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EVALUATION OF ELECTROLYTE BALANCE AND RENAL FUNCTION IN END-STAGE RENAL FAILURE PATIENTS WITH HEMODIALYSIS IN DIYALA

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NOOR DHEYAA IBRAHIM IBRAHIM

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EVALUATION OF ELECTROLYTE BALANCE AND RENAL FUNCTION IN END-STAGE RENAL FAILURE PATIENTS WITH HEMODIALYSIS IN DIYALA

By Noor Dheyaa Ibrahim IBRAHIM

January 2023

We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Noor Dheyaa Ibrahim IBRAHIM

ABSTRACT

EVALUATION OF ELECTROLYTE BALANCE AND RENAL FUNCTION IN END-STAGE RENAL FAILURE PATIENTS WITH HEMODIALYSIS IN DIYALA

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Master of Science in Chemistry
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January 2023

The kidneys play a pivotal role in regulating electrolyte and acid-base balance. The study aimed to evaluate the evaluation of some biochemical variables in hemodialysis patients. These parameters were determined to check renal function in end-stage renal failure by (urea, creatinine), and electrolyte levels in end-stage renal failure (Na, K, Cl, Mg, Phosphorus, Bicarbonate, and Ca). The study included two groups: the patient group included 100 samples, while the control group included 40 samples, and the results were as follows: The mean age and gender indicated that there were statistically significant differences at P = 0.094. These results indicate that the disease may affect people of different ages and that the injury may be more severe in old age. As for gender, the results indicated that men are more likely to have kidney disease than women. The signal of sodium levels is clearly affected in renal patients. It also found potassium averages have statistically significant differences and have clinical importance and may increase the early diagnosis of kidney failure and that the results were statistically significant between the two groups. The calcium levels can be used in diagnosing and studying the development of the disease.

2023, 59 pages

Keywords: Electrolyte balance, Renal failure, End-stage, Hemodialysis, Bicarbonate

ÖZET

DIYALA ŞEHRİNDE HEMODİALİZ OLAN SON DÖNEM BÖBREK YETMEZLİĞİ HASTALARINDA ELEKTROLİT DENGESİ VE BÖBREK FONKSİYONUNUN DEĞERLENDİRİLMESİ

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Ocak 2023

Böbrekler elektrolit ve asit-baz dengesinin düzenlenmesinde önemli bir rol oynar. Bu çalışmada hemodiyaliz hastalarında bazı biyokimyasal değişkenlerin değerlendirilmesi amaçlandı. Bu parametreler son dönem böbrek yetmezliğinde böbrek fonksiyonunu kontrol etmek için (üre, kreatinin) ve son dönem böbrek yetmezliğinde elektrolit seviyeleri (Na, K, Cl, Mg, Fosfor, Bikarbonat ve Ca) ile belirlendi. Çalışma iki grup içermiştir: hasta grubu 100, kontrol grubu 40 örnek içermiştir ve sonuçlar şöyledir: Ortalama yaş ve cinsiyet P = 0,094'te istatistiksel olarak anlamlı farklılıklar olduğunu göstermiştir. Bu sonuçlar, hastalığın farklı yaşlardaki insanları etkileyebileceğini ve yaşlılıkta yaralanmanın daha şiddetli olabileceğini göstermektedir. Cinsiyete gelince, sonuçlar erkeklerin böbrek hastalığına yakalanma olasılığının kadınlardan daha yüksek olduğunu gösterdi. Böbrek hastalarında sodyum düzeylerinin sinyali açıkça etkilenir. Ayrıca potasyum ortalamalarının istatistiksel olarak anlamlı farklılıklara sahip olduğunu ve klinik öneme sahip olduğunu ve böbrek yetmezliğinin erken teşhisini artırabileceğini ve sonuçların iki grup arasında istatistiksel olarak anlamlı olduğunu buldu. Kalsiyum seviyeleri, hastalığın gelişimini teşhis etmede ve incelemede kullanılabilir.

2023, 59 sayfa

Anahtar Kelimeler: Elektrolit dengesi, Böbrek yetmezliği, Son dönem, Hemodiyaliz, Bikarbonat

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Noor Dheyaa Ibrahim IBRAHIM
Çankırı-2023

CONTENTS

LIST OF SYMBOLS

-	Minus
%	Percent
**	Significant
+	Plus
<	Greater than
±	Plus minus
µg	Microgram
dL	Deciliter
g	Gram
kg	Kilogram
L	Liter
m^2	Square meter
min	Minute
mL	Milliliter
ng	Nanogram
nm	Nanometer
rpm	Revolutions per minute
µL	Microliter

LIST OF ABBREVIATIONS

AV	Arteriovenous
CKD	Chronic kidney disease
CVD	Cardiovascular diseases
DNA	Deoxyribonucleic acid
ESRD	End-stage renal disease
GFR	Glomerular filtration rate
MDH	Malate dehydrogenase
NAD	Nicotinamide adenine dinucleotide
NADH	Nicotinamide adenine dinucleotide - hydrogen
PEPC	Phosphoenolpyruvate carboxylase
pH	Degree of acidty

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1. INTRODUCTION

It is estimated that the prevalence of chronic kidney disease (CKD) is 14% in the United States and between 5% and 15% everywhere else in the globe. This illness has become a worldwide pandemic. Early on in the progression of CKD, patients may have abnormalities such as metabolic acidosis. More advanced stages of the disease, on the other hand, are characterized by hyperkalemia as well as changes in sodium (Na+) and water balance. Patients with ESRD who are receiving hemodialysis virtually always have substantial solute and volume changes, pre- dialysis acidosis, post-dialysis alkalosis, dyskalemia, and different degrees of pre-dialysis acidosis (Martins *et al.* 2021).

Under normal physiological circumstances, each day the kidneys filter about 4,500 mEq of HCO_3. The proximal tubule is responsible for reclaiming around 80% of the filtered HCO_3, the thick ascending arm of Henle and distal convoluted tubule are responsible for reclaiming approximately 16%, and the collecting ducts are responsible for reclaiming approximately 4% of the HCO_3 (Hasona and Elasbali 2016).

1.1 Aim of Study

The current medical job is to assess several biochemical markers in individuals undergoing hemodialysis, these criteria were chosen so that we could explore the following: 1. renal function in patients who are in the end-stage of renal failure through (urea, and creatinine), and (2) restoration of electrolyte balance in patients with advanced renal failure by means of (Na, K, Cl, Mg, Phosphorus, Bicarbonate, and Ca). Studies to control for bias were conducted on a total of fifty Iraqi patients diagnosed with chronic kidney disease and ranging in age from twenty to sixty-eight years old. There were twenty-five male patients and twenty-five female patients included in the study, and fifty healthy volunteers to serve as a control group (25 Male and 25 female).

2. LITERATURE REVIEW

2.1 Haemodialysis

2.1.1 Background

Hemodialysis is a procedure that recreates the function of healthy kidneys by removing waste products and excess water from the patient's blood. Hemodialysis is beneficial for maintaining a healthy blood pressure and maintaining proper mineral levels in the blood, including potassium, sodium, and calcium. On average, about eighty percent of patients undergoing dialysis are treated with haemodialysis (Lim *et al.* 2016).

A substantial blood flow and a blood artery that is able to endure being pierced with a thick needle as often as the patient wants dialysis (usually three times per week) are also requirements for successful dialysis. In order to construct an arteriovenous fistula, also known as fistula, a surgical surgery is performed as part of the preparations for dialysis. During this treatment, an artery in the forearm is linked to a vein in order to form the fistula (Wong *et al.* 2015).

When the vein is subjected to the blood pressure in the artery, it enlarges, and the rate of blood flow increases to between 1000 and 1500 ml per minute. One month later, it may serve both as a puncture site to enable blood to be delivered to the dialysis machine and as a puncture site to allow blood to be returned to the patient from the machine. This is because it has healed enough. Dialysis may be performed on a patient who does not have a fistula with the use of a central dialysis catheter, which has two ports (Lenglet *et al.* 2017). The blood and the dialysis liquid both flow in the opposite direction and on opposing sides of a semipermeable membrane in the dialyzer, which is where the purifying process takes place (Dembowska *et al.* 2022). Toxic waste materials are removed from the body by the dialysis fluid after passing through the dialyzer membrane through the process of diffusion (Ronco *et al.* 2018).

Following the same basic concept, but in the reverse way, bicarbonate and electrolytes are transferred from the dialysis fluid to the blood as they pass through the dialyzer membrane. In addition to this, the membrane is used to extract the additional fluid that has built up in the space between treatments. Some patients put on four to five kilograms of weight in the time between dialysis treatments. This is because they consume more fluids by drinking and eating, and also because they are unable to properly create urine volumes owing to the impairment to their renal function (Chang *et al.* 2021).

This process of eliminating fluids is referred to as "ultrafiltration," and it might be a pre-programmed feature of the dialysis equipment. The ultrafiltration function of the dialysis machine may be used alone, without the need for the dialysis process to be performed at the same time. The whole process of dialysis is monitored and regulated by the dialysis machine itself, as well as by a nurse who has received specialized training, see Figure 2.1 (Broers *et al.* 2015).

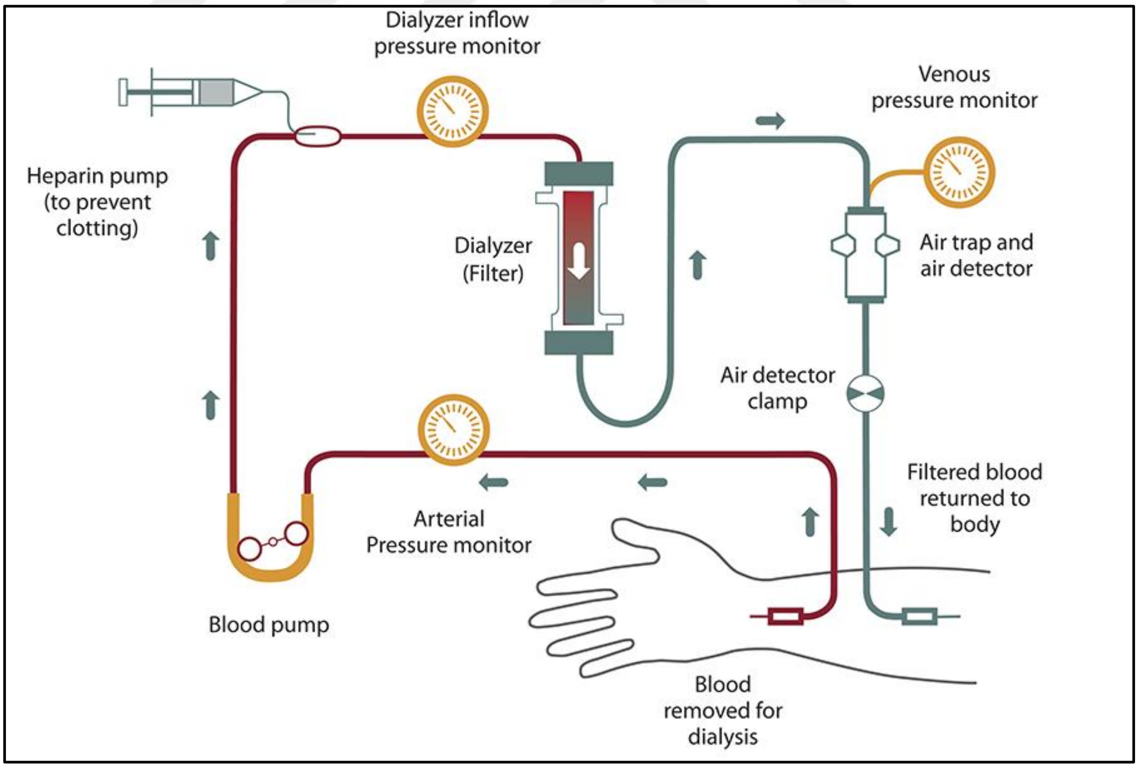

Figure 2.1 Simple sketch of haemodialysis process (Locatelli *et al.* 2018)

It is possible to do dialysis either in a clinic or in the comfort of one's own home. Home dialyzers are people who have learnt how to dialyze on their own and perform the process of dialysis at home, the arm will be pierced with two needles as the first step in the hemodialysis process, this will be performed by a dialysis nurse or technician. After receiving proper instruction from the medical staff, you may decide that it is more convenient for you to insert your own needles (Ajam 2020). If the placement of the needles causes you discomfort, you may apply a numbing lotion or spray. Each needle is linked to a flexible tubing that is in turn connected to the machine that performs dialysis (Monaro *et al.* 2014).

