown that more females achieved dialysis adequacy compared to men(Shahdadi et al., 2015; TEIXEIRA NUNES et al., 2008). This was due to the good health-seeking behavior of females compared to males(Bello et al., 2015). Also, the older you get, the odds of achieving dialysis adequacy(Rezaiee et al., 2016) are significantly decreased. This is due to reduced glomerular capillary plasma flow rate, glomerular capillary ultrafiltration coefficient, and structural changes that occur with increasing age(Weinstein & Anderson, 2010).

In sub-Saharan Africa and Ghana, increased infectious and parasitic diseases such as HIV and malaria, coupled with increased non-communicable diseases such as hypertension and diabetes, are significant contributing factors for CKD. The unavailability of dialysis centers and machines, the high costs of hemodialysis, and the lack of skilled personnel are also major factors associated with dialysis inadequacy(Naicker, 2013).

Diabetes, hypertension, and chronic glomerulonephritis are the three main causes of ESRD in the world(Jeong, 2023). Low proportions of Diabetic and/or hypertensive patients have been shown to achieve dialysis adequacy. This implies that being diabetic and/or with ESRD increases your chances of not achieving dialysis adequacy and mortality (Maciej Serda et al., 2013) . Although 70-80% of patients undergoing hemodialysis are hypertensive, it is not associated with dialysis adequacy(Agarwal et al., 2003; Ali Tayyebi et al., 2012; Sarafidis et al., 2017). Studies by (Cupisti & Kalantar-Zadeh, 2013) in the United States and Europe have shown that dialysis inadequacy is associated with hypoalbuminemia, hyperphosphatemia, hypercalcemia, and anemia. Albumin is an important indicator of nutritional status, protein, and an inflammatory biomarker. Therefore, Hypoalbuminemia is a strong predictor of mortality in dialysis patients, as it reflects both malnutrition and the inflammatory state in CKD (Cupisti & Kalantar-Zadeh, 2013) . Hyperphosphatemia is axiomatic in ESRD without serum phosphorus and supplemental phosphate binders. This increases the risk of developing secondary hyperparathyroidism. Hyperphosphatemia and hypercalcemia predispose ESRD patients to develop metastatic calcification (G. A. Block et al., 1998). These two contribute significantly to the increased mortality observed among patients with ESRD. Although normocytic, normochromic, and hyperproliferative anemia is typical in kidney patients, the risk of severe anemia is increased in patients with ESRD due to reduced production of erythropoietin production by the kidneys (Babitt & Lin, 2012) . Patients with hemolysis have compromised dietary iron absorption. Also, ESRD patients on hemodialysis lose about 1/3g per year of iron caused by bleeding from uremia-associated platelet dysfunction, frequent phlebotomy, and blood trapped in the dialysis apparatus(Babitt & Lin, 2010).

Several studies in Nigeria, Tanzania, Iran, the US, and the UK have shown that patients who have three or more dialysis sessions per week achieve dialysis adequacy (Bharati & Jha, 2020; Kurella & Chertow, 2005; Shahdadi et al., 2015) . This is largely dependent on the socioeconomic status of the patient, as dialysis care is paid out of pocket (Abene et al., 2017a; Eghan et al., 2009).

However, no study has been done to assess dialysis adequacy and associated factors for ESRD patients in Ghana. This study aims to evaluate factors affecting dialysis adequacy at Korle Bu Teaching Hospital, Accra-Ghana in 2018.

1.1.2 Problem Statement

End-stage kidney disease is a degenerative disease that affects over 800 million people globally, which is over 10% of the world's population(world health organisation, 2024). The US Centers for Disease Control and Prevention (CDC) estimates that over 37 million Americans, or approximately 15% of the adult population, have chronic kidney disease (CKD). In Ghana, the prevalence of CKD is 13.3%. CKD progresses inevitably to ESRD(Tannor et al., 2018).

Hemodialysis is the predominant form of renal replacement therapy in Ghana(Boima et al., 2019; Tannor et al., 2023). There were 625 patients on hemodialysis in Ghana in 2018 (Tannor et al., 2018) . Dialysis adequacy measures the minimum dialysis dose needed for good long-term outcomes (Owen et al., 1993) . Kt/V and urea reduction rate (URR) quantify the efficacy of a hemodialysis treatment session. Kt/V determines how much urea (K) is effectively removed in each patient at a certain time (t) (with a specific volume of distribution V for urea) (Garzotto et al., 2019), and URR determines how much urea is removed by each hemodialysis session. A

Kt/V of at least 1.2 and URR > 0.65 is paramount to achieving dialysis adequacy(Bharati & Jha, 2020; Somji et al., 2020a) . Dialysis adequacy has proven to improve patient outcomes significantly (Rocco et al., 2015) . However, the effectiveness of hemodialysis, measured as dialysis adequacy, is influenced by factors such as demographic, clinical, biochemical, and treatment characteristics. (Garzotto et al., 2019; Okyere et al., 2022; Rocco et al., 2001) .In the United States of America (USA), over 75% of patients undergoing hemodialysis were achieving dialysis adequacy, whereas in Iran and Tanzania, only 39.1% of patients were achieving dialysis adequacy(Somji et al., 2020a). Older age, diabetes, anemia, hypoalbuminemia, and late initiation of hemodialysis have been found to decrease the chances of achieving dialysis adequacy (Bakari et al., 2024; Jeong, 2023; Owen et al., 1993). According to (Toussaint et al., 2012), the mortality risk increases by 18% with each 1 mg/dL (0.32 mmol/L) elevation in blood phosphate, with a relative risk (RR) of 1.18 (95% confidence interval (CI) 1.12–1.25).In contrast, younger age, early initiation of dialysis, and having three (3) or more dialysis sessions per week have increased the chances of achieving dialysis adequacy (Bakari et al., 2024; Rezaiee et al., 2016). However, such proportions and associations are unknown in Ghana.

Inadequate dialysis leads to increased morbidity and mortality, increases the financial burden on patients, and decreases cognitive function(Aghsaeifard et al., 2022; Seyyedeh Sahereh Mortazavi Khatibani et al., 2022; Spiegel et al., 2008). The mortality rate attributed to renal diseases was 5.9% between 1994 to 2009 (Adjei et al., 2018) doubled between 2010 to 2013 (10.8%). Additionally, patients who do not attain dialysis adequacy undergo lots of psychological trauma with a high incidence of depression, often from constant anxiety from the sense of impending doom (Halili et al., 2021) and stress (Shdaifat et al., 2024). This is coupled with overwhelming dietary requirements, physical, and psychological restrictions, which can cause personal and social withdrawals. This makes coping with the disease very difficult (Spiegel et al., 2008) . However, no study has been done in Ghana to assess the factors associated with dialysis adequacy in ESRD patients. This could indicate that some patients undergoing hemodialysis may have inadequate dialysis due to these factors. Assessing clinical, biochemical, demographic factors, and treatment characteristics associated with dialysis adequacy will help guide clinical practice and optimize clinical outcomes in patients with ESRD at KBTH and around the world. This study will also serve as a stepping stone for further research.

1.1.3 Conceptual Framework

Narrative

The conceptual framework shows how dialysis adequacy is affected by four main factors: demographic factors, clinical factors, biochemical factors, and treatment characteristics. Furthermore, it shows how each factor relates to the others, ultimately affecting dialysis adequacy.

Sociodemographic factors (age, sex, and marital status) are a combination of social and demographic characteristics that affect dialysis adequacy. Some characteristics, such as age and sex, have been shown to influence treatment, which ultimately affects achieving dialysis adequacy. For example, several studies worldwide have reported higher proportions of younger individuals and females achieving dialysis adequacy. This is due to their good health-seeking behavior. Also, females and the younger are likely to get funds easily for their treatment (Abene et al., 2017a).

Treatment characteristics entail the duration of dialysis per session, frequency of dialysis per week, and type of vascular access. The more dialysis sessions you have in a week, the higher your chances of achieving dialysis adequacy. Three or more dialysis sessions per week are recommended to achieve this goal. Also, vascular access and duration of dialysis are likely to affect dialysis adequacy. Furthermore, clinical factors, which include comorbidities at the point of data collection, are likely to influence treatment characteristics and vice versa. For example, comorbidity such as anemia is directly associated with dialysis adequacy. However, good treatment characteristics improve anemia significantly. Clinical factors and treatment characteristics affect biochemical factors such as serum albumin, calcium, and phosphate levels, and vice versa.

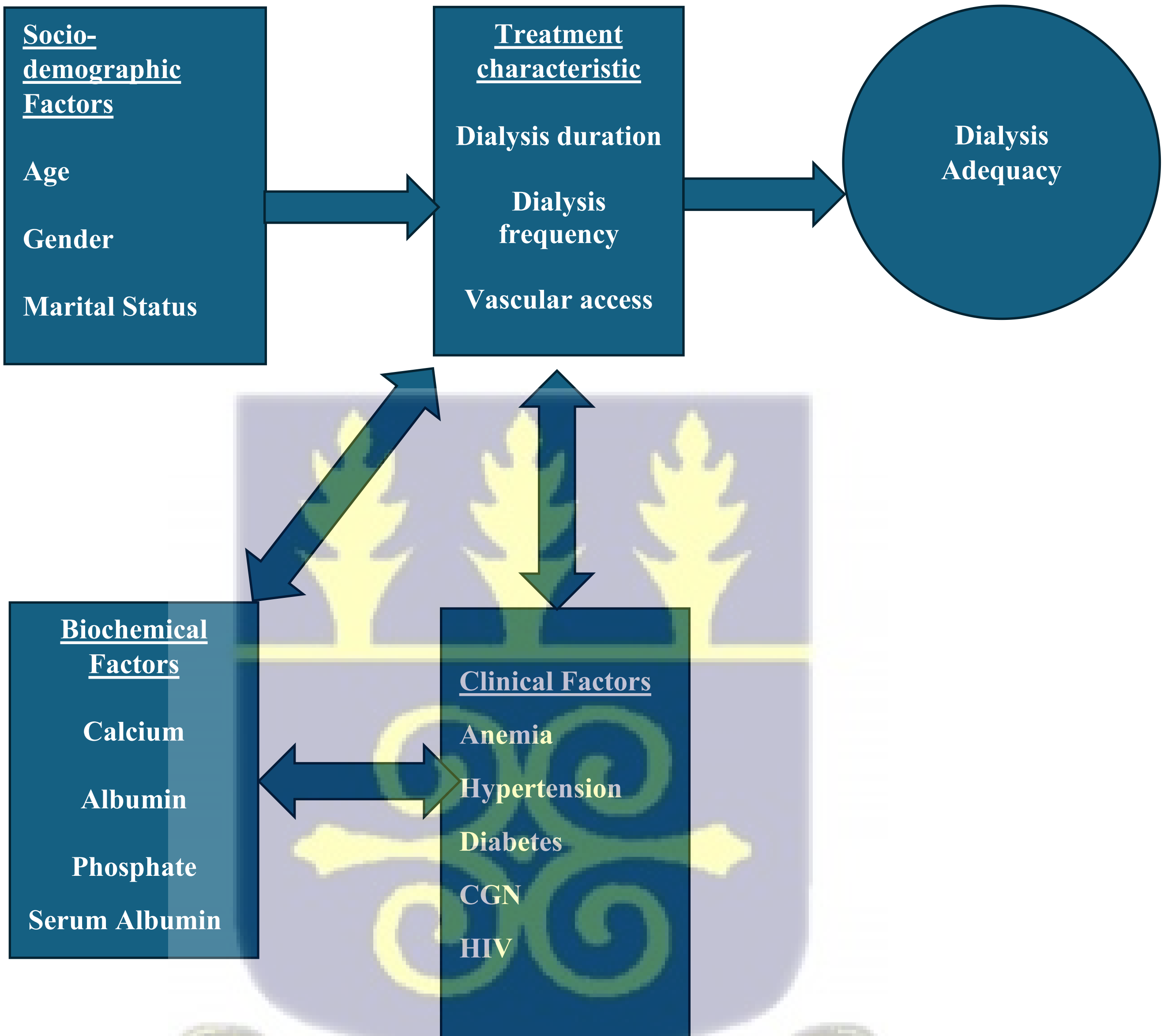


Figure 1.1.1 Conceptual Framework of the factors associated with dialysis adequacy

The conceptual framework presented in Figure 1.1.1 was designed by me based on a synthesis of relevant theories, empirical findings, and contextual considerations specific to this study. It reflects my interpretation and integration of these elements to guide the study.

1.1.4 Justification of Study

Several studies have been done globally to assess dialysis adequacy and its associated factors. However, no such research has been done in Ghana. Patients who achieve dialysis adequacy with well-controlled factors related to it have proven to decrease their chances of mortality and improve their quality of life. This study presents the opportunity for members of the Ghana Kidney Association to optimize dialysis care in the country. The findings from this research will help the association evaluate its renal and dialysis programs nationwide. It will also contribute to relevant data for use by the Ghana Renal Registry.

Lastly, this study will serve as a foundation for further research in dialysis adequacy and other factors not evaluated in this study.

Overall, this study addresses a growing public health concern in Ghana and helps inform policymakers and dialysis care providers.

1.1.5 Research question

1. What proportion of ESRD cases are adequately receiving dialysis?
2. Which socio-demographic factors are associated with dialysis adequacy at Korle Bu Teaching Hospital?

3. What clinical factors are associated with dialysis adequacy at Korle Bu Teaching Hospital?
4. What biochemical factors are associated with dialysis adequacy at Korle Bu Teaching Hospital?
5. Which treatment characteristics are associated with dialysis adequacy at Korle Bu Teaching Hospital?

1.1.6 Objectives of the Study

1.1.6.1 General Objectives

To evaluate the overall dialysis adequacy and factors associated with dialysis adequacy of end-stage renal disease at Korle Bu Teaching Hospital, Accra-Ghana in 2018.

1.1.6.2 Specific Objectives

1. To determine the proportion of cases with dialysis adequacy at Korle-Bu Teaching Hospital.
2. To determine the demographic factors associated with dialysis adequacy at Korle Bu Teaching Hospital.
3. To determine the clinical factors associated with dialysis adequacy at Korle Bu Teaching Hospital.
4. To determine the biochemical factors associated with dialysis adequacy at Korle Bu Teaching Hospital.

5. To determine the treatment characteristics associated with dialysis adequacy at Korle Bu Teaching Hospital.

CHAPTER TWO

LITERATURE REVIEW

2.1.1 Overview of chronic kidney disease (CKD)

CKD is defined as a persistent decline in kidney function, usually assessed through the glomerular filtration rate (GFR), over three months or more (Kidney Disease: Improving Global Outcomes [KDIGO], 2013) (Wilson et al., 2021). Similarly, (Ammirati, 2020) defined CKD as a clinical syndrome to the gradual, irreversible, and progressive structural and functional changes to the kidney. Although (*KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease - Kidney International*, 2024; Kovesdy, 2022) had similar definitions for CKD as defined by (Wilson et al., 2021) , they included albuminuria (typically defined as an albumin-to-creatinine ratio of >30 mg/g) as a criterion for defining CKD. Globally, hypertension and diabetes are the leading causes of CKD (Ngendahayo et al., 2019; Wilson et al., 2021; world health organisation, 2024) . Several factors, including genetic, environmental, and lifestyle determinants, influence the development of CKD. Common risk factors encompass hypertension, diabetes, obesity, and aging (Kovesdy, 2022). The pathophysiology of CKD involves complex interactions between these risk factors, leading to nephron damage, glomerulosclerosis, and progressive loss of kidney function. In sub-Saharan

Africa (SSA), coupled with hypertension and diabetes, there are increasing levels of infectious diseases such as HIV, malaria, (Kalima NA et al., 2015; Stanifer et al., 2014; Yirsaw, 2012) and the genetic predisposition to CKD (George et al., 2021) are the common causes of CKD. There are five stages of CKD based on GFR (Ammirati, 2020; Hashmi et al., 2023) and three stages based on albuminuria (*KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease - Kidney International*, 2024; Kovesdy, 2022) . A systematic review by (Kovesdy, 2022) revealed that about 10% of the global population has CKD. Out of this 10%, it is estimated that 70% live in low-income countries such as countries in Sub-Saharan Africa (SSA) (Ammirati, 2020; Kovesdy, 2022; Meremo et al., 2017; Ngendahayo et al., 2019; Stanifer et al., 2014; Thurlow et al., 2021). In Ghana, the proportion of people with CKD is 13.3%(Tannor et al., 2018). According to the World Health Organization report in 2024, mortality from CKD has surged from 813,000 in 2000 to 1.3 million in 2019 globally (world health organisation, 2024) . In Africa, an estimated 1.4 million cases (1.3–1.5 million) and 127,158 deaths (113,401–142,425 cases) are expected to result from renal disease. In 2015, this figure was 116,436 [105,243 - 128,891], indicating a 10% rise in deaths. End-stage renal failure is the terminal end of CKD with a GFR of less than 15 mL/min (Hashmi et al., 2023) and an albumin to creatinine ratio greater than 300mg/g(Pradeep Arora, 2024).

The International Society of Nephrology's (ISN) 2019 Global Kidney Health Atlas (GKHA) cross-sectional survey, which used available data from 79 countries, revealed that in 2019, there were 144 individuals per million general population (pmp) with ESRD (*Second Edition of ISN Global Kidney Health Atlas Now Available for Download - International Society of Nephrology*, 2019) . At a GFR of 30 mL/min, the National Kidney Foundation's Kidney Disease Outcomes

Quality Initiative (KDOQI) recommends that discussions on renal replacement therapy (RRT) are essential as a requirement (Hashmi et al., 2023; Preka & Shroff, 2023).