2.1.2 Risks

The majority of patients who need hemodialysis suffer from a wide range of health conditions, although hemodialysis helps to extend the lives of many patients, the average life expectancy of those who need the treatment is still lower than that of the general population. Even while hemodialysis therapy may be effective in replacing some of the renal function that has been lost, you still run the risk of developing some of the connected disorders that are described below. However, not everyone develops all of these problems. They may be managed with the use of this dialysis treatment (Nistor *et al.* 2015).

One of the frequent adverse effects of hemodialysis is a reduction in blood pressure. A number of symptoms may accompany low blood pressure, including difficulty breathing, nausea, muscular and stomach cramping, and vomiting or sickening. Although it is unclear what causes them, muscular cramps are a typical side effect of hemodialysis treatment. Changing the dosage of the hemodialysis medication may help alleviate the cramping in some cases. Altering one's intake of fluid and salt between hemodialysis sessions is another potential method for relieving symptoms experienced during treatments (Ashby *et al.* 2019).

People who go through hemodialysis often have itchy skin, which frequently becomes worse during the operation or immediately after it. This may be the result of pauses in breathing that occur during sleep (a condition known as sleep apnea) or of legs that are painful, unpleasant, or restless. Anemia is a frequent consequence of both renal failure and hemodialysis, since it occurs when there are not enough red blood cells in the blood. The production of a hormone known as erythropoietin (uh-rith-roe-POI-uh-tin), which encourages the development of red blood cells, is decreased when the kidneys are not functioning properly. Anemia may also be caused by restricting one's diet, having poor iron absorption, having regular blood tests, or having hemodialysis, which removes iron and vitamins from the body (Hayes *et al.* 2015).

In the event that damaged kidneys are unable to digest vitamin D, which aids in the absorption of calcium, this might lead to a weakening of the bones. In addition, calcium may be released from the bones when there is an excess production of parathyroid hormone, which is a typical consequence of renal failure (Berndl *et al.* 2018). Because it removes either too much or not enough calcium, hemodialysis may make these diseases even more severe. High blood pressure may worsen and eventually cause heart issues or strokes if the individual consumes an excessive amount of salt or drinks an excessive amount of fluid (Kirkman *et al.* 2014).

Because hemodialysis involves the removal of fluid from the body, ingesting more fluids than is suggested in the time between hemodialysis treatments might put a person at risk for developing life-threatening problems such as heart failure or fluid buildup in the lungs (pulmonary edema) (Sano *et al.* 2016). Inadequate hemodialysis can cause inflammation of the membrane that surrounds the heart, which can impair the ability of the heart for the normal human pump to send the blood to the rest of the body, this stage of human life can be considered to lead to death (Ghimire *et al.* 2015).

Since hemodialysis is a process that rids the body of excess potassium, a mineral is ordinarily eliminated from the body by the kidneys. It is possible for the heart to cease beating altogether or beat erratically if too much or too little potassium is removed during dialysis. It is possible for potentially life-threatening consequences, such as infection, constriction or ballooning of the blood vessel wall (aneurysm), or obstruction, to have an adverse effect on the quality of hemodialysis treatment (Lim *et al.* 2016).

Follow the guidelines that are provided by the dialysis team for how to check for changes in access site that may signal a problem. People who have been treated with hemodialysis for a number of years are more likely to suffer from this illness. Those who suffer from renal failure often experience shifts in their mood. If you start experiencing symptoms of depression or anxiety after beginning hemodialysis, it is important to discuss your choices for successful therapy with the health care team (Prezerakos *et al.* 2015).

2.1.3 Performance

During the process of hemodialysis, blood is drawn from the patient's body, passed through an artificial kidney in the form of a dialyzer, which is a membrane created in a laboratory, and then the blood is returned to the patient. During dialysis, just one pint of blood, which is equivalent to roughly two cups, is removed from the body at a time. The typical individual has around 10 to 12 pints of blood. In order to carry out hemodialysis, an access must first be made so that blood may be transported from the body to the dialyzer and then returned to the body. Hemodialysis may be performed using one of three different access methods: an arteriovenous (AV) fistula, an AV graft, or a central venous catheter (Walker *et al.* 2014).

The patient may have to have some of their extra fluid drained throughout the therapy depending on how much weight they have gained. The next step is to "place the patient on the machine." Patients who have vascular access (AV fistula or AV graft) will have two needle sticks made in their access; the first needle will remove blood from the body, and the second needle will return the blood to the body. Patients who have a central venous catheter will have the two tubes leading from their access point linked to the blood tubes that go to the dialyzer and then return to the body. After the patient has been "placed on the machine," the dialysis equipment is then configured, and treatment may then commence (Palmer *et al.* 2014).

Blood does not pass through the dialysis equipment at any point in the process, the dialysis machine may be thought of as a combination of a large computer and a pump. It monitors the circulation of blood, the pressure of the blood, the amount of fluid that is evacuated, and other essential data (Séret *et al.* 2020). Dialysate, also known as dialysis solution, is the fluid bath that is introduced into the dialyzer, and this process mixes it (Gerogianni *et al.* 2019).

This fluid assists in the removal of toxins from the blood, and thereafter, the bath is flushed down the toilet. The blood pump in the dialysis machine maintains the circulation of blood by exerting a pumping action on the blood tubes that transport blood from the patient's body to the dialyzer and then back to the patient's body. In addition to that, the dialysis machine offers a lot of other safety detecting measures. If you go to a dialysis facility, you will most certainly get familiar with the many alarms that are produced by the machines there (Tharmaraj and Kerr 2017).

Hemodialysis cannot be performed without the dialyzer. Because it filters the blood in the same way that the kidneys used to, the dialyzer is often referred to as the "artificial kidney." The dialyzer is a hollow tube made of plastic that is about one foot long and three inches in diameter. It includes a large number of very small filters. Dialyzers are available in a variety of sizes, allowing physicians to select the model that is most appropriate for each individual patient (Hanafusa *et al.* 2018).

There are two compartments inside the dialyzer: one is designated for the dialysate, and the other is designated for the blood. In order to prevent the two parts from being mixed up with one another, a semipermeable membrane separates them. Only some chemicals are able to pass through a membrane that is only partially permeable because it has small pores. The membrane is semipermeable, so it allows water and waste to pass through it, but it prevents blood cells from passing through it (Murray *et al.* 2015).

Dialysate can be thought of as a solution, this solution consists of pure water, in addition to some other components, for example electrolyte and some salts such as sodium and bicarbonate. It is also known as dialysis fluid, dialysis solution, or bath. Toxins are removed from the blood and into the dialysate by the process of the dialysate pulling. A method known as diffusion is what makes this possible in the first place. The patient undergoing hemodialysis has a high concentration of waste in their blood, whereas the dialysate has a low quantity of waste (van Gelder *et al.* 2020).

Because of the disparity in its level, the waste will pass through the semipermeable membrane in order to bring the quantity on both sides of the membrane to the same level. A method known as filtering is used to get rid of the surplus fluid that was present. On the blood side of the dialyzer, the pressure is greater than on the dialysate side, which causes the fluid to be expelled (Ghimire *et al.* 2017).

In order to properly purify the blood and rid the body of extra fluid, the blood must be allowed to circulate through the dialyzer for a number of hours. In-center hemodialysis, which is the traditional method, is typically performed three times a week for approximately four hours per session. However, healthy kidneys function 24 hours a day, seven days a week, and dialysis must complete the job in just 12 or so hours a week at most. Some people have the misconception that the process of dialysis takes a lengthy time (Robinson *et al.* 2016).

Nocturnal and short-term daily sessions are two examples of alternative hemodialysis schedules. People who do hemodialysis at home are the ones who often carry out treatments like this. A patient undergoing nocturnal hemodialysis receives treatment for around eight hours during the night while sleeping (Cai *et al.* 2018).

Patients remark that they have less issues with cramping and the sense of being "washed out" following standard hemodialysis when they undergo this therapy, since it is longer and gentler than the latter (Zhao *et al.* 2020). On the basis of studies that patients report feeling better about their quality of life and having better lab results while undergoing in-center nocturnal hemodialysis, more dialysis clinics are starting to provide the treatment (Lenglet *et al.* 2017).

2.2 Chronic Kidney Disease

2.2.1 Background

The gradual loss of kidney function that characterizes chronic renal disease, also known as chronic kidney failure, is one of the defining features of this medical condition. The kidneys filter the blood, getting rid of waste items and extra fluids that are present in there. These are eliminated from the body through the urinary tract (Zhu *et al.* 2016). If you have reached a more advanced stage of chronic renal illness, it may encounter a buildup of fluid, electrolytes, and wastes that might put your health in jeopardy (Crofts *et al.* 2015).

As kidney disease worsens, it is possible for potentially lethal volumes of waste to swiftly collect inside the body. This may be fatal. The degree CKD may vary from very low to very severe. Despite the fact that treatment with medicine has been shown to slow the progression of the disorder, it often becomes worse with time. CKD may bring about renal failure and an early stage of cardiovascular disease if the illness is not treated. In the case that kidney function has been lost, either dialysis or a kidney transplant is required for survival in order to continue living. The phrase "end-stage renal disease" refers to kidney failure that has been managed medically by either dialysis or the transplantation of a healthy kidney of ESRD (Peytremann-Bridevaux *et al.* 2015).

In addition to the progressive loss of function that may occur in organs such as the heart as a result of aging, renal function can also gradually deteriorate. It has been shown that impaired renal function is connected to an increased risk of morbidity and death (Ma *et al.* 2020). This is notably the case when it comes to cardiovascular diseases (CVD), the risk of which is multiplied by many orders of magnitude in individuals whose renal function has already begun to decline, particularly to the point where they need dialysis (Zhu *et al.* 2020).

If the sick people additionally have DM, then the risk of dying from CVD is deemed to be much higher than it already was. Nephropathy caused by diabetes, chronic glomerulonephritis, nephrosclerosis, and polycystic kidney disease are the most frequent conditions that lead to chronic renal failure and the need for dialysis. Anemia, regular urination, and tiny kidneys are some of the symptoms that often accompany the beginning stages of chronic renal failure (with the exception of patients with amyloidosis, diabetic nephropathy and polycystic kidney disease) (Santoro *et al.* 2015).

In people who have diabetes mellitus, various diseases, in addition to the traditional progressive diabetic nephropathy, often decrease renal function. For example, diabetics have a much higher risk of developing pyelonephritis, which is a chronic or acute inflammation of the parenchyma for kidney that is caused by the infections of the bacterial. Diabetic neuropathy may also cause problems with urine function, which is another issue. Patients who have diabetes mellitus almost always have high blood pressure, and this is one of the factors that leads to a higher risk of atherosclerosis and subsequent kidney impairment. Common factors that lead to chronic renal failure (Kakitapalli *et al.* 2020).

2.2.2 Evaluation

Laboratory data such as serum creatinine, urea, and cystatin C, which are the most frequent analyses conducted in everyday clinical practice, may be used to provide an approximate assessment of kidney function. This can be accomplished by employing these variables (Leion *et al.* 2017). These factors, by themselves, do not provide an accurate measurement of the clearance capacity of the kidney, which is quantified as the glomerular filtration rate (GFR). You need to estimate your GFR, and then make sure to adjust it based on your body weight in order to receive a more precise reading of your kidney function (Praditpornsilpa *et al.* 2012).

Measuring the amount of time it takes for a drug to be removed from plasma is one of the approaches that may be used to establish this (plasma clearance) (Thomson *et al.* 2012). The second method involves determining the amount of time it takes for iohexol to be cleared from the plasma. These procedures often come at a high cost and require a significant amount of time (Cockwell and Fisher 2020).

One such possibility is to examine the amount of waste that is eliminated via the urine (renal clearance). Because this method needs the patient to be thorough with urine collection, i.e. throughout the course of a whole day, it is an inexpensive method, but it is also more challenging for the patient. Utilizing blood samples that include creatinine or cystatin C is yet another method that may be used to assess GFR (Mian and Schwartz 2017).

These numbers may be plugged into models that take into account a variety of characteristics, including age, gender, and total body weight. An estimate of the renal function may often be obtained in this manner that is considered to be rather accurate (Ruiz *et al.* 2020).

2.2.3 Stages

In order to identify the stage, GFR must be examined. For instance, when a person's GFR is at least 90 mL per minute (ml/min) per 1.73 meters squared, medical professionals classify them as having stage 1 CKD. However, despite the fact that the kidneys seem to be operating correctly, there are indications that renal impairment is present. Two possible indications of kidney impairment in stage 1 CKD are the presence of protein in a person's urine and physical damage (Heerspink *et al.* 2020).