2.1.2 Renal Replacement Therapy

Renal replacement therapy (RRT) remains the mainstay for the management of ESRD(Liyanage et al., 2015). (Davies & Leslie, 2008) highlights the aim of RRT as:

1. Excessive fluid removal

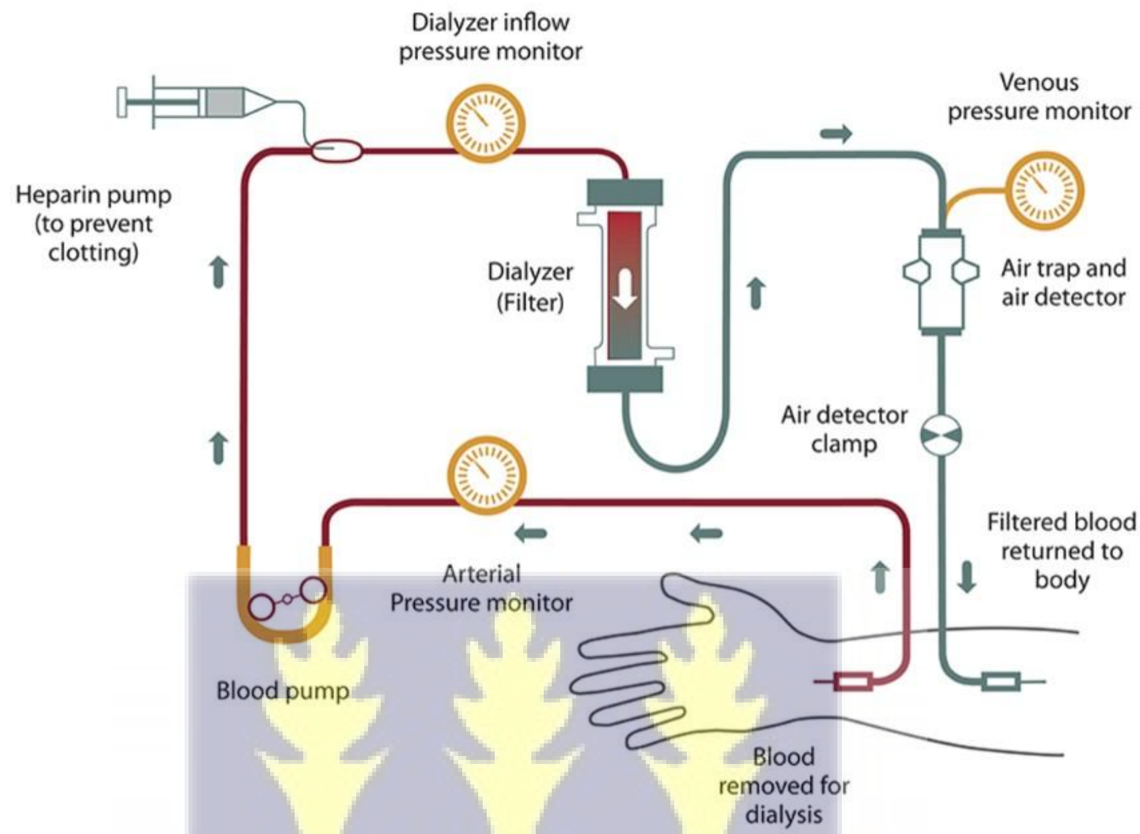
2. Solute clearance (e.g., refractory hyperkalemia, uremia, toxin removal)

RRT treatment modalities include dialysis (hemodialysis and peritoneal dialysis) and renal transplantation (Liyanage et al., 2015) . The choice of RRT modality is influenced by the availability of local resources (clinical, technical, and financial), clinical circumstances, and the indication for management(Preka & Shroff, 2023).

In Ghana, there are only two RRT options (Boima et al., 2019) . These are renal transplantation and hemodialysis. Hemodialysis is one of the main treatment options for clinicians in managing renal failure in Ghana due to the high cost of kidney transplantation (Tannor et al., 2018) . This process helps remove waste products, especially urea, from the body to prevent irreversible kidney damage (Bakari et al., 2024) . It is estimated that about 823 per million people are receiving hemodialysis globally (See et al., 2024) . In Ghana, there were 652 patients receiving hemodialysis in 2018 (Tannor et al., 2018). **Figure 1.2.1** shows the hemodialysis process, where contaminated blood (blood with high levels of urea) is drawn from the patient by the blood pump. Heparin is then administered to the drawn blood to prevent blood from clotting. Air entrance detection, pressure monitoring, and saline or heparin infusion are all done through the dialyzer's side ports connected to the bloodlines. The semi-permeable membrane of the dialyzer keeps the dialysate compartment from the blood compartment when pushed through it. The dialyzer bridges the Blood circuit and the Dialysis solution circuit(See et al., 2024).

2.1.3 Dialysis Adequacy Definition and Measurement

However, the effectiveness of hemodialysis is measured as dialysis adequacy. (Owen et al., 1993) defines dialysis adequacy as the minimum dose of dialysis needed for a good prognosis in the long term. Globally, this is evaluated by calculating Kt/v or urea reduction rate (URR). Kt/V is calculated using the following parameters: urea clearance (K), treatment duration (t), and volume of urea distribution (V). The manufacturer determines the filter clearance (K in the formula), and the duration (*t* in the formulation) of the dialysis is directly related to the adequacy of dialysis(Aghsaeifard et al., 2022; Bharati & Jha, 2020; Rocco et al., 2015). Therefore, Kt/V = - In (R-0.03) + [(4–3.5 R) × (UF ÷ W)], Where UF is the filtration volume in liters, W is the patient's weight after dialysis in kilograms, and R is the urea ratio after dialysis before dialysis(Aghsaeifard et al., 2022). URR is calculated as pre-urea – post-urea / 100 (Ashby et al., 2019; Bakari et al.,



2024). Image Source: National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)

Figure 1.2.1 Process of hemodialysis

2.1.4 Prevalence of Dialysis Adequacy

Dialysis adequacy varies widely based on healthcare infrastructure and resources. In high-income countries, the proportion of patients meeting dialysis adequacy standards is significantly higher due to the availability of advanced technologies, consistent monitoring, and trained healthcare providers. A study in the United States reported that over 85% of patients on hemodialysis achieved adequate clearance rates due to adherence to treatment protocols and the availability of high-efficiency dialyzers (Jha et al., 2013). Similarly, European countries report high adequacy rates because of standardized healthcare practices and equitable access to dialysis services (Bikbov et al., 2020). In Japan, the National Health System mandates frequent dialysis sessions of at least four hours, resulting in an adequacy rate of 85% nationwide (Bharati & Jha, 2020). Similarly, Germany and France enforce dialysis treatment durations of at least four hours per session, achieving better outcomes (Ashby et al., 2019). In north Iran, a cross-sectional, multi-center study conducted by (Seyyedeh Sahereh Mortazavi Khatibani et al., 2022) 51.2% of patients achieved adequate dialysis, as measured by Kt/v. A prospective longitudinal study in Tanzania by (Kilonzo et al., 2023) the prevalence of dialysis adequacy was 36.7% in Mwanza and 34.3% in Dar es Salaam, respectively. In West Africa, 34.3% of Nigerians achieve adequate dialysis based on URR, reflecting significant resource limitations, including shortages of dialysis machines and trained personnel (Abene et al., 2017a). Achieving dialysis adequacy reduces mortality, improves quality of life, and minimizes complications such as anemia, hypertension, and cardiovascular diseases(Elimby Ngande Lionel Patrick Joel et al., 2024).

However, resource limitations, cultural barriers, and economic disparities affect dialysis adequacy in low- and middle-income countries (LMICs). In these settings, achieving adequate dialysis is often challenging due to reduced session durations, infrequent treatments, and lower-quality equipment (Naicker, 2018). LMICs also face difficulties in maintaining continuous care due to financial constraints on patients and health systems, leading to a reduced proportion of patients meeting adequacy standards.

In Africa, dialysis adequacy rates are markedly lower compared to global averages, primarily due to limited healthcare infrastructure, economic constraints, and the high cost of treatment. Sub-Saharan Africa faces challenges, as the region has some of the lowest dialysis coverage globally, with 2–6 dialysis machines per million people, compared to over 30 machines per million in high-income countries (Naicker, 2018). These limitations often result in suboptimal treatment schedules, with many patients receiving fewer than the recommended three sessions per week (Elimby Ngande Lionel Patrick Joel et al., 2024).

Clinical practices in sub-Saharan Africa further contribute to inadequate dialysis outcomes. Studies in Nigeria and Kenya have reported that only 30-40% of dialysis patients achieve recommended Kt/V or URR targets, mainly due to irregular access to dialysis services and inconsistent monitoring (Abene et al., 2017b) . Furthermore, vascular access type significantly influences dialysis adequacy, with patients using temporary catheters showing lower adequacy rates than those with arteriovenous fistulas (AVFs) (Liyanage et al., 2015).

2.1.5 Factors Associated with Dialysis Adequacy

2.1.5.1 Socio-demographic factors

Demographic factors, such as age, sex, and marital status also play a significant role. Age-related trends are reported in the United States, where older patients face greater comorbidity burdens and reduced urea clearance rates (Weinstein & Anderson, 2010). Additionally, a study in Japan found that patients below age 50 were twice as likely to achieve dialysis adequacy compared to older age groups, largely due to fewer underlying conditions and better tolerance of prolonged sessions (Bharati & Jha, 2020). In Pakistan, age-related disparities were also noted, where patients younger than 40 years achieved adequacy rates of 45%, significantly higher than their older counterparts (Anees, 1969). A study in Italy highlighted that elderly patients (≥65 years) often face challenges such as cardiovascular complications and frailty, reducing the likelihood of achieving dialysis adequacy (Ashby et al., 2019). Older patients usually experience lower adequacy rates due to reduced physiological resilience and higher comorbidity burdens, such as diabetes and hypertension (Cupisti & Kalantar-Zadeh, 2013). Meanwhile, younger patients from higher socioeconomic backgrounds are more likely to achieve adequate dialysis due to better access to healthcare resources and the ability to afford longer or more frequent sessions (Bakari et al., 2024).