The disease is regarded to be at stage 2 when a person's GFR is measured to be between 60 and 89 mL/min per 1.73 m^2 at this point in the disease's progression. If a person's GFR is within this range, it is often a sign that their kidneys are operating properly. Normal kidney function is defined as a GFR that falls within this range (MacIsaac *et al.* 2015). On the other hand, the GFR implies that a person with stage 2 chronic renal disease has more signs of kidney impairment (Levey *et al.* 2020).

This is because stage 2 chronic renal disease is further advanced. It's possible that one of these signs is the presence of protein in a person's urine, or even real damage to their kidneys itself (Figure 2.2). A person who is in stage 1 or 2 of CKD should discuss with their doctor the option of taking medications that will help them to keep their kidneys for as long as possible (Yang *et al.* 2020).

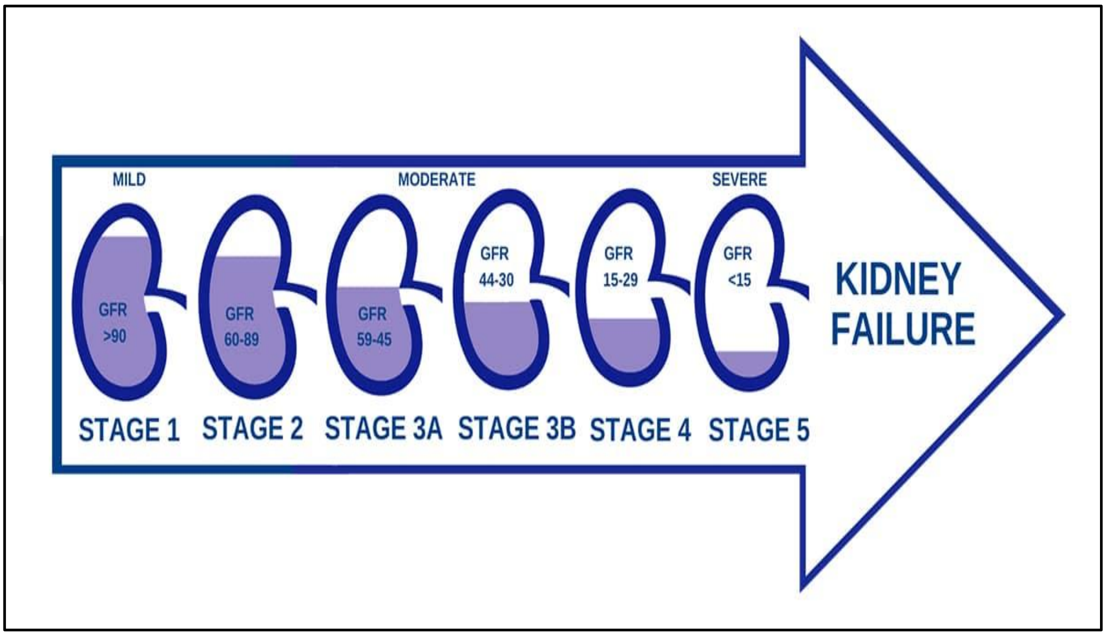

Figure 2.2 CKD stages (Bakris *et al.* 2020)

The GFR of a person with chronic renal disease is in stage 3 may vary anywhere from 30 to 59 mL/min per 1.73 m^2 at this point. It is likely that the individual in question suffers from renal damage if their creatinine level falls within this range. When a person's kidneys have reached the stage 3 of chronic renal disease, they are not performing as well as they should be. At the stage 3 level, there are two different subtypes of CKD that may be separated from one another: If a person's GFR is between 45 and 59 mL/min per 1.73 m^2, then they are considered to be in the Stage 3a range of CKD, if a person's GFR is between 30 and 44 mL/min per 1.73 m^2, then they are deemed to be in the Stage 3b range of chronic kidney disease (Lamb *et al.* 2007).

A person who has reached stage 3 of chronic renal disease may also want to see a dietitian about the importance of keeping a diet that is balanced. A person who has reached stage 3 of chronic renal disease is also able to discuss with their physician the potential of utilizing angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers. Both of these classes of medication are used to lower blood pressure. It has been shown that these medications lower blood pressure, which in turn may aid in halting the course of CKD (Carney 2020).

A person's GFR in stage 4 of chronic renal disease might vary anywhere from 15 to 29 ml/min per 1.73 m^2 of the area of the surface body. When a person reaches this degree, the damage that has been done to their kidney's ranges from mild to severe. A person is said to be in a perilous state known as stage 4 of CKD if they have reached the last stage of the disease before they develop renal failure. A person whose chronic kidney disease has advanced to stage 4 is at an increased risk of acquiring symptoms such as swollen hands and feet, soreness in the back, and an increase in the frequency with which they have to urinate (Lamb *et al.* 2014). In addition to this, there is a heightened possibility of consequences such as anemia and bone diseases. A patient who has reached stage 4 of chronic renal disease may be referred by their primary care physician to see a nephrologist or dietitian (Ammirati 2020).

For the purpose of making a diagnosis of stage 5 CKD, a GFR of 15 mL/min/1.73 m^2 or less is necessary CKD. At this stage, a person's kidneys have either completely ceased functioning or are extremely close to reaching the point when they will do so. The information suggests that in 2018, there was a 15% increase in the number of people who were diagnosed with stage 1 chronic renal disease (Cirillo 2010). During this time, there was not much of a change in the total number of individuals that had stages 2 through 5 of CKD. It is essential for patients to have a fast diagnosis and treatment for their renal sickness as quickly as possible in order to prevent more damage from taking place (Huang *et al.* 2011).

People who have diabetes need to be examined once a year for something called microalbuminuria, which is short for microalbuminuria but is more often recognized as having tiny amounts of protein in their urine. This test is able to detect diabetic nephropathy, which is kidney disease brought on by diabetes, in its earliest stages.

When a person's GFR is at least 90 mL per minute (mL/min) per 1.73 meters squared, medical professionals classify them as having stage 1 CKD. However, despite the fact that the kidneys seem to be operating correctly, there are indications that renal impairment is present (Bhatt *et al.* 2021).

Stage 3; the GFR of a person with chronic renal disease is in stage 3 may vary anywhere from 30 to 59 mL/min per 1.73 m^2 at this point. It is likely that the individual in question suffers from renal damage if their creatinine level falls within this range. When a person's kidneys have reached the stage 3 of chronic renal disease, they are not performing as well as they should be. At the stage 3 level, there are two different subtypes of CKD that may be separated from one another: If a person's GFR is between 45 and 59 mL/min per 1.73 m^2, then they are considered to be in the Stage 3a range of chronic kidney disease. If a person's GFR is between 30 and 44 mL/min per 1.73 m^2, then they are deemed to be in the Stage 3b range of chronic kidney disease (Pottel 2017).

A person who has reached stage 3 of chronic renal disease may also want to see a dietitian about the importance of keeping a diet that is balanced. A person who has reached stage 3 of chronic renal disease is also able to discuss with their physician the potential of utilizing angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers. Both of these classes of medication are used to lower blood pressure. It has been shown that these medications lower blood pressure, which in turn may aid in halting the course of it (Bhatt *et al.* 2021).

For stage 4, a person's GFR in stage 4 of chronic renal disease might vary anywhere from 15 to 29 mL/min per 1.73 m^2 of body surface area. When a person reaches this degree, the damage that has been done to their kidneys ranges from mild to severe. A person is said to be in a perilous state known as stage 4 of CKD if they have reached the last stage of the disease before they develop renal failure. A person whose chronic kidney disease has advanced to stage 4 is at an increased risk of acquiring symptoms such as swollen hands and feet, soreness in the back, and an increase in the frequency with which they have to urinate. In addition to this, there is a heightened possibility of consequences such as anemia and bone diseases. A patient who has reached stage 4 of chronic renal disease may be referred by their primary care physician to see a nephrologist or dietitian (Kalantar *et al.* 2021).

In stage 5, making a diagnosis chronic renal disease, a GFR of 15 mL/min/1.73 m^2 or less is necessary CKD. At this stage, a person's kidneys have either completely ceased functioning or are extremely close to reaching the point when they will do so. The information suggests that in 2018, there was a 15% increase in the number of individual that diagnosed with stage 1 CKD. During this time, there was not much of a change in the total number of people who had stages 2 through 5 of CKD. It is essential for patients to have a fast diagnosis and treatment for their renal sickness as quickly as possible in order to prevent more damage from taking place. People who have diabetes need to be examined once a year for something called microalbuminuria, which is short for microalbuminuria but is more often recognized as having tiny amounts of protein in their urine (Larson-Nath and Goday 2019).

2.3 Electrolyte balance

2.3.1 Background

Electrolytes are compounds that are found to exist naturally in the fluids of the body. Chloride, phosphate, potassium, sodium, and calcium are all examples of these elements. These are necessary for the body to perform its usual activities and need to be present at certain concentrations. The kidneys are responsible for regulating the amounts of sodium throughout the body in order to keep the electrolyte balance in check. An electrolyte imbalance is a condition that may occur when the levels of certain electrolytes in your body are either too low or too high. The electrolyte balance in your body must be maintained properly in order for it to work properly (Satué *et al.* 2021).

The inner environment of early unicellular creatures was isotonic with the surrounding environment since these organisms lacked the ability to regulate their internal osmotic pressure). As life developed, creatures became more sophisticated and eventually abandoned the watery environment. This necessitates adaptation in four key areas: nutrition, gas exchange, thermoregulation, and fluid and electrolyte balance. Due to the fact that early terrestrial life forms had to deal with nutrient, salt, and water deficits rather than excesses, the mechanisms to deal with salt and water deficiency or loss seem to be more effective than those to deal with excesses. Numerous illnesses and pathological conditions are connected with or caused by abnormalities in the water compartments of the body, which impede normal physiology (Khelil-Arfa *et al.* 2014).

2.3.2 Function

In order for the body to operate correctly, it is essential to keep all of its levels at the optimal levels. Electrolytes are ionized minerals that have an electric charge and may be either positive or negative. They can be found in the fluids, blood, and urine of the body. Na+ (sodium), K+ (potassium), Cl– (chloride), Ca2+ (calcium), H+ (hydrogen), HCO_3– (bicarbonate), and phosphates are the most important electrolytes in the body. It may get all of these electrolytes through the food and drinks that you eat on a regular basis. They are in charge of a wide variety of bodily functions, including, to mention just a few, the movement of water and other fluids throughout the body, the action of the muscles, and even the metabolism (Yasoob and Tauqir 2017).

Any individual's functioning may be affected negatively if they fail to maintain a healthy balance of their electrolyte levels, regardless of whether the quantity is too high or too low. The body requires a certain amount of each of the electrolytes in order to operate properly (Figure 2.3). By consuming the food, maintaining a healthy balance in the body's electrolyte levels is among the many aspects of one's body that must be attended to on a daily basis in order to ensure optimal functioning (Alfarouk *et al.* 2020).

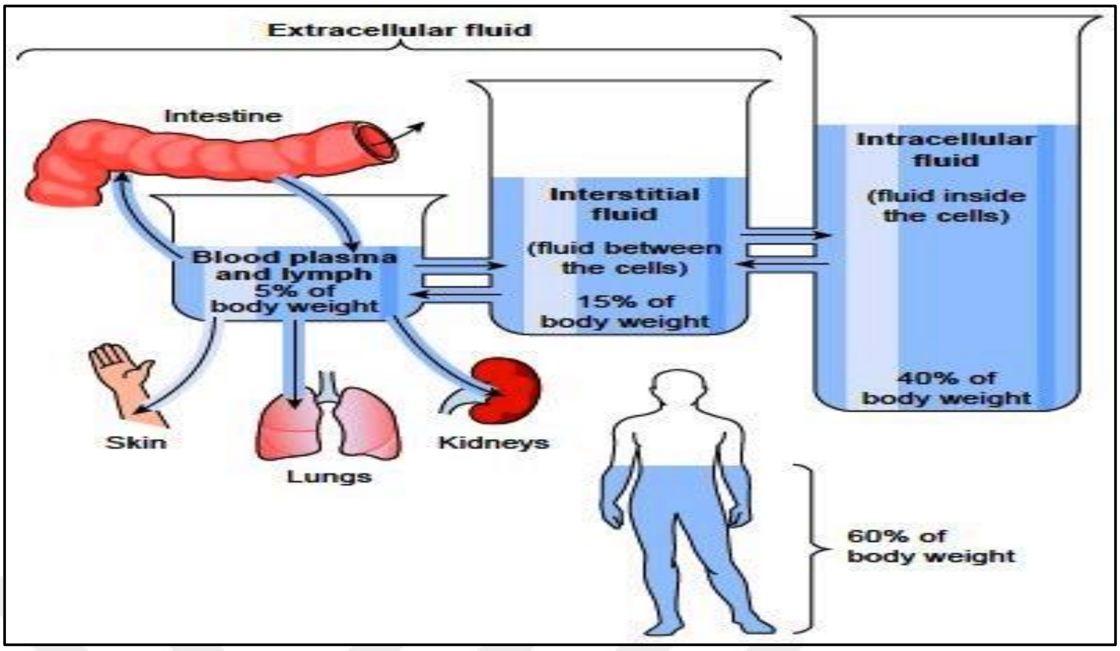

Figure 2.3 Functions of electrolytes (Sigolo *et al.* 2021)

The osmolarity of the fluids in the body, which refers to the quantity of mineral content that is present in the fluid itself, may be altered by electrolytes. Electrolytes have a direct connection to the body's water balance because they collaborate with the water in the body to carry out its processes. Additionally, because of the positive or negative charges that result from the solutions, electrolytes assist in the transportation and distribution of substances across membranes. Because of this, water and electrolytes are reliant on one another. This means that if water levels are inadequate or there is an excess, it will change the osmolarity, which will throw off the balance and cause solutions throughout the body to be either more dilute or more concentrated (Goyal and Monroe 2017).

Electrolyte levels that were either too low or too high would lead to the same kinds of difficulties. The electrolytes are unable to function properly when this occurs. To put this into perspective, the degree of oedema may be proportional to the availability of both salt and water, and it may be made worse by refeeding. The diarrhea that afflicts victims of famine may also have an influence on sodium and water balance, as well as cardiovascular decompensation, which is connected with the effects of malnutrition on the myocardium (Isazade *et al.* 2016).

2.3.3 Causes

When losing a significant volume of bodily fluid, the body might end up with an electrolyte imbalance as a result. For instance, if you are vomiting excessively or perspiring excessively, this might cause the levels of certain electrolytes in the body to drop. In point of fact, when you sweat, you lose anything from two percent to six percent of your body weight. Sweating may cause the concentration of electrolytes in the body to drop if enough hydration is not maintained. Burns have the potential to cause an electrolyte imbalance in certain patients. In certain cases, drugs used to treat underlying disorders, such as chronic renal disease, may also throw off the body's natural electrolyte balance (Alfarouk *et al.* 2020).

It is not very difficult to keep the electrolyte levels in your body in proper balance. To begin, it is necessary to ensure that you drink water at least two hours before engaging in any type of physical activity, whether it be going to the gym or any other kind of exercise. In addition to this, make it a point to drink at least four to six ounces of water after every 20 minutes of physical exercise, and also drink water after finished working out. Consuming water is the easiest and most effective approach to avoid the difficulties that might arise from an electrolyte imbalance (Boersema *et al.* 2014).

Coconut water, on the other hand, contains a relatively modest amount of sugar and will not lead to a surge of sugar in your blood. Even yet, it has a higher caloric content than regular drinking water. If you're looking to cut down on calories, your best bet is to use unsweetened coconut water whenever you can. Because they include electrolytes, sports drinks may also assist in making up for the electrolytes that have been lost. The vast majority of them include sodium chloride and potassium chloride. If your workout lasts for less than seventy-five minutes, regular water should be plenty. Consume meals that are high in electrolytes. It may also enhance the amount of electrolytes in body by eating specific foods, such as potatoes, avocados, oranges, bananas, strawberries, turkey, and spinach, which are all good examples (Pereira *et al.* 2016).

Because the quantity of fluid that is contained in a given compartment is dependent on the amount (concentration) of electrolytes that are present in that compartment, electrolytes, and sodium in particular, assist the body in maintaining appropriate fluid levels in the fluid compartments. When there is a high concentration of electrolytes, fluid will go into that compartment (a process called osmosis). In a similar manner, fluid will migrate out of that compartment if there is a low concentration of electrolytes. The body is capable of actively moving electrolytes into or out of cells in order to regulate fluid levels (Souza *et al.* 2016).

As a result, ensuring that the electrolytes are present in the correct concentrations (a process that is referred to as electrolyte balancing) is essential for successfully maintaining fluid equilibrium between the compartments. Consuming a lot of water before, during, and after exercise may help avoid an electrolyte imbalance. Consume a well-rounded diet that is high in electrolyte-containing foods. When the weather is hot, you should avoid engaging in vigorous exercise outside (Triplitt 2012).

The kidneys perform the function of filtering electrolytes and water from the blood, with part of the filtered electrolytes and water being returned to the blood and any surplus electrolytes and water being eliminated via the urine. Therefore, the kidneys play a role in helping to maintain a balance between the number of electrolytes and water that is consumed on a daily basis and the amount that is excreted (Cruvinel *et al.* 2021).

2.3.4 Components

In order to keep its electrolyte levels stable, the body requires a number of essential components in particular. The next paragraph will cover the primary factors, which will be denoted as either positive (+) or negative (-), as well as what might occur when there is either an excess of or a deficiency in each factor. The function that sodium plays in assisting cells in maintaining the appropriate fluid balance is an extremely important one. In addition to that, it assists the body's cells in absorbing nutrients. It is the electrolyte ion that is present in the body in the greatest abundance (Emenike *et al.* 2014).

Magnesium is essential for the process through which cells convert nutrients into energy. Magnesium is very important to the function of both the brain and the muscles. Additionally, potassium is used by the cells in addition to sodium. When a sodium ion enters a cell, it forces the exit of a potassium ion, and the reverse is also true. Potassium is an element that plays an extremely important role in the functioning of the heart. Both too much and too little may put a significant strain on the heart (Ludvigsson 2020).

Calcium is an essential component of the body, but it has other functions as well, such as maintaining healthy bones and teeth. In addition, it is used in the transmission of impulses within neurons, the regulation of the beat of the heart, and other functions. When calcium levels in the blood are either too high or too low, it may trigger a broad variety of symptoms that can affect a variety of systems throughout the body. The body's second-most prevalent ion is called chloride, which is the word for an ion that contains chlorine (Gamba *et al.* 2015). It is also an essential component in the process by which cells maintain the fluid balance both inside and outside of their cells. Additionally, it contributes to the preservation of the natural pH equilibrium of the body. Phosphate is a molecule that is based on phosphorous and is an essential component in the process of moving chemical compounds and molecules outside of cells. It does this by assisting cells in the process of metabolizing nutrients, and it is also an essential component of molecules that are termed nucleotides. Nucleotides are the fundamental components of DNA (Zhang *et al.* 2020).

Not all of the carbon dioxide that is produced by the body is transported to the lungs so that it may be exhaled. Instead, part of it is converted back into bicarbonate, which the body utilizes to maintain the regular pH levels of the blood. Besides, Acidosis is condition known as acidosis that may develop when there is not enough bicarbonate in the body. This makes you feel tired, sick, and sick to your stomach, and causes you to breathe more quickly and deeply. Additionally, it may lead to misunderstandings. An excessive amount of bicarbonate may lead to alkalosis, a condition in which the blood becomes overly alkaline. Confusion, apathy, irregular heartbeats, and twitching of the muscles are some of the symptoms (Boubred *et al.* 2015).

2.4 Bicarbonate

2.4.1 Background

The body requires the molecule known as a base, which is bicarbonate, in order to assist in maintaining a proper acid-base (pH) balance. This equilibrium protects the body from becoming too acidic, which is a state that may lead to a variety of health issues. By expelling excess acid from the blood, the lungs and kidneys help to maintain a healthy blood pH. The majority of the serum bicarbonate that is transported across the body is in the form of carbon dioxide (CO_2), which is a gas that is dissolved in the blood. Because of this, the concentration of carbon dioxide in the blood is measured to determine the level of serum bicarbonate (base), and therefore, the acid-base equilibrium. If the CO_2 level in the blood is excessively low, this indicates that the serum bicarbonate (base) level is also low, and the body has an excess of acid (Figure 2.4) (Fiore *et al.* 2016).

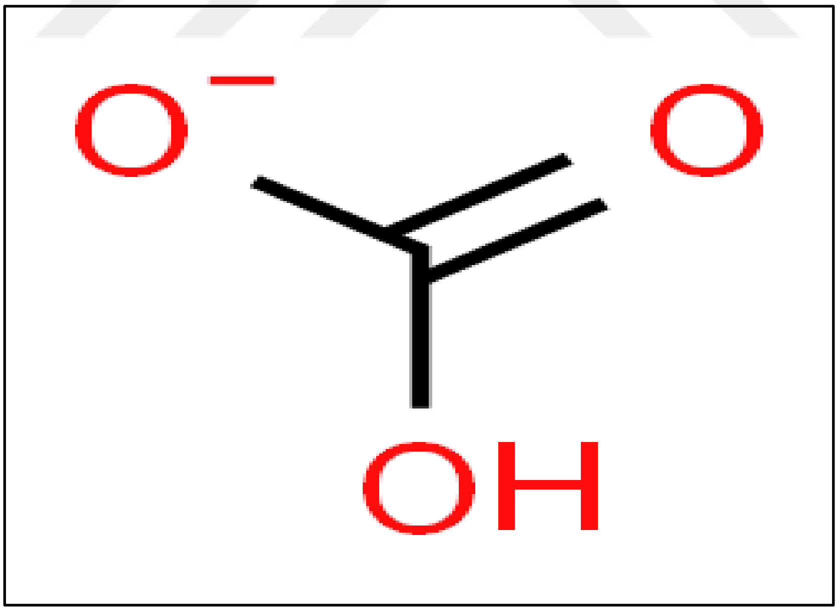

Figure 2.4 Structure of bicarbonate (Melamed *et al.* 2020)

On the other hand, this particular test determines how much bicarbonate, which is a kind of carbon dioxide, is present in the blood. Bicarbonate is also effective when combined with sodium and potassium, in addition to chloride. Electrolytes are the name given to these many chemicals. It is common practice to do these measurements at the same time as those for bicarbonate. A disease known as metabolic alkalosis, which leads to an elevation in tissue pH, may be the source of a high bicarbonate concentration in the blood. The loss of acid from the body, which may occur as a result of things like vomiting and dehydration, can lead to metabolic alkalosis. There is a possibility that it is connected to other illnesses, such as anorexia and chronic obstructive pulmonary disease. A condition known as metabolic acidosis, often known as an excess of acid in the body, may be brought on by an insufficient amount of bicarbonate in the blood. Metabolic acidosis may be brought on by a broad variety of illnesses, including but not limited to diarrhea, renal disease, and liver failure (Loniewski and Wesson 2014).

2.4.2 Treatment

According to a number of studies, receiving therapy in the form of the base chemicals sodium bicarbonate (also known as baking soda) or sodium citrate tablets may assist in preventing the progression of renal disease. However, tablets containing sodium bicarbonate or sodium citrate should not be taken until directed to do so by a member of the healthcare team. An other therapy modality that binds excess acid in the colon is now under investigation as a potential treatment for metabolic acidosis (Abramowitz 2017).

In addition to consuming a large quantity of fruits and vegetables, following a diet that is mostly composed of plant-based proteins as opposed to animal-based proteins may assist in preventing an increase in blood acid levels. When performed as part of an electrolyte or metabolic panel, measuring bicarbonate may assist in the diagnosis of an electrolyte imbalance, as well as acidosis or alkalosis. Both acidosis and alkalosis are terms used to describe abnormal states that may arise as a consequence of an imbalance in the pH of the blood, which can be brought on by an accumulation of either acid or alkali (base). This imbalance is generally brought on by a preexisting ailment or sickness more below the surface (Boedtkjer and Aalkjaer 2022).

The principal organs responsible for the elimination of excess bicarbonate from the blood are the lungs and the kidneys. This helps to maintain a healthy blood pH. Through the release of carbon dioxide, the lungs remove acid from the body. Altering the pace of breathing in and out may cause a change in the quantity of carbon dioxide exhaled, which in turn can have an immediate impact on the pH of the blood. The kidneys are responsible for eliminating acids in the urine and regulating the amount of bicarbonate (HCO_3–, a base) that is present in the blood. Changes in acid-base balance brought on by shifts in HCO_3– concentration occur far more slowly than shifts in CO_2 concentration, requiring hours or days to take effect (Adeva *et al.* 2014).

Acidosis and alkalosis are both conditions that have the potential to be brought on by any illness or condition that has an effect on the lungs, kidneys, metabolism, or respiration. A healthcare practitioner may get a general idea of the patient's acid-base balance by using the bicarbonate test. In most cases, this is adequate; however, if more information is required, measurements of the gases that are dissolved in the blood, known as blood gases, may be performed. In an electrolyte panel, bicarbonate is often measured with sodium, potassium, and potentially chloride. This is because the equilibrium of these molecules is what provides the healthcare practitioner with the most information (Dobre *et al.* 2015).