Similar Gender and marital status have been inconsistently associated with dialysis adequacy. A study in Pakistan found that males were more likely to achieve adequacy due to physiological differences in muscle mass and metabolic rate (Anees, 1969). In contrast, studies from Tanzania and Rwanda found no significant gender differences in adequacy rates, suggesting that cultural or resource factors may play a role in bridging gender disparities (Somji et al., 2020; Ndahayo et al., 2021). In Japan, research indicated a slightly higher adequacy rate among females, attributed to better adherence to prescribed dialysis regimens (Bharati & Jha, 2020). Similarly, a study in Brazil highlighted that while no inherent physiological advantage was noted for either gender, females reported higher compliance with dietary and medication protocols, positively influencing outcomes (Ashby et al., 2019).

2.1.5.2 Clinical Factors

Hypertension is the most common comorbidity among dialysis patients. A study in Japan similarly highlighted that well-controlled hypertension through medication adherence significantly improved dialysis adequacy rates (Bharati & Jha, 2020). In Saudi Arabia, interventions targeting hypertension through dietary modifications and antihypertensive therapies have shown a 20% improvement in dialysis adequacy among patients with chronic kidney disease (Ashby et al., 2019). In contrast, the combined burden of hypertension and diabetes significantly impairs dialysis outcomes, as shown in Nigerian and Indian studies (Abene et al., 2017b; Kurella & Chertow, 2005). Research from South Africa echoes these findings, where patients with dual comorbidities of hypertension and diabetes exhibited significantly lower adequacy rates, driven by compounded metabolic demands and poorer vascular health (Naicker, 2013).

Anemia is a critical clinical factor in determining dialysis adequacy. Interventions in the United States and Europe, including nutritional supplementation and iron therapy, have reduced inadequacy rates by up to 20% (Kaysen, 2003; Block et al., 1998). In Japan, introducing continuous monitoring and individualized nutritional plans has resulted in a 25% improvement in dialysis adequacy rates (Bharati & Jha, 2020). Similarly, in Canada, integrated care models combining erythropoiesis-stimulating agents and dietary interventions have been shown to enhance hemoglobin levels, improving overall dialysis outcomes by 30% (Kaysen, 2003). In South Korea, targeted protocols focusing on correcting anemia and protein energy wasting resulted in a significant reduction in mortality rates among hemodialysis patients, highlighting the critical role of holistic care (Li et al., 2023). These approaches underline the importance of comprehensive care in addressing clinical contributors to dialysis adequacy, even in diverse healthcare systems.

2.1.5.3 Biochemical Factors

Biochemical markers such as hypoalbuminemia, low hb levels, and hyperphosphatemia are prevalent in African ESRD patients and negatively impact dialysis adequacy. (Cernaro et al.,

2023) found that uncontrolled phosphate levels were associated with higher mortality risks, as inadequate dialysis limits the removal of toxins. (Eghan et al., 2009) found that patients with hypoalbuminemia were less likely to achieve dialysis adequacy, as it reflects malnutrition and inflammation, which exacerbate ESRD complications. Low serum albumin (≤2.5 g/dL) is consistently associated with inadequate dialysis, as seen in studies from Brazil and the United States (Ashby et al., 2019; Burrowes et al., 1993). A study in India reported that patients with serum albumin levels below 3 g/dL were 40% less likely to achieve dialysis adequacy (Kurella & Chertow, 2005). In the Ethiopian context, hypoalbuminemia among dialysis patients is strongly linked to increased hospitalizations and mortality (Ali Tayyebi et al., 2012) . Research from Canada further supports these findings, emphasizing that nutritional interventions targeting albumin improvement significantly enhance patient outcomes (Kaysen, 2003).

Furthermore, the limited availability of erythropoiesis-stimulating agents and phosphate binders restricts the ability of healthcare providers to manage anemia and hyperphosphatemia effectively. Hyperphosphatemia is a sure accompaniment among ESRD patients without dietary phosphate restriction or supplemental phosphate binders. Hyperphosphatemia, often indicative of poor dietary phosphate control, affects over 99% of dialysis patients in resource-limited settings such as Ghana and aligns with similar findings from South Korea (Li et al., 2023) . In Spain, implementing comprehensive phosphate management protocols reduced hyperphosphatemia prevalence by 25%, demonstrating the importance of dietary and pharmacological interventions in managing this marker (Ashby et al., 2019). In a cross-sectional study of two special studies of the United States Renal Data System, the Case Mix Adequacy Study (1990) and the Dialysis Morbidity and Mortality Study Wave 1 (1993) done by (G. Block et al., 1998), the risk of death from high serum phosphate levels (hyperphosphatemia) was increased markedly. Therefore, the significance of maintaining normal phosphate levels is echoed by Japanese studies, where patients with controlled phosphate levels had an 80% improvement in survival rates (Bharati & Jha, 2020).

Although hypercalcemia is a prevalent consequence of advanced chronic renal disease, it contributes to increased morbidity and mortality (Cernaro et al., 2023). In a cross-sectional study by (Seyyedeh Sahereh Mortazavi Khatibani et al., 2022) patients with normal calcium levels achieved adequate dialysis compared to those with high and low serum calcium levels. Findings from Rwanda and India show that low hb substantially reduces dialysis adequacy due to insufficient oxygen transport and inflammation (Ndahayo et al., 2021; Kurella & Chertow, 2005). It is universally known that low hb is a common complication of patients on dialysis and patients having inadequate dialysis (URR<0.65) require more erythropoietin and iron supplementation to manage anemia (Li et al., 2023). Adequate hemodialysis is a prerequisite for improving anemia among hemodialysis patients (Ayesh et al., 2014). A study in Brazil also demonstrated that integrating iron supplementation and regular administration of erythropoietin resulted in a 20% improvement in dialysis adequacy rates (Ashby et al., 2019). Similarly, in the United States, comprehensive anemia management protocols that included targeted iron therapy and erythropoiesis-stimulating agents achieved a 15% reduction in inadequacy among chronic kidney disease patients (Babitt & Lin, 2010). In South Africa, addressing anemia with erythropoietin therapy improved adequacy rates by 15% over 12 months (Naicker, 2013). Additionally, Japanese studies have shown that continuous monitoring and adjustment of hemoglobin levels led to significant increases in patient survival and dialysis success rates (Bharati & Jha, 2020).

2.1.5.4 Treatment Characteristics

Frequent and prolonged dialysis sessions are pivotal in achieving adequacy. Japanese guidelines recommend four-hour sessions at least three times weekly, resulting in 85% adequacy rates nationwide (Bharati & Jha, 2020). In Germany and France, mandates for session lengths of four hours or more significantly reduced long-term complications (Ashby et al., 2019). Conversely, fewer than three sessions weekly, common in Sub-Saharan Africa, are associated with markedly lower adequacy rates, as reported in Tanzania (Somji et al., 2020). This is due to financial constraints which often force patients to miss scheduled sessions or reduce session duration, further compounding the problem. Many patients can only afford one or two sessions per week, below the recommended three sessions, leading to reduced toxin clearance and increased complications (Eghan et al., 2009).

Arteriovenous fistulas are considered the gold standard, with studies in South Africa showing a 30% higher adequacy rate compared to patients using catheters (Naicker, 2013). The reliance on temporary catheters instead of AVFs in Ghana contributes to inadequate dialysis due to frequent infections and poor blood flow rates (Adjei et al., 2019). In Brazil, efforts to increase fistula use have improved adequacy rates by 10% over two years (Ashby et al., 2019).

Dialysis adequacy remains a critical issue globally, with significant disparities between high-income countries and low-resource settings like sub-Saharan Africa and Ghana. While advanced healthcare systems ensure better outcomes in developed countries, systemic barriers such as limited resources, financial constraints, and inadequate monitoring contribute to suboptimal dialysis adequacy in Africa. Despite these challenges, there are ongoing efforts to improve dialysis adequacy in Africa. Increasing training for healthcare providers, advocating for public-private partnerships to subsidize dialysis costs, and improving patient education on adherence to treatment protocols have shown promise in enhancing dialysis outcomes across the continent (Naicker, 2018). Nutritional support, frequent dialysis, and better management of comorbidities have also demonstrated success globally.

Addressing these issues requires comprehensive interventions, including increasing healthcare investments, expanding dialysis facilities, and improving patient education on adherence to treatment protocols.

CHAPTER THREE

METHODS

3.1.1 Study design

This study was a health facility-based retrospective cross-sectional study employing a quantitative approach. It analyzed data from the Korle Bu Teaching Hospital Dialysis unit database on patients with ESRD who were on hemodialysis in 2018.

Study Area

Founded on October 9, 1923, Korle Bu Teaching Hospital is Ghana's top tertiary healthcare center. Equipped with 21 clinical and diagnostic departments/units and over 2000 beds, it is the largest hospital in Ghana, the third-largest referral hospital in Africa, and has three Centres of Excellence. It also has an average of 1,500 outpatient visits and around 250 inpatient hospitalizations daily (Okyere et al., 2022) . Most cases KBTH receives come from Ghana's central to southern regions, and sometimes from the northern areas. Additionally, it receives cases from Burkina Faso, Nigeria, Togo, and other African nations.(Korle-Bu Teaching Hospital – Excellence in Healthcare, 2020).

The renal and dialysis unit is a specialized facility under the medicine and therapeutic department that provides the following services:

-Management of acute renal failure and kidney disease

-screen, perform, and follow up on kidney transplant patients

-Epidemiological research

-Hemodialysis of patients

The unit is headed by Dr. Edward Kwakye. It has five (5) nephrologists, nine (9) medical officers, sixteen (16) residents, two (2) house officers, and fifty-nine (59) nurses.

3.1.2 Sampling

3.1.2.1 Study Population

The study included patent records with ESRD on hemodialysis at Korle Bu Teaching Hospital in 2018.