It is imperative that considerable care be used prior to the administration of bicarbonate. Although there are circumstances in which bicarbonate may be beneficial, it is essential to keep in mind that there is research suggesting that abrupt correction of blood pH might paradoxically result in a lower pH level in cerebral fluid. It is essential that you be aware of the fact that the metabolization of ketones will result in the formation of bicarbonate on an endogenous level. Because of this, the standard calculation used to correct acidosis will result in an overestimation of the amount of bicarbonate that is necessary to correct acidosis in patients who have the disease. The impact that the injection of bicarbonate has on serum potassium must also be taken into consideration, and it is possible that extra potassium must be given (Madeswaran and Jayachandran 2018).

3. MATERIALS AND METHODS

3.1 Materials

3.1.1 Devices, tools, and kits

Some of medical requirements and others materials that used in the current study to arrive to the study aim are illustrated in Table 3.1, Table 3.2 shows the kits used and their lot nomber, the real photos of some laboratory devices are illustrated in appendicses.

Table 3.1 Medical requirements and tools

The medical requirements	**Origins**
Water distilled	GFL, Germany
Water path	Memmert, Germany
Laboratory medical device kind Centrifuge	Hettich, Germany
Colling system (Refrigerator)	Samsung, Korea
Laboratory medical device kind ELISA analyzer	Germany
Precision pipette 50 µL, 100 µL, 1 mL	China
Disposable pipette tips	China
Vortex mixer	UK
Microtiter plate readre	UK

3.1.2 Chemicals and reagents

Table 3.2 The kits used and their lot number

Kits used	**Lot No.**
Urea	P420
Creatinin	D484
Sodium	NA160
Potasum	K203
Calcium	B311
Chloride	21002

Magnessium	2101
Phosphorus	2100

3.1.3 Patients chosen

Patients participating in this medical research were selected and classified according to Wagner's classification and consent. Ethical commitment was taken from the participants. The selection and division was for individuals and it was randomly assigned to groups.

3.1.4 Studied groups

The current study included two groups, the first group is the patient's group, it is performed on 100 subjects (Men and Women) of Iraqi patients with CKD in the age range (20-68 years) in Baquba teaching hospital in Ibn Sina Center for Dialysis, the second group is called control group, it is included about 40 healthy subjects as control (Men and Women). Figure 3.1 refers the our groups of the current medical job to determine the aim of the study.

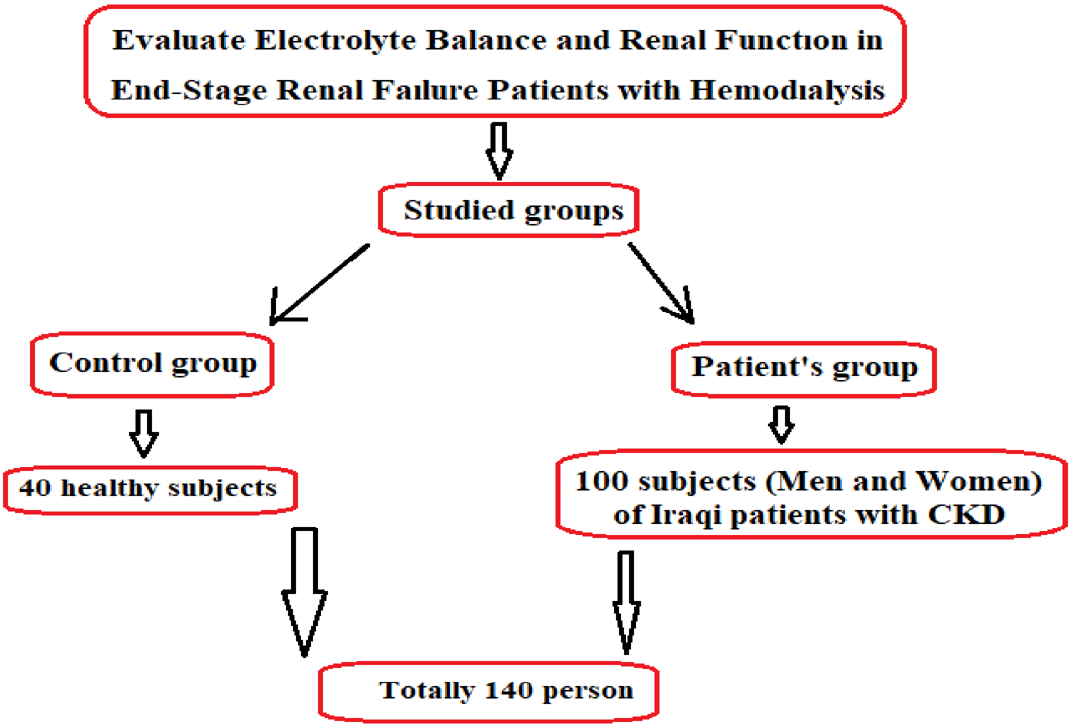

Figure 3.1 Studied groups

3.2 Methods

3.2.1 Determination of Calcium (Ca)

We have prepared triple test tubes (blank, standard and sample) to complete this type of medical laboratory test. In each tube, approximately 0.5 ml of working reagent for this type of test No. 1 and 0.5 ml of factor reagent No. 1 have been placed. 2. After this step, we added approximately 25 µL of distilled water to the three test tubes (empty), then approximately 25 µL of the standard solution was added to one of the three test tubes (standard tube). After this step, it is important to add approximately 25 µL of blood sample drawn from participants and placed into a sample tube. The last step was the process of incubating all tubes for about 5 minutes, thermometer at below room temperature, reading the absorbance at 500 nm and recording the results, Equation (3.1) shows the procedure to determine the Calcium level (mg/dL).

$$\text{Calcium concentration (mg/ dL)} = (A_{\text{specimen}} / A_{\text{standard}}) \times \text{Concentration}_{\text{Standard}} \quad (3.1)$$

3.2.2 Determination of sodium in blood serum

This method is based on precipitating the sodium and protein in the serum using magnesium uranyl acetate. After that, the excess uranyl ions combine with thioglycolic acid to generate a complex that disrupts inversely to the concentration of sodium in the sample. Equation (3.2) shows the procedure for calculations Sodium (Na) levels.

$$\text{Sodium (mmol/ L)} = \{(A_{\text{Blank}} - A_{\text{Sample}}) / (A_{\text{Blank}} - A_{\text{Standard}}) \times C_{\text{Standard}} \quad (3.2)$$

3.2.3 Potassium (K) test

We used the Potassium (K) measurements to moniter the electrolyte balance in the disease diagonsis coditions characterised by high or low Potassium levels in the blood. The kinetic coupling assay is used to determined the Potassium levels by using Potassium dependent pyruvate kinase, then the pyruvate is converted to lactate accompanying conversion of NADH to NAD. The decreas of optical density at 380 nm is proportional to the Potassium concetration in the sample. For the calculation the Potassium levels, it can be use the Equation (3.3).

$$\text{Potassium concetration (mmol / L)} = \{(\text{A2-A1})_{\text{Sample}} / (\text{A2-A1})_{\text{Calibrator}}\} \times C_{\text{Calibrator}} \quad (3.3)$$

3.2.4 Chloride test

The thiocyanate is displaced from mercuric thiocyanate by chloride ions in the sample (as illustrated in Equation (3.4) and Equation (3.5) respectively, the thiocyanate ions reacts with ferric ions to form a complex of red ferric thiocyanate proportional to the chloride concetration present in the sample.

$$2Cl^{-} + Hg\,(SN)_2 \longrightarrow HgCl_2 + 2\,SCN^{-} \quad (3.4)$$

$$3SCN^{-} + Fe^{+3} \xrightarrow{\qquad} Fe(SCN)_3 \qquad (3.5)$$

3.2.5 Magnessium (Mg) test

This procedure is based on the binding of calmogite and Magnessium at pH 11.5 to form a complex of calmagite – Magnessium (Equation (3.6). The compophore intensity formed is proportional to the Magnessium level in the collected sample. For calculations the Magnessium values, it uses Equation (3.7).

$$\text{Calmagite + Magnessium} \xrightarrow{\text{pH 11.5}} \text{Calmagite – Magnessium complex} \qquad (3.6)$$

$$\text{Magnessium concentration (mg/dL)} = (A_{\text{Sample}} / A_{\text{Standard}}) \times C_{\text{Standard}} \qquad (3.7)$$

3.2.6 Phosphorus test

In the presence of sulfuric acid, inorganic phosphate reacts with ammonia molybdate to form a phosphomolybdic complex which is measured at 340 nm. Equation (3.8) shows the procedure for calculation the Phosphorus levels.

$$PO4^{-3} + H^{+} + (NH4)_6\,MO_7O_{24} \xrightarrow{\text{Pi}} \text{Phosphomolybdic complex} \qquad (3.8)$$

3.2.7 Bicarbonate test

Principle

The oxaloacetate is produced from PEPC catalyses the reaction (see Equation (3.9), Equation (3.10, and Equation (3.11) respectively. In the presence of MDH, the reduced cofactor undergoes oxidation at the hands of oxaloacetate. The reduction in the concentration of reduced cofactor, which was measured at 405-415 nm, has a relationship that is proportionate to the total carbon dioxide content in the sample. The PEPE is very selective for the bicarbonate ion, and as a result, it throws off the balance during the conversion of carbon dioxide to bicarbonate.

$$\mathrm{PEP} + \mathrm{HNO_3} \xrightarrow{\mathrm{PEPg + Mg}} \mathrm{Oxaloacetate} + \mathrm{H_2PO_4} \tag{3.9}$$

$$\mathrm{Oxaloacetate} + \mathrm{Redused\ cofactor} + \mathrm{H^+} \xrightarrow{\mathrm{HDH}} \mathrm{Malate} + \mathrm{cofactor} \tag{3.10}$$

$$\mathrm{CO_2} + \mathrm{H_2O} + \mathrm{H_2O} \Longleftrightarrow \mathrm{H_2CO_3} \Longleftrightarrow \mathrm{H^+}\ \mathrm{HNO_3^-} \tag{3.11}$$

3.2.8 Urea test

This technique is based on urease enzyme is hydrolyzed the urea into ammonia and carbon dioxide. Ammonia reacts with alkaline hypochloride and Sodium (Na) salicylate in presence of Sodium nitroprusside to form a green cromophore. The color intensity formed is proportional of the urea concentration in the sample. For this kind of calculations, it can be use Equation (3.12) and Equation (3.13).

$$\mathrm{Urea} + \mathrm{H_2O} \xrightarrow{\mathrm{Urease}} 2\mathrm{NH_3} + \mathrm{CO_2} \tag{3.12}$$

$$\mathrm{NH4^+} + \mathrm{Salicylate} + \mathrm{NaClO} \xrightarrow{\mathrm{Nitroprusside\ /OH^-}} \mathrm{Indolphenol} + \mathrm{NaCl} \tag{3.13}$$

3.2.9 Creatinine test

Under alkaline conditions, creatinine reacts with bicarbonate ions, resulting in the formation of a new compound. This new compound has a reddish color. It is necessary to measure the rate of absorption through the formation of a compound in a predetermined period of time, the concentration of this compound is proportional to the concentration of creatinine in the sample. Equation (3.14) shows the principle for for calculation creatinine levels.

$$\text{Creatinine} + \text{Picric acid} \xrightarrow{\text{pH 12, 37 °C}} \text{Red complex} \tag{3.14}$$

4. RESULTS

The aim of the study is to evaluate the evaluation of some biochemical variables in hemodialysis patients, these parameters were determined to investigate renal function in end stage renal failure by (urea, creatinine), and electrolyte levels in end stage renal failure by (Na, K, Cl, Mg, Phosphorus, Bicarbonate and Ca).

The study included two groups, the patient group included 100 samples, while the control group included 40 samples, and the results were as follows:

Table 4.1 The results of the current study parameters

Group Statistics						
	Groups	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**P**
Age	Group A	40	43.8000	17.23324	2.72481	0.044
	Group B	100	48.7300	14.95168	1.49517	0.018
Na	Group A	40	138.1850	4.97989	0.78739	0.000
	Group B	100	130.4440	5.22052	0.52205	0.000
K	Group A	40	3.3095	0.39417	0.06232	0.002
	Group B	100	4.7733	0.86941	.08694	0.000
Cl	Group A	40	127.2775	158.10274	24.99824	0.115
	Group B	100	102.2730	6.60613	0.66061	0.324
Ca	Group A	40	9.9502	0.36780	0.05815	0.300
	Group B	100	8.7020	1.03788	0.10379	0.300
Creatinine	Group A	40	0.7740	0.15238	0.02409	0.000
	Group B	100	5.7476	1.84493	.18449	0.000
Urea	Group A	40	25.2425	6.50999	1.02932	0.000
	Group B	100	113.1975	37.93759	3.79376	0.000
Mg	Group A	40	2.1855	0.16986	0.02686	0.308
	Group B	100	2.2517	0.39440	0.03944	0.168
PO_4	Group A	40	3.6725	0.67406	0.10658	0.000
	Group B	100	4.8812	1.62348	0.16235	0.000
Bicarbonate	Group A	40	24.6075	0.92303	0.14594	0.000
	Group B	100	21.7830	2.06089	0.20609	0.000

4.1 The Age and Gender

The average age indicated that there are significant differences of statistical significance between the group of patients (48.73 ± 14.95168) and the control group (43.80 ± 17.23324) at P = 0.094. This indicates that the disease may affect people of different ages. But it may indicate a little that the injury may be more severe in old age. As for gender, the results indicated that men were more susceptible to kidney disease than women. As a shown in Figure 4.1 and Table 4.1. The results of the correlation between age with urea r = 0.107 at P = 0.210, with creatinine r = 0.034 at P = 0.688, as in Table 4.3, which indicated that there is no correlation.