Sample size calculations were performed assuming a baseline prevalence of 13%, two-sided α = 0.05, and 80% power. For equal group allocation, detecting a 15 percentage-point difference (13% vs. 28%) required 110 participants per group (246 after 10% missing-data inflation). Smaller effect sizes (5–10 pp) required substantially larger samples, while larger effects (20 pp) required fewer participants. Under unequal allocations (2:1 or 3:1), the required total sample increased, reflecting a loss of efficiency. With a fixed smaller group (n_1 = 139), the detectable effect size was constrained, requiring at least 249 total participants to detect a 15-pp difference after accounting for 10% missing data.

Although power calculations indicated that detecting a 15%-point difference in adequacy would require approximately 246 participants (after accounting for 10% missing data), the present study relied on a census of 167 patients undergoing hemodialysis at Korle Bu Teaching Hospital in 2018. Since the sample size was fixed by the available population, the study may be underpowered to detect small to moderate differences in dialysis adequacy across subgroups. Consequently, results will be interpreted with caution, acknowledging that true associations of clinical relevance may not reach statistical significance due to limited statistical power.

3.1.2.2 Inclusion Criteria

1. Patent records with ESRD undergoing hemodialysis at KBTH in 2018
2. Patent records with complete sociodemographic, clinical/comorbidities, and treatment characteristic information.
3. Patent records with completed laboratory information on blood urea and nitrogen test (BUN), vital electrolytes such as potassium and calcium, and complete blood count (CBC).
4. Patent records of patients who are older than 12 years.

3.1.2.3 Exclusion Criteria

1. Patent records without evidence of ESRD or those not undergoing hemodialysis at KBTH in 2018.
2. Patent records with incomplete sociodemographic, clinical/comorbidity, or treatment characteristic information.
3. Patent records missing laboratory data, specifically blood urea electrolyte (BUE), other electrolytes (potassium, calcium), or complete blood count (CBC).
4. Patent records of patients aged 12 years or younger.

3.1.2.4 Sample Size Determination and Technique

A census sampling technique was used. This method included all participants who met the inclusion criteria. Only 167 participants met the inclusion criteria. Fifteen participants did not meet the inclusion criteria.

3.1.2.5 Collection Technique and Tool

Patent data was extracted from the hospital's electronic data into an Excel spreadsheet.

3.1.2.6 Variables for Analysis

The study variables were grouped into dependent (Table 3.1) and independent (Table 3.2).

3.1.2.7 Dependent Variable

Table 3.1 **The dependent variable for the study**

Variable	Definition	Scale of Measurement	Definition of Scale of Measurement
Dialysis Adequacy	Dialysis adequacy achieved by patients on hemodialysis at KBTH in 2018	Ordinal categorical	0 = URR <65% (inadequate dialysis) 1= URR ≥ 65% (adequate dialysis)

3.1.2.8 Independent Variables

Table 3.2 Independent variables for the study

Variable	**Definition**	**Scale of Measurement**	**Definition of Scale of Measurement**
Sociodemographic factors			
Age	Age of participant in years as of last birthday	Ordinal	1= <20 2= 20-29 3= 30-39 4= 40-49 5= >=50
Sex	Sex of participant	Nominal categorical	1=Male 2=Female
Marital status	Marital status of the participant	Nominal categorical	1=Married 2=Separated

			3=Widowed 4=Single
Clinical Factors (Comorbidity)			
Anemia	Hemoglobin level of participants	Ordinal categorical	0= Hb≥9.0g/dl (normal) 1= Hb<9.0g/dl (anemia)
Other comorbidities	Comorbidities of participants	Nominal categorical	1=CGN 2=DM 3=HIV 4=Hypertension 5=Hypertension and DM 6=Others (pneumonia, etc)

Biochemical Factors			
Serum albumin levels	Serum albumin levels of participants	Ordinal categorical	0= hypoalbuminemia (<35g/l) 1= normal (35-55 g/l) 2= hyperalbuminemia (>55 g/l)
Serum phosphate levels	Serum phosphate levels of participants	Ordinal categorical	0= hypophosphatemia (<1.12 mmol/L) 1= normal (1.12 - 1.45 mmol/L) 2= hyperphosphatemia (>1.45 mmol/L)

Serum calcium levels	Serum calcium levels of participants	Ordinal categorical	0= hypocalcemia (<2.25 mmol/L) 1= normal (2.25 - 2.62 mmol/L) 2= hypercalcemia (>2.62 mmol/L)
Treatment characteristics			
Hours per session	Duration of hemodialysis in hours per session	Ordinal categorical	1= 3 hours 2= 3.5 hours 3= 4 hours
Duration of hemodialysis	Duration of hemodialysis from the onset of clinical diagnosis (ESRD)	Ordinal categorical	1= less than 12 months 2= 12 – 24 months 3= more than 24 months

Frequency of hemodialysis	The number of times participants undergo hemodialysis in a week	Ordinal categorical	1= less than 3 sessions per week 2= 3 or more sessions per week
Vascular access	Vascular route for hemodialysis of participants	Nominal categorical	1= catheter 2= femoral 3= fistula

3.1.3 Data Management and Analysis

Data was collected from the KBTH's database, coded, cleaned with Microsoft Excel 2016, and analyzed using Stata (version 18). A total of 182 patients were included in the initial dataset. Fifteen patients were excluded as they did not meet the inclusion criteria due to incomplete data, resulting in a final analytic sample of 167 participants. The only derived variable generated was the Urea Reduction Ratio (URR), calculated by subtracting post-dialysis urea values from pre-dialysis urea values and dividing the result by 100. The outcome variable (URR) was dichotomized as adequate dialysis and inadequate dialysis. All variables were recoded into their respective categorical formats as outlined in Table 3.2. The variables dry weight, pre-weight, weight, white blood cell count (WBC), neutrophils, lymphocytes, and eosinophils were excluded from the final dataset. No data files were merged during the data management process.

Descriptive statistics, including mean (standard deviation), were used for the numeric variables. Frequency and percentages were presented as categorical variables. The association between the factors and the outcome was determined using Pearson's chi-square ($\chi2$). For variables with expected values less than 5, a Fishers test. Variables with a p-value <0.1 from Fisher's exact and Pearson's chi-square ($\chi2$) were used for the univariate regression analysis. After the univariate logistic regression, variables found to be statistically significant at 0.1 were subjected to a multivariate logistic regression. Crude and adjusted odds ratios (OR) were reported with their p-values and corresponding 95% confidence intervals (CI).

Variables that were excluded from the logistic regression analysis on account of having p-values to more than 0.1 include marital status, comorbidities, serum calcium level, serum phosphate, hours per session, vascular access, and duration of dialysis.

3.1.4 Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board, Korle Bu Teaching Hospital. Patient confidentiality was strictly established by assigning unique codes to participants before analysis to protect patient privacy. Data were stored securely, while access had been restricted to only authorized personnel.

CHAPTER FOUR

RESULTS

4.1.1 Social Demographic Characteristics

This study involved 167 participants undergoing hemodialysis at the Korle Bu Teaching Hospital. The participants' mean (SD) age was 48.93 ± 1.20 years. **Table 4.1** shows the distribution of socio-demographic characteristics of the participants.

Table 4.1 Distributions of Socio-demographic Characteristics of Participants. (N=167)

Variable	Category	Frequency(n)	Percent (%) (95%CI)
Age (Mean ± SD)		48.93 ± 1.20	
Age	<20	7	4.2 (2.9 – 9.1)
	20-29	12	7.2 (4.0 – 12.2)
	30-39	28	16.8 (12.8 – 23.2)
	40-49	32	19.2 (14.3 – 26.1)
	>=50	88	52.7 (45.0 – 60.2)
Sex	Male	116	69.5 (62.8 – 76.0)
	Female	51	30.5 (24.0 – 38.0)
Marital status	Married	124	74.3 (67.0 – 80.3)
	Separated	7	4.2 (2.9 – 9.9)

Single	28	16.8 (11.7 – 23.2)
Widow	8	4.8 (2.3 – 9.3)

Table 4.2 Distributions of Clinical/Comorbidity of Participants.

Clinical/Comorbidity Factor	Frequency	Percent (%) (95%CI)
Anemia	138	82.6 (76.1 - 87.7)
Hypertension	102	61.1 (53.4 - 68.2)
Diabetes	13	7.8 (4.5 - 13.0)
Hypertension and Diabetes	18	10.8 (6.9 - 16.5)
CGN	10	6 (1.6 - 7.8)
HIV	9	5.4 (2.8 - 10.1)
Other causes	19	11.4 (7.3 - 17.2)

4.1.2 Prevalence of Dialysis Adequacy by Sociodemographic Factors

Table 4.5 shows the prevalence of dialysis adequacy among each socio-demographic factor. Out of 167 participants, 115 (68.9%) had inadequate dialysis, and 52 (31.1%) had adequate dialysis. The highest prevalence for dialysis adequacy was among males, 33(63.5%), those aged between 30-39, 17 (32.7%), and married 38(73.1%). The Chi-square test ($\chi 2$) of statistics for age only was found to be statistically significant ($p < 0.001$).

Table 4.3 Distributions of Biochemical Factors of Participants.

Biochemical Factors	Frequency	Percent (%) (95%CI)
Hypoalbuminemia	78	46.7 (39.2 - 54.4)
Normal serum albumin	89	53.3 (45.6 - 60.8)
Hyperalbuminemia	0	0
Hypophosphatemia	0	0
Normal serum phosphate levels	2	1.2 (0.3 - 4.7)
Hyperphosphatemia	165	98.8 (95.3 - 99.7)
Hypocalcemia	9	44.3 (36.9 - 51.9)
Normal serum calcium levels	84	50.3 (42.7 – 57.9)
hypercalcemia	74	5.4 (2.8 - 10.1)

4.1.3 Prevalence of Dialysis Adequacy by comorbidities/ clinical factors

Among the comorbidities of ESRD participants on hemodialysis, the majority [102 (61.1%)] were diagnosed with hypertension. Nineteen (11.4%) participants were diagnosed with other causes. 18 (10.8%) participants had both diabetes and hypertension. Thirteen (7.8%) participants were diagnosed with DM, 9 (5.4%) with HIV, and 10 (6%) with CGN. Among all the participants, 138 (82%) were diagnosed with anemia**.** **Table 4.2** illustrates the distribution of clinical factors. Comorbidities/ clinical factors were not statistically significant (p=0.832) using Pearson's Chi-square. **Table 4.6** illustrates the prevalence of dialysis adequacy by comorbidities/ clinical factors.

Table 4.4 Distributions of Treatment Characteristics of Participants.

Treatment characteristics	**Frequency**	**Percent (%) (95%CI)**
Hours per Session		
3 hours	19	11.4 (7.3 - 17.2)
3 hours 30 minutes	108	64.7 (57.1 – 71.6)
4 hours	40	23.9 (18.0 - 31.1)
Vascular Access		
Fistula	139	83.2 (76.7 - 88.2)
Perm catheter	22	13.2 (8.8 - 19.3)
Femoral vascular	6	3.6 (1.6 - 7.8)
Frequency of Dialysis per Week		
Less than 3 times a week	44	73.7 (66.4 - 79.8)
3 or more times a week	123	26.3 (20.2 – 33.6)
Duration of Dialysis		
12 months or less	26	15.6 (10.8 – 21.9)
13 months and 24 months	49	29.3 (22.9 – 36.8)

24 months or more	92	55.1 (47.4 – 62.5)

4.1.4 Prevalence of Dialysis Adequacy by Biochemical Factors

As shown in **Table 4.3**, participants with normal albumin levels were 89 (53.3%), whereas those with low albumin levels (hypoalbuminemia) were 78 (41.7%). More participants had high serum phosphate levels 165, (98.8%), and very few had normal serum phosphate levels 2 (1.2%). Nine (5.4%) participants had low serum calcium levels (hypocalcemia), 84 (50.3%) participants had normal serum calcium levels, and 74 (44.3%) participants had high serum calcium levels.

Table 4.5 Prevalence of Dialysis Adequacy by Socio-demographic Factors

Variable	**Inadequate dialysis** **N (%) = 115(68.9%)**	**Adequate dialysis** **N (%) =52(31.1%)**	**χ2**	**p-value**
Age			29.226	**<0.001**
Less than 20	5 (4.3)	2 (3.8)		
20-29	3 (2.6)	9 (17.3)		
30-39	11 (9.6)	17 (32.7)		
40-49	25(21.7)	7 (13.5)		
50 and above	71 (61.7)	17 (32.7)		
Sex			1.281	0.258
Female	32(27.8)	19(36.5)		

Male	83(72.2)	33(63.5)		
Marital status			0.616	0.893
Married	86(74.8%)	38(73.1)		
Separated	4(3.5%)	3(5.8)		
Widowed	6(5.2%)	2(3.8)		
Single	19(16.5%)	9(17.3)		

Patients with normal serum calcium levels recorded the highest prevalence of dialysis adequacy at 29 (55.8%).

Table 4.6 Prevalence of Dialysis Adequacy by comorbidities/ clinical factors

Variable	**Inadequate dialysis**	**Adequate dialysis**	**χ2**	**p-value**
	N (%) = 115(68.9%)	**N (%) =52(31.1%)**		
Comorbidities			2.123	0.832
CGN	4 (3.5)	2 (3.8)		
DM	11 (9.6)	2 (3.8)		
HIV	7 (6.1)	2 (3.8)		
Hypertension	68 (59.1)	34 (65.4)		
Hypertension and DM	12 (10.4)	6 (11.5)		
Others	13 (11.3)	6 (11.5)		

Hemoglobin levels and serum albumin levels were statistically significant ($p < 0.001$ and $p=0.015$, respectively) using Pearson's Chi-square. This is shown in **Table 4.7**.

4.1.5 Prevalence of Dialysis Adequacy by Treatment Characteristics

The hours per hemodialysis session are enumerated in **Table 4.4**. Most participants [108 (64.7%)] had 3 hours and 30 minutes of hemodialysis per session. Forty (23.9%) and 19 (11.4%) participants had 4 and 3 hours of hemodialysis per session, respectively.

Most participants, 139 (83.2%), had a fistula as their vascular access for hemodialysis. Twenty-two (13.3%) had a perm catheter, and 6 (3.6%) had femoral vascular access. Ninety-two (55.1%) off participants have been on hemodialysis for at 24 months or more as shown in **Table 4.4.**

Table 4.7 Prevalence of Dialysis Adequacy by Biochemical Factors

Variable	**Inadequate dialysis N (%) = 115(68.9%)**	**Adequate dialysis N (%) =52(31.1%)**	**χ2**	**p-value**
Hemoglobin (Hb) level			37.981	**<0.001**
Low(anemia)	107 (93.0)	31 (59.6)		
Normal	8 (7.0)	21 (40.4)		
Serum Calcium Level			1.046	0.593

Hypocalcemia	53 (46.1)	21 (40.4)		
Normal	55 (47.8)	29 (55.8)		
Hypercalcemia	7 (6.1)	2 (3.8)		
Serum Phosphate Level			0.336	0.527*
Hypophosphatemia	0(0)	0(0)		
Normal	1 (0.9)	1 (1.9)		
Hyperphosphatemia	114 (99.1)	51 (98.1)		
Serum Albumin Level			5.958	**0.019***
Hypoalbuminemia	61 (53.0)	17 (32.7)		
Normal	54 (47.0)	35 (67.3)		
Hyperalbuminemia	0(0)	0(0)		

**** Fisher's exact values***

The associations between DA and frequency of dialysis in **Table 4.8** were found to be statistically significant ($p < 0.001$) using Pearson's Chi-square.

Table 4.8 Prevalence of Dialysis Adequacy by Treatment Characteristics

Variable	**Inadequate dialysis** N (%) = 115(68.9%)	**Adequate dialysis** N (%) =52(31.1%)	**χ2**	**p-value**
Hours per Session			0.395	0.821

3 hours	13(11.3)	6(11.5)		
3½ hours	76(66.1)	32(61.5)		
4 hours	26(22.6)	14(26.9)		
Vascular Access			0.838	0.658
Fistula	94(81.8)	45(86.5)		
Perm Catheter	16(13.9)	6(11.5)		
Femoral	5(4.3)	1(2)		
Frequency of Dialysis per Week			29.426	**<0.001**
Less than 3	99 (86.1)	24 (46.2)		
3 or more	16 (13.9)	28(53.8)		
Duration of Dialysis			3.393	0.183
12 months or less	19 (16.5)	7 (13.5)		
13-24 months	38 (33.1)	11 (21.1)		
24 months or more	58 (50.4)	34 (65.4)		

Odds Ratios (OR) of Dialysis Adequacy by statistically significant $\chi2$ variables

Table 4.9 presents the crude and adjusted odds ratios with 95% confidence intervals for dialysis adequacy based on statistically significant $\chi2$ of the variables under study.

In both unadjusted and adjusted logistic regression models, age showed no statistically significant association with dialysis adequacy at the 0.1 significance level. Compared to participants aged less than 20 years , those aged 20–29 years had higher odds of achieving dialysis adequacy in the crude analysis (cOR = 7.50, 95% CI: 0.92–61.04, p = 0.060), which was statistically significant but attenuated and no longer significant after adjustment (aOR = 2.10, 95% CI: 0.21–21.31, p = 0.530). Participants aged 30–39 years also demonstrated higher odds of adequacy in the unadjusted model (cOR = 3.86, 95% CI: 0.63–23.53, p = 0.143), although this did not meet the 0.1 significance threshold, and the association was eliminated after adjustment (aOR = 1.07, 95% CI: 0.15–7.65, p = 0.944). In contrast, participants aged 40–49 years and those aged ≥50 years exhibited lower odds of adequacy in both crude and adjusted models, with all associations remaining statistically non-significant (p > 0.10).

Low hemoglobin levels (anemia) were strongly associated with lower odds of achieving dialysis adequacy. In the univariate analysis, patients with low hemoglobin had 93% lower odds of achieving adequacy compared to those with normal hemoglobin levels (cOR = 0.07, 95% CI: 0.03–0.19, p<0.001). After adjusting for potential confounders in the multivariate analysis, the association remained significant, with patients having 87% lower odds (aOR = 0.13, 95% CI: 0.04–0.42, p=0.001). Hypoalbuminemia (low serum albumin) was also significantly associated with reduced dialysis adequacy. In univariate analysis, patients with hypoalbuminemia had 57% lower odds of achieving adequacy (cOR = 0.43, 95% CI: 0.22–0.85, p=0.016). This association persisted in the multivariate analysis (aOR = 0.37, 95% CI: 0.15–0.87, p=0.023). Undergoing more than three dialysis sessions per week was associated with higher odds of achieving dialysis adequacy. In univariate analysis, patients receiving more than three sessions weekly had over seven times higher odds of adequacy compared to those with fewer sessions (cOR = 7.22, 95% CI: 3.38–15.42, p<0.001). After adjustment, the odds remained significantly twice as high (aOR = 2.84, 95% CI: 1.11–7.27, p=0.030).