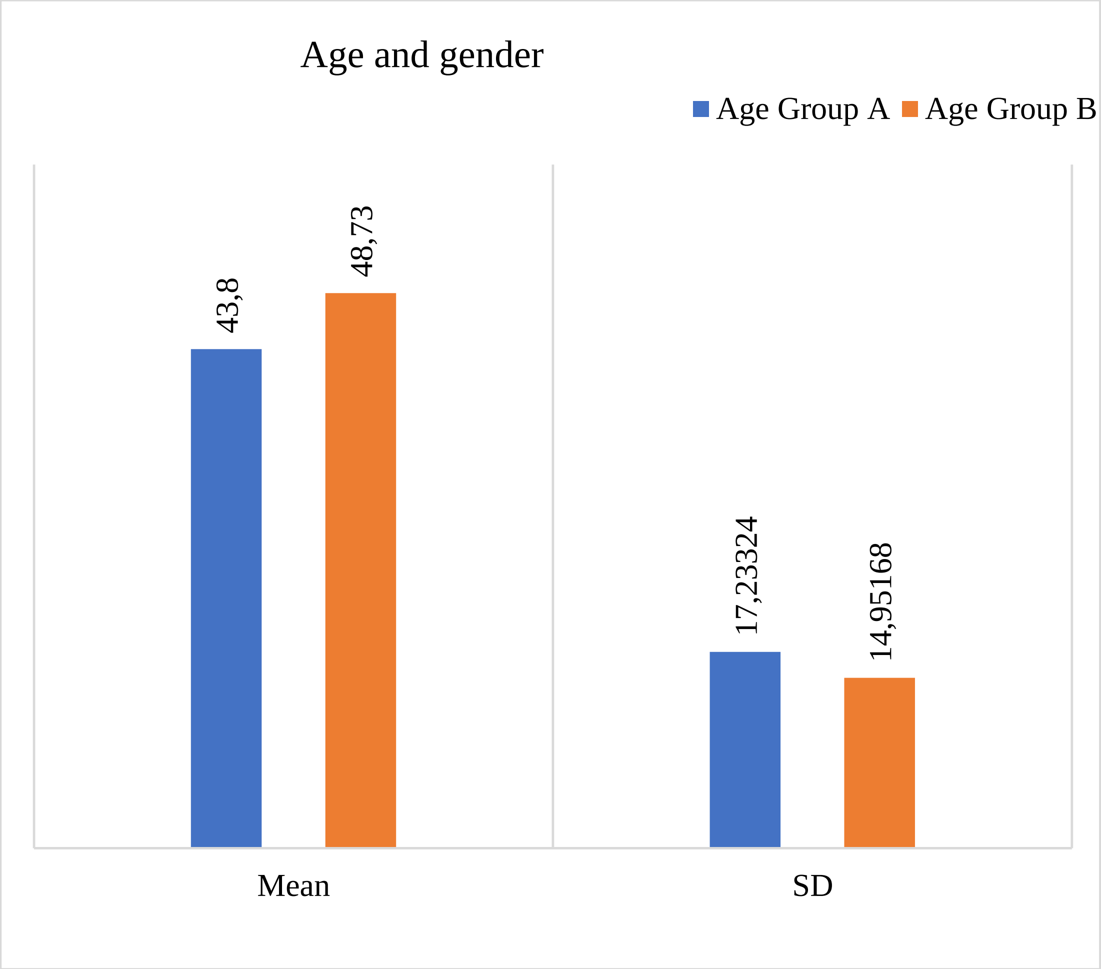

Figure 4.1 The age and gender results

4.2 The Potassium (K)

In the same study, the averages of Potassium levels have indicated that there are high significant statistically significant differences between the group of patients (130.444 ± 5.22052) and the control group (138.185 ± 4.97989) at P = 0.000. This indicates that Potassium levels are clearly affected in patients with kidney disease. Which leads us to the fact that its levels must be maintained within the normal level in kidney patients in order to maintain the stability of the patient's condition. As a shown in Figure 4.2 and Table 4.1. The results of the correlation between age with urea r = -0.460 ** at P = 0.000, with creatinine r = -0.464** at P = 0.00, as in Table 4.3, which indicated that there is some correlation.

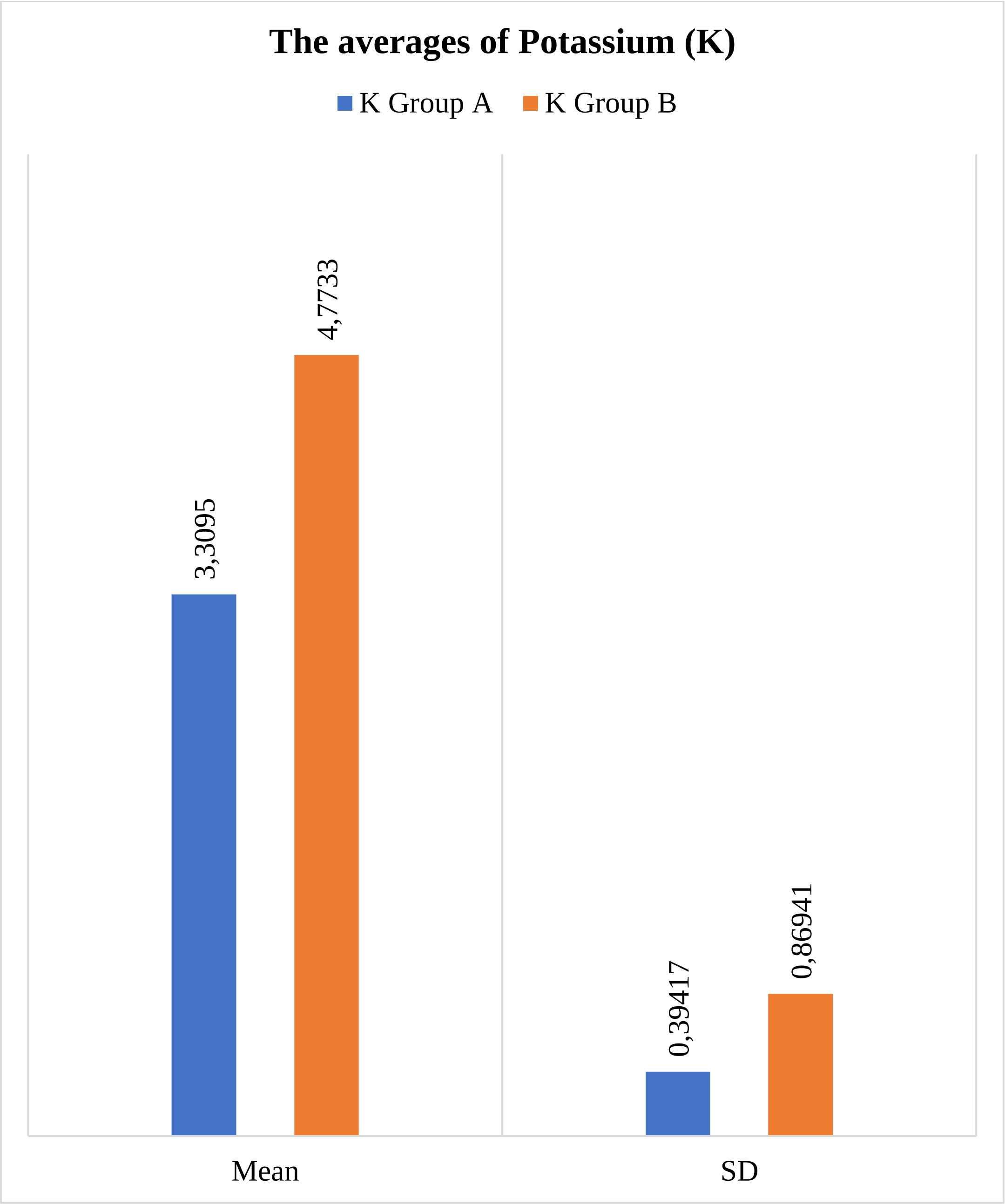

Figure 4.2 The average of potassium (K) levels

4.3 The Sodium (Na)

The averages of Sodium (Na) also found that there are significant differences that have clinical importance and may increase the early diagnosis of kidney failure, and that the results were statistically significant between the patient's group (4.7733 ± 0.86941) and the control group (3.3095 ± 0.39417) at P = 0.002. As a shown in Figure 4.3 and Table 4.1. The results of the correlation between age with urea r = 0.469** at P = 0.000, with creatinine r = 0.436** at P = 0.00, as in Table 4.3, which indicated that there is some correlation.

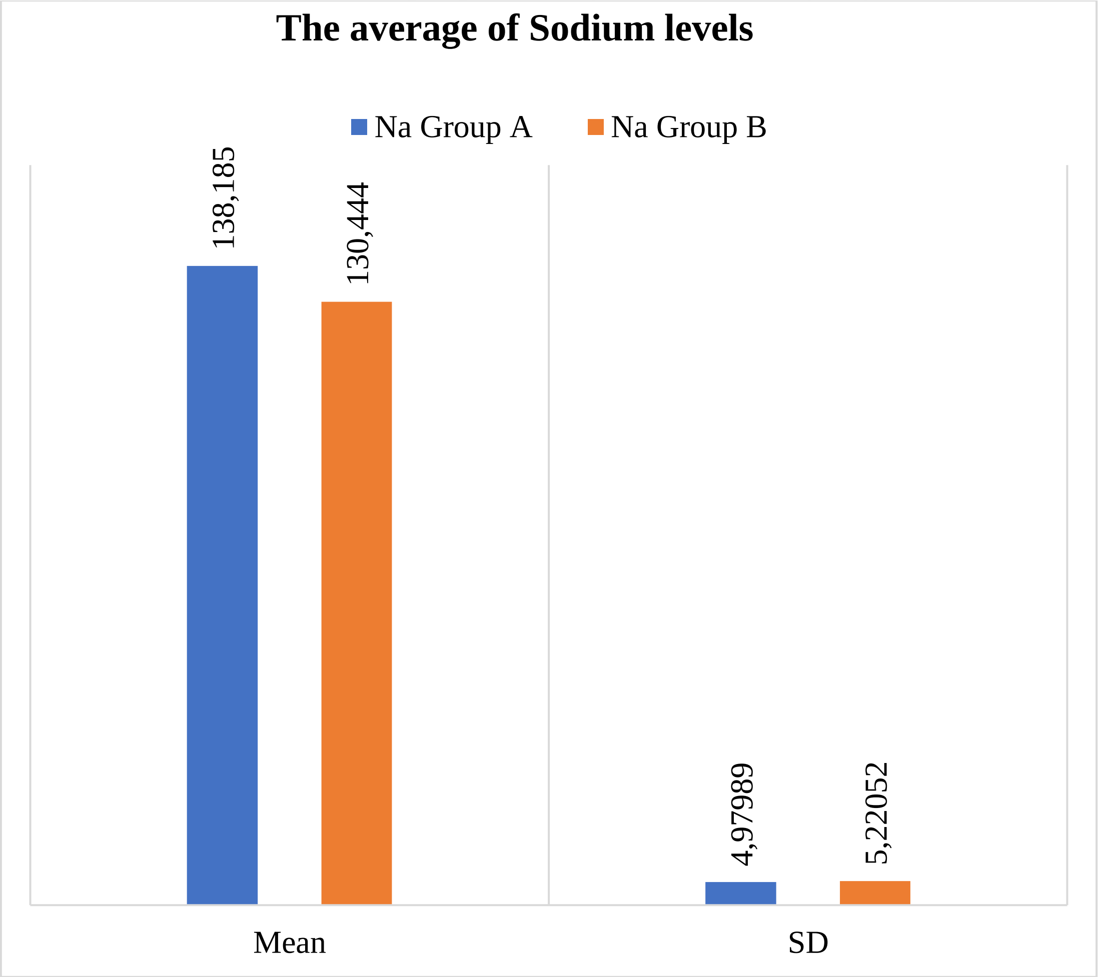

Figure 4.3 The average of sodium (Na) levels

4.4 The Chlorine

The results of the averages of chlorine indicated that there were no significant differences and their levels did not change in a way that can be used in diagnosing the disease, but it is possible to increase the chances of following up on the disease, and that the results were non-statistically significant between the group of patients (102.2730 ± 6.60613) and the control group (127.2775 ± 158.10274) when P = 0.115. As a shown in Figure 4.4 and Table 4.1. The results of the correlation between age with urea r = -0.110 at P = 0.197, with creatinine r = -0.109 at P = 0.201, as in Table 4.3, which indicated that there is no correlation.