Table 4.9 Univariate and Multivariate Logistic Regression Analysis between Dialysis Adequacy and Statistically Significant χ2 Variables

Variables	Adequate dialysis N (%) = 52 (31.1%)	Unadjusted Model Crude OR (95%CI)	p-value	Adjusted Model Adjusted OR (95%CI)	p-value
Age					
Less than 20	2 (3.8)	Ref		Ref	
20-29	9 (17.3)	7.50 (0.92-61.04)	**0.060**	2.10(0.21-21.31)	0.530
30-39	17 (32.7)	3.86 (0.63-23.53)	**0.143**	1.07 (0.15-7.65)	0.944
40-49	7 (13.5)	0.70 (0.11-4.41)	0.704	0.43 (0.06-3.0)	0.396
50 and above	17 (32.7)	0.59 (0.11-3.35)	0.559	0.31 (0.05-1.91)	0.208
Hemoglobin level					
Normal	107 (93.0)	Ref		Ref	
Anemia	8 (7.0)	0.07 (0.03-0.19)	**<0.001**	0.13 (0.04-0.42)	**0.001**
Serum					

Albumin level					
Normal	61 (53.0)	Ref		Ref	
Hypoalbuminemia	54 (47.0)	0.43 (0.22-0.85)	**0.016**	0.37 (0.15-0.87)	**0.023**
Frequency of Dialysis sessions per week					
Less than 3	99 (86.1)	Ref		Ref	
3 or more	16 (13.9)	7.22 (3.38-15.42)	**<0.001**	2.84 (1.11-7.27)	**0.030**

cOR-crude odds ratio, aOR-adjusted odds ratio,95%CI-95% confidence interval

4.1.6 Model Diagnostics

Multicollinearity was assessed using the Variance Inflation Factor (VIF) for all predictors in the adjusted logistic regression model. VIF values ranged from 1.02 to 6.50, with a mean VIF of 3.15, indicating no evidence of problematic multicollinearity (all VIF < 10) (Table 4.9.1).

Model fit was evaluated using the Pearson goodness-of-fit test. The results indicated no evidence of poor fit ($\chi^2 = 21.05$, df = 19, p = 0.334), suggesting that the model adequately described the relationship between the predictors and dialysis adequacy.

The model's discriminative ability was assessed using the area under the Receiver Operating Characteristic (ROC) curve. The AUC was 0.799, indicating good ability of the model to distinguish between patients with adequate and inadequate dialysis.

Classification statistics showed that the adjusted model correctly classified 82.63% of cases. The model achieved a sensitivity of 53.85%, correctly identifying patients with adequate dialysis, and a specificity of 95.65%, correctly identifying patients with inadequate dialysis. The positive predictive value was 84.85%, and the negative predictive value was 82.09%, indicating strong predictive performance, particularly for ruling in cases of adequate dialysis.

Table 4.9.1 Variance Inflation Factors for Predictors in the Adjusted Logistic Regression Model

Predictor	**VIF**	**1/VIF**
Age category = 20–29	2.74	0.365
Age category = 30–39	4.45	0.225
Age category = 40–49	4.56	0.219
Age category = ≥50	6.50	0.154
Normal serum albumin	1.02	0.978
Dialysis frequency >3/week	1.39	0.718
Low hemoglobin	1.42	0.705
Mean VIF	**3.15**	

CHAPTER FIVE

DISCUSSION

This study aimed to determine factors associated with end-stage renal disease dialysis adequacy at Korle Bu Teaching Hospital, Accra, Ghana, in 2018. Achieving dialysis adequacy is a pivotal clinical indicator for hemodialysis patients, with rates as low as 22% in low-income countries and as high as 90% in developed countries (Bharati & Jha, 2020; Somji et al., 2020a) . This disparity necessitated the need to evaluate the factors associated with dialysis adequacy in KBTH. A literature review on this subject showed that little to no research has been done in Korle Bu Teaching Hospital and Ghana as a whole. Although most patients with ERSD are on hemodialysis, it is possible that many of them are not achieving adequate dialysis, which ultimately affects clinical outcomes. Several factors are associated with patients having adequate or inadequate hemodialysis.

This study comprehensively assessed the factors associated with dialysis adequacy for end-stage renal disease at Korle Bu Teaching Hospital, Accra, Ghana. The factors were categorized into demographic, clinical, biochemical, and treatment characteristics. The quantitative method used for this study makes the analysis more robust. This is the first study of its kind in the Korle Bu Teaching Hospital and in Ghana. This study bridges the gap in knowledge on the factors associated with dialysis adequacy of end-stage renal disease at Korle Bu Teaching Hospital, Accra, Ghana. It will help guide groundbreaking potential interventions that could enhance clinical outcomes in patients with ESRD on hemodialysis at KBTH and around the world.

5.1.1 PREVALENCE OF DIALYSIS ADEQUACY

5.1.1.1 Overall Prevalence

This study showed that the majority (68.9%) of the population failed to meet adequate dialysis. This indicates that 2/3rds of patients on dialysis at KBTH were generally not meeting the recommended hemodialysis targets as per KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease - Kidney International (*KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease - Kidney International*, 2024) . This low prevalence of dialysis adequacy among patients on hemodialysis was consistent with a finding from Tanzania, where only 34.3% of patients achieved adequate dialysis (Somji et al., 2020b) . Their cross-sectional study enrolled 143 patients from 4 different dialysis centers. Although their multicenter approach allowed them to assess patients from various backgrounds, their findings were not too different from this study. In contrast, another study in Tanzania by (Bakari et al., 2024) revealed that 72% of patients achieved dialysis adequacy. This huge discrepancy could be due to the different time frames (2019 and 2020) these studies were conducted. It was axiomatic that improved hemodialysis services and care between 2019 to 2020 significantly improved dialysis outcomes in Tanzania. Furthermore, studies in Rwanda and Nigeria have generally shown a higher prevalence of dialysis adequacy [62% and (28.6%-45.3%), respectively] (Abene et al., 2017b; Ndahayo et al., 2021) . In developing countries such as Brazil, Algeria, Egypt, and Kenya, about 40%-80% of patients achieve dialysis adequacy. The prevalence of dialysis adequacy was generally higher in developed countries such as Switzerland, where 76% of patients achieved dialysis adequacy (Saudan et al., 2005) . Countries such as Canada, the USA, France, and Russia all achieved dialysis adequacy of over 90%. This was due to their advanced healthcare system.

Although China is a developed country, only 50% to 70% of its patients on hemodialysis achieve adequacy. This is largely because about 25% of their patients have less than the recommended weekly hemodialysis sessions (three sessions per week)(Bharati & Jha, 2020).

These discrepancies in the prevalence of dialysis adequacy across different studies in different geographical areas could result from differences in the clinical characteristics of participants, healthcare systems, and statistical methods used.

5.1.1.2 Factors Associated with Dialysis Adequacy

Socio-demographic Factors

Using Chi2, this study revealed a statistical association of dialysis adequacy with age, with younger patients (≤39 years) achieving better outcomes ($p<0.001$). However, both unadjusted and adjusted models showed no association with dialysis. This could indicate that the association may not hold up or be strong enough when tested in a predictive or adjusted context. Similarly, associations were found in a study done in Rwanda, where the chi2 showed an association ($p=0.007$) while their unadjusted and adjusted models showed no association($p=0.604$). In any case, studies by (TEIXEIRA NUNES et al., 2008) and (Rezaiee et al., 2016) have shown that younger individuals tend to achieve dialysis adequacy compared to older individuals. (TEIXEIRA NUNES et al., 2008) (Rezaiee et al., 2016) . This relationship was also consistent with studies in Pakistan, Iran, and the USA, which found that dialysis adequacy decreases with increasing age(Anees, 1969) (TEIXEIRA NUNES et al., 2008), and (Anees, 1969; Rezaiee et al., 2016; TEIXEIRA NUNES et al., 2008) . This was because kidney function and renal blood supply decline steadily with age. This causes reduced glomerular capillary plasma flow rate and glomerular capillary ultrafiltration coefficient. Structural changes such as renal mass loss and hyalinization of afferent arterioles also occur in turn causing tubulointerstitial fibrosis. Aging is associated with impaired vasoactive stimulus response. These changes increase the risk of developing acute kidney injury and eventually ESRD with growing age(Weinstein & Anderson, 2010). Among patients on hemodialysis, both the bivariate and multivariate analyses showed that patients aged between 20 and 39 had a higher chance of achieving dialysis adequacy in this study. This could be due to socioeconomic factors, as people aged 20-39 belong to the working class and, therefore, can easily fund dialysis care compared to the other age groups, who primarily depend on other sponsorship forms. Sex and marital status showed no significant associations, and were consistent with findings by (Halili et al.2021; Shahdadi et al., 2015; Bakari et al., 2024; Bello et al., 2015; Rezaiee et al., 2016; Somji et al., 2020).

5.1.2 Clinical Factors

Comorbidities

Although hypertension was the most prevalent comorbidity in this study (61.1%), with 65.4% achieving dialysis adequacy, no association was found. Similar prevalence rates have been observed in studies from Brazil, Tanzania, and Ghana, where hypertension was a primary contributor to chronic kidney disease (Boima et al., 2019; Somji et al., 2020). A study from the United Kingdom also reported hypertension as a predominant factor among dialysis patients, significantly influencing adequacy rates (Rocco et al., 2015). Among ESRD patients, those with comorbidities were more likely to have challenges achieving dialysis adequacy. Anemia, prevalent in 82.6 % (138) of participants in this study [107 (93.0%); did not achieve dialysis adequacy], significantly impedes dialysis adequacy ($p < 0.001$). This finding aligns with global data from Rwanda and India, where anemia was consistently associated with suboptimal dialysis due to inadequate oxygen transport and chronic inflammation (Ndahayo et al., 2021; Kurella & Chertow, 2005). In addition, research from South Africa identified anemia as a critical barrier to achieving adequacy, particularly in under-resourced dialysis units (Naicker, 2013). Anemia is a common clinical condition among ESRD patients. This is due to the frequent blood loss during dialysis, inflammation, infection, and dietary insufficiency(Rocco et al., 2001). Anemia's role as a limiting factor is well-documented; inadequate erythropoiesis reduces oxygen transport, negatively impacting health outcomes (Babitt & Lin, 2012; Ndahayo et al., 2021). In Iran, 65% of patients on hemodialysis had anemia, which was in line with the high prevalence of anemia in this study (Hasanzamani & Sabbagh, 2020). Amenia decreased the chances of patients achieving adequate dialysis. However, adequate dialysis can correct anemia by removing substances that hinder erythropoiesis(Locatelli et al., 2021).

5.1.3 Biochemical Factors

Serum albumin was strongly associated with dialysis adequacy in this study. Hypoalbuminemia, affecting 46.7% of participants, was a significant predictor of inadequacy ($p = 0.015$). Global studies have reported similar associations in studies by (Ashby et al., 2019), Burrowes et al. (1993), and (Ashby et al., 2019; Bharati & Jha, 2020), where low serum albumin was strongly linked to higher mortality and suboptimal dialysis outcomes. In this study, hypoalbuminemia decreased the chances of dialysis adequacy by 60%. Studies in the United States and Brazil similarly identified low albumin levels as markers of protein-energy wasting and inflammation, which impair dialysis outcomes (Burrowes et al., 1993; Ashby et al., 2019). However, research from India and Tanzania supports these findings, indicating that improving nutritional status and addressing hypoalbuminemia are critical for achieving dialysis adequacy (Somji et al., 2020). Patients with normal albumin and hemoglobin levels had significantly better outcomes, consistent with findings by Block et al. (1998). Hyperphosphatemia was significantly prevalent (98.8%) but did not considerably influence dialysis adequacy in this study, likely due to limited variance in the dataset. This aligns with Brazil's studies, where limited phosphate level variance yielded no significant associations (Ashby et al., 2019). However, it is important to note that the mortality risk increases by 18% with each 1 mg/dL (0.32 mmol/L) elevation in blood phosphate for patients on hemodialysis (Toussaint et al., 2012) . Therefore, it is crucial to achieve normal levels of serum phosphate levels for a good prognosis of patients. Similar findings and reasons were also seen for serum calcium levels in this and other studies(Abedi-Samakoosh et al., 2017). In contrast, a correlational study by (He LiJuan He LiJuan, 2018) in South Korea showed a negative correlation between serum Calcium and dialysis adequacy among patients on hemodialysis (r=-0.328, -0.399, -0.294, P<0.05). Patients with hypercalcemia were less likely to achieve dialysis adequacy.

5.1.4 Treatment Characteristics

Frequent dialysis (≥3 sessions/week) was predictors of adequacy. Global studies consistently demonstrate similar findings. For instance, in the United States, adherence to frequent dialysis schedules significantly improved solute clearance, reducing hospitalization rates (Rocco et al., 2015). Studies from Japan also highlight that extended session durations contribute to better volume and urea management, resulting in higher adequacy rates compared to shorter sessions (Bharati & Jha, 2020). In India, similar trends were observed, where patients attending ≥3 sessions/week had improved mortality rates due to enhanced waste clearance (Kurella & Chertow, 2005). Multicenter analyses in high-income countries, such as those cited by Ashby et al. (2019), further validate that frequency and duration are critical in optimizing patient outcomes. Patients attending ≥3 sessions/week were 1.67 times more likely to achieve adequate dialysis ($p < 0.001$). Prolonged session durations ensure sufficient urea clearance and fluid removal, essential for managing chronic kidney disease effectively. In this study, no association was found between dialysis adequacy and duration of dialysis. In contrast, studies by (Bakari et al., 2024; Kurella & Chertow, 2005; Rezaiee et al., 2016) showed a relationship between the duration of dialysis and dialysis adequacy. The longer the duration of the dialysis, the higher the likelihood of attaining dialysis adequacy. Also, early initiation of dialysis leads to an increased likelihood of achieving dialysis adequacy.

Vascular access was predominantly via fistulas (86.5%), a standard associated with improved dialysis efficiency (Tannor et al., 2018). However, fewer patients relied on permcatheters and femoral access, highlighting infrastructural challenges at KBTH. However, no relationship between vascular access and dialysis adequacy. This was also evident in studies by (Rezaiee et al., 2016). Although short session lengths have seen increased chances of morbidity and mortality(Kurella & Chertow, 2005), there was no association between dialysis adequacy in this study and other studies. Longer session lengths allow toxic substances such as urea to be cleared from the bloodstream. Due to the limited data on this study variable, a universal conclusion cannot be made. According to (Bakari et al., 2024), the duration of dialysis in months, and the number of dialysis sessions per week in days were statistically associated with dialysis adequacy.

The more sessions you have, the better your chances of achieving dialysis adequacy, as more toxins (urea) are excreted from the bloodstream. Patients who recently started hemodialysis were less likely to achieve dialysis adequacy (Rocco et al., 2001).

5.1.5 Study Implications

This study is essential in addressing challenges and enhancing dialysis care in Ghana and the world. It sheds more insight into the proportion of patients achieving hemodialysis at KBTH and highlights the impact of demographic, clinical, and biochemical factors and treatment characteristics on dialysis adequacy.

Healthcare providers at dialysis centers need to incorporate these evidence-based associations in their management to ensure patients on hemodialysis achieve dialysis adequacy.

This research also serves as a foundation for further exploration into other factors that may be associated with dialysis adequacy.

5.1.6 Limitations

This study uniquely combines demographic, clinical, biochemical, and treatment characteristics to holistically evaluate dialysis adequacy. However, its cross-sectional design limits causal inferences and restricts the ability to assess changes in dialysis adequacy over time. Longitudinal or cohort studies would provide more robust insights into changes in adequacy rates and underlying factors. Additionally, self-reported data on treatment adherence could introduce bias.

While associations between biochemical markers and dialysis adequacy were identified, confounding variables such as diet, medication type, and adherence were not fully controlled for, potentially influencing the observed relationships.

The reliance on self-reported clinical data may have introduced recall bias. Additionally, other potential clinical determinants, such as residual kidney function and specific comorbidity severity, were not included in the analysis.

The study was conducted at a single center, which may limit generalizability to other regions with different demographic profiles or healthcare access. Broader multicenter studies are required to verify these findings.

While treatment duration and frequency were examined, other critical parameters such as machine efficiency, dialyzer type, and blood flow rates were not evaluated, which could also significantly affect adequacy.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1.1 Conclusion

Only one-third (31.1%) of the patient population achieved dialysis adequacy at KBTH. This is a result of suboptimal clinical management, driven by anemia, hypoalbuminemia, and limited session frequency. Addressing these modifiable factors through targeted interventions, coupled with systemic improvements in healthcare service delivery, can enhance outcomes and reduce mortality risks. Collaborative efforts between clinicians, policymakers, and international partners are crucial to overcoming existing systemic barriers. Successful interventions in other countries provide valuable insights. For example, Japan has achieved high adequacy rates by implementing nationwide protocols for frequent and extended dialysis sessions (Rocco et al., 2015). In the United States, initiatives like the End-Stage Renal Disease (ESRD) Quality Incentive Program incentivize adherence to adequacy standards through performance-based rewards (Bharati & Jha, 2020). Similarly, public-private partnerships in Brazil have improved dialysis access and patient education, emphasizing the importance of cross-sector collaborations (Ashby et al., 2019). Applying such strategies in Ghana, tailored to local challenges, could significantly enhance patient outcomes.

6.1.2 Recommendation

From the study, these are recommended:

1. Patients on hemodialysis should consider dialysis three times a week.
2. Patients on hemodialysis should be advised to increase their protein and calorie intake as this has proven to correct hypoalbuminemia and achieve dialysis adequacy (Burrowes et al., 1993)
3. Iron supplementation and anemia correction should be prioritized to mitigate the effects of anemia on dialysis adequacy.
4. Collaborative efforts between clinicians, policymakers, and international partners are crucial to overcoming existing systemic barriers.
5. A multi-dimensional research approach should be considered to better understand and improve dialysis adequacy, particularly in resource-constrained settings

6.1.3 Future research

A prospective cohort study or a longitudinal study on factors associated with dialysis adequacy can be employed to determine incidence, risk factors, and eliminate recall bias. Also, it will strengthen associations and establish causality. Other variables such as diet, routine medications taken and adherence, residual kidney function, comorbidity severity, machine efficiency, dialyzer type, and blood flow rates should be investigated.

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