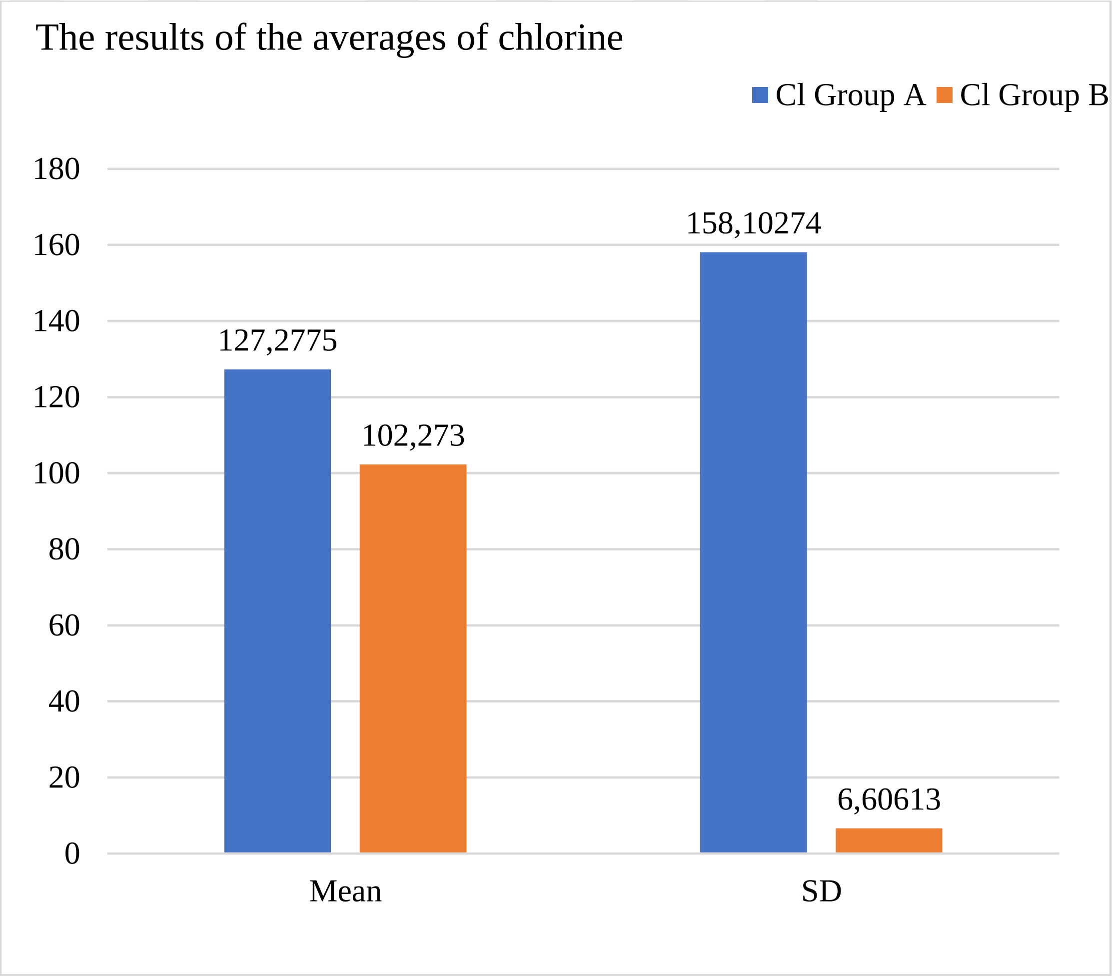

Figure 4.4 The results of the averages of chlorine

4.5 The Calcium (Ca)

When conducting a statistical analysis of the results of Calcium concentrations, it was indicated that there are slight significant differences and their levels did not change from the normal level in a way that they can be used in diagnosing the disease, studying the development of the disease, but it is possible that the levels of their concentrations can be used in the follow-up of the disease during the treatment period, and the results are between Patients group (8.7020 ± 1.03788) and control group (9.9502 ± 0.36780) had statistical differences between them at P = 0.300. As a shown in Figure 4.5 and Table 4.1. The results of the correlation between age with urea r = -0.564** at P = 0.000, with creatinine r = -0.496** at P = 0.000, as in Table 4.3, which indicated that there is some correlation.

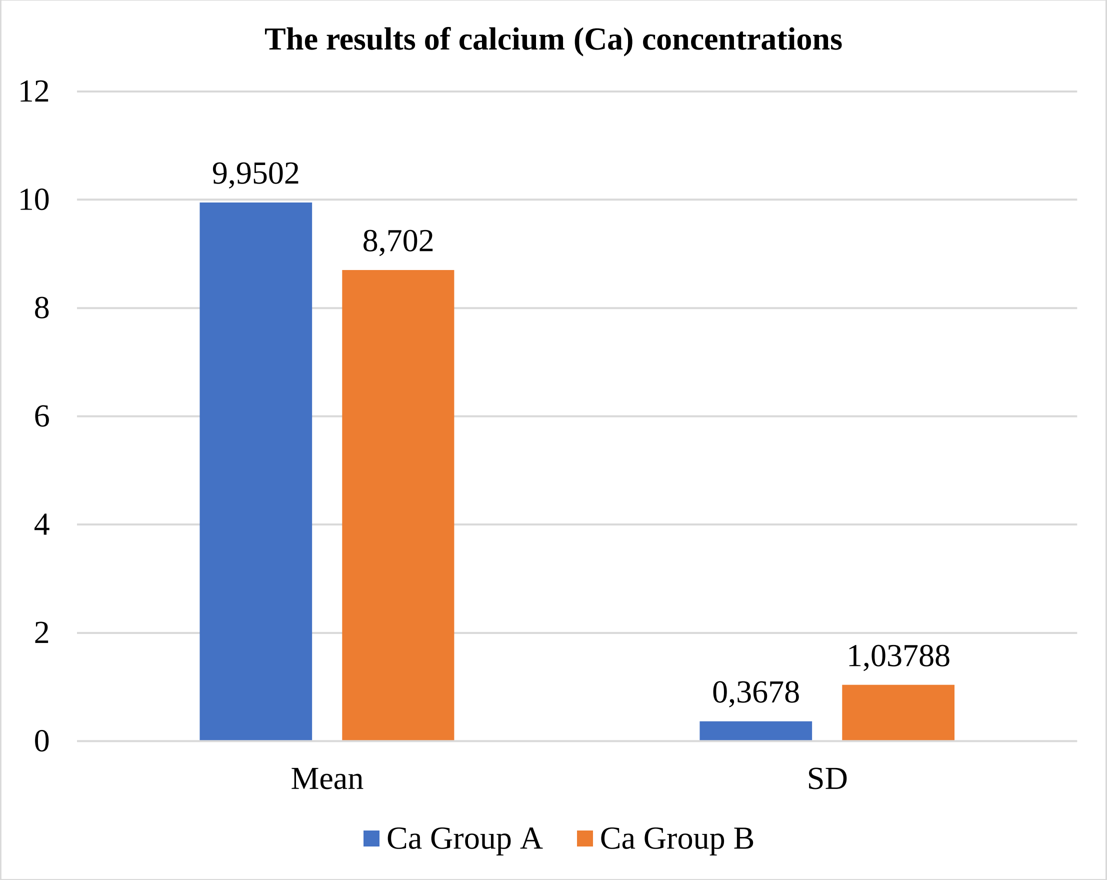

Figure 4.5 The results of calcium (Ca) concentrations

4.6 The Blood Urea and Creatinine

The urea and creatinine tests are important in diagnosing patients with renal failure, and the results of the statistical analysis in our study were that the results between the group of patients (113.1975 ± 37.93759 and creatinine = 5.7476 ± 1.84493) and the control group (Urea= 25.2425 ± 6.50999 and creatinine = 0.7740 ± 0.15238) were statistically significant at P = 0.000. It indicates high statistical differences of great clinical importance in the diagnosis and follow-up of patients, as well as the importance of the test through their association with electrolyte treatments. As a shown in Figure 4.6, Figure 4.7, and Table 4.1.

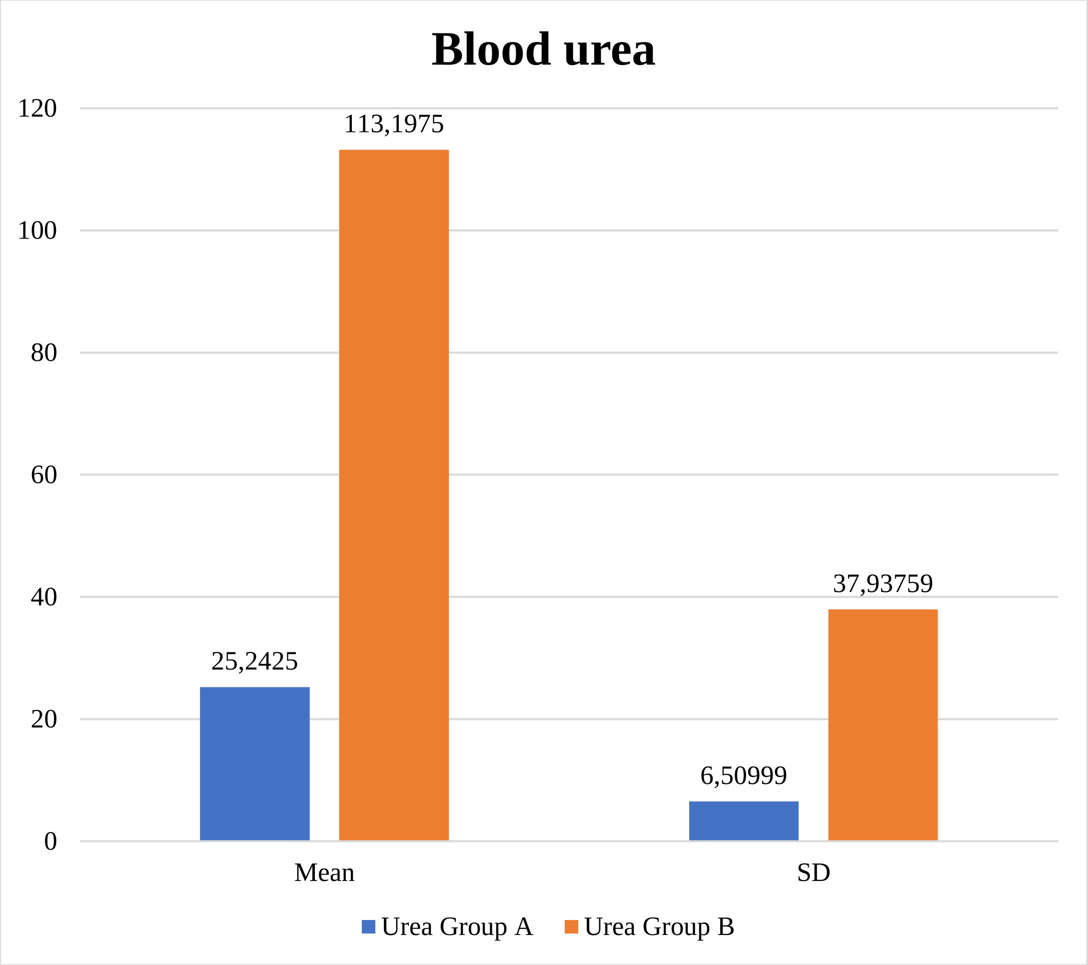

Figure 4.6 The results of blood urea

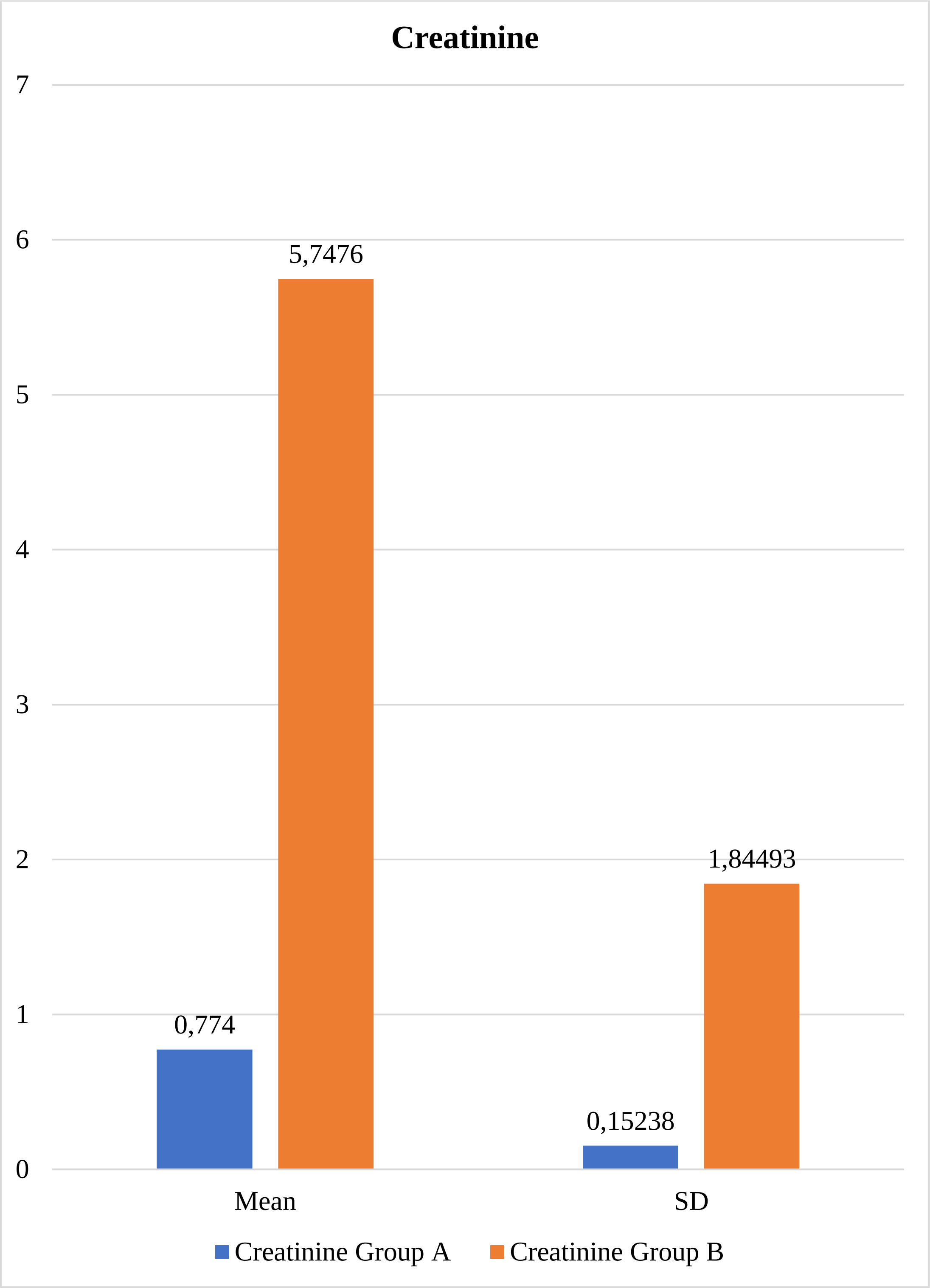

Figure 4.7 The results of creatinine levels

4.7 The Magnesium (Mg)

The average magnesium refers to no statistically significant differences between the patient group (2.2517 ± 0.39440) and the control group (2.1855 ± 0.16986) at P = 0.308. The ratios of the means were close to equal, and this indicates that the patient's magnesium levels may not be affected. As a shown in Figure 4.8 and Table 4.1. The results of the correlation between age with urea r = 0.217** at P = 0.010, with creatinine r = 0.236** at P = 0.005, as in Table 4.3, which indicated that there is some correlation.

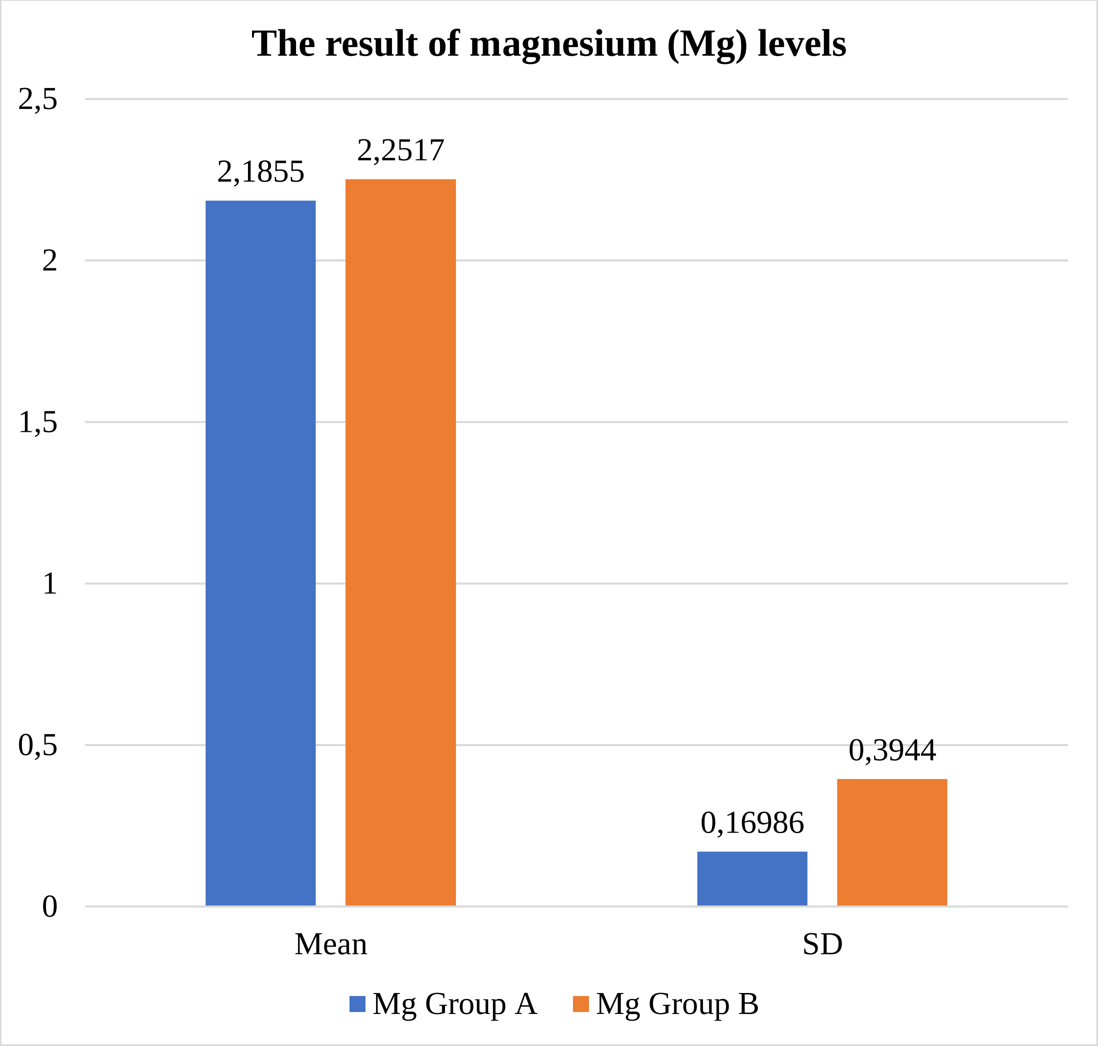

Figure 4.8 The result of magnesium (Mg) levels

4.8 The PO_4

In the same study, PO_4 averages indicated highly significant differences between patient group (4.8812 ± 1.62348) and control group (3.6725 ± 0.67406) at $P = 0.000$. This indicates that PO_4 levels are clearly affected in renal patients. Which leads us to the need to maintain its levels within the normal level in patients with kidneys in order to maintain the stability of the patient's condition, and is considered important in the diagnosis and follow-up of the disease. As a shown in Figure 4.9 and Table 4.1. The results of the correlation between age with urea $r = 0.632^{**}$ at $P = 0.000$, with creatinine $r = 0.640^{**}$ at $P = 0.000$, as in Table 4.3, which indicated that there is some correlation.

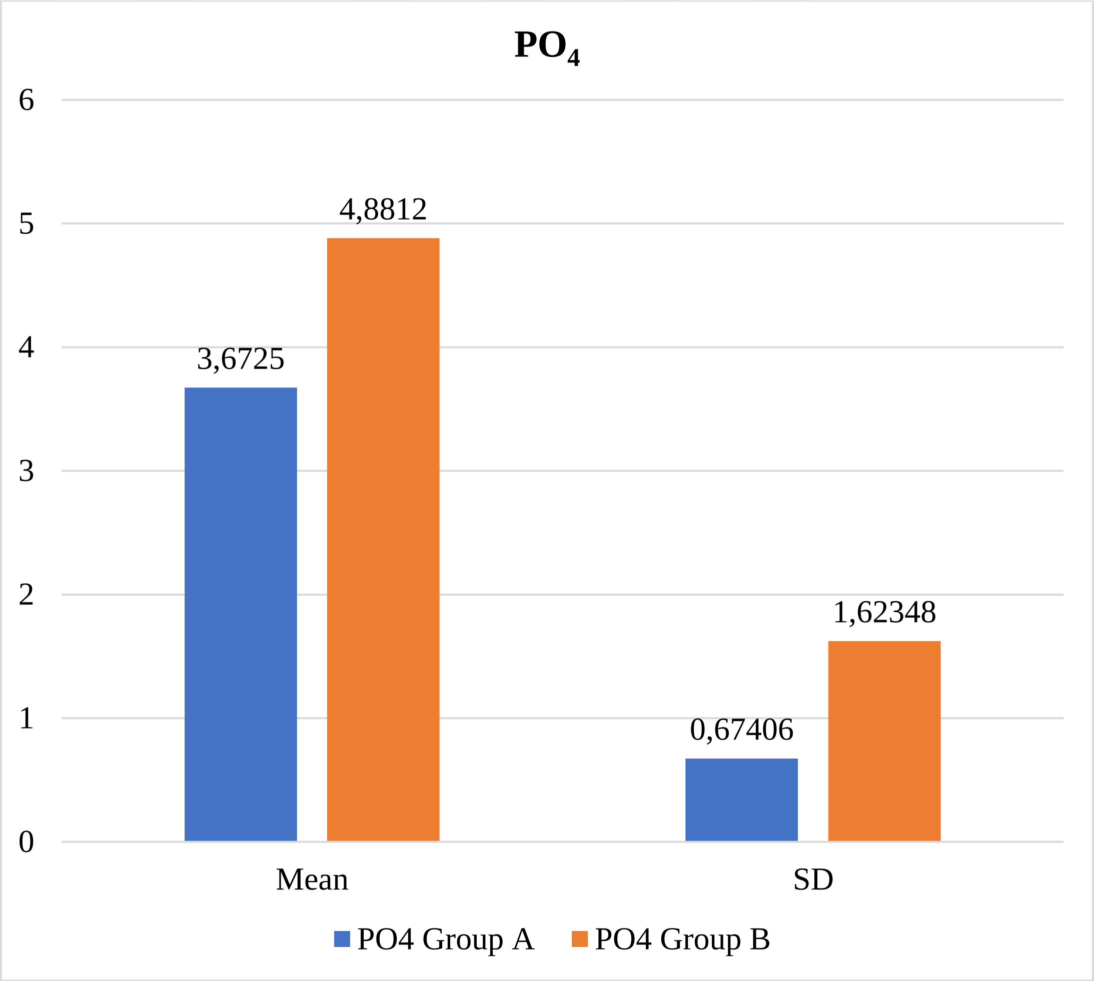

Figure 4.9 The results of PO_4

4.9 The Bicarbonate

When conducting a statistical analysis of the results of Bicarbonate concentrations, it was indicated that there are slight statistically significant differences and their levels may change from the normal level in a way that can be used in the diagnosis of the disease and the study of disease progression. But it is possible to use the levels of Bicarbonate concentrations in the follow-up of the disease through the time of the treatment, and the results between the patient's group (21.7830 ± 2.06089) and the control group (24.6075 ± 0.92303) had a statistically significant difference between them at P = 0.000. As a shown in Figure 4.10 and Table 4.1. The results of the correlation between age with urea r = -0.720** at P = 0.000, with creatinine r = -0.844** at P = 0.000, as in Table 4.3, which indicated that there is some correlation.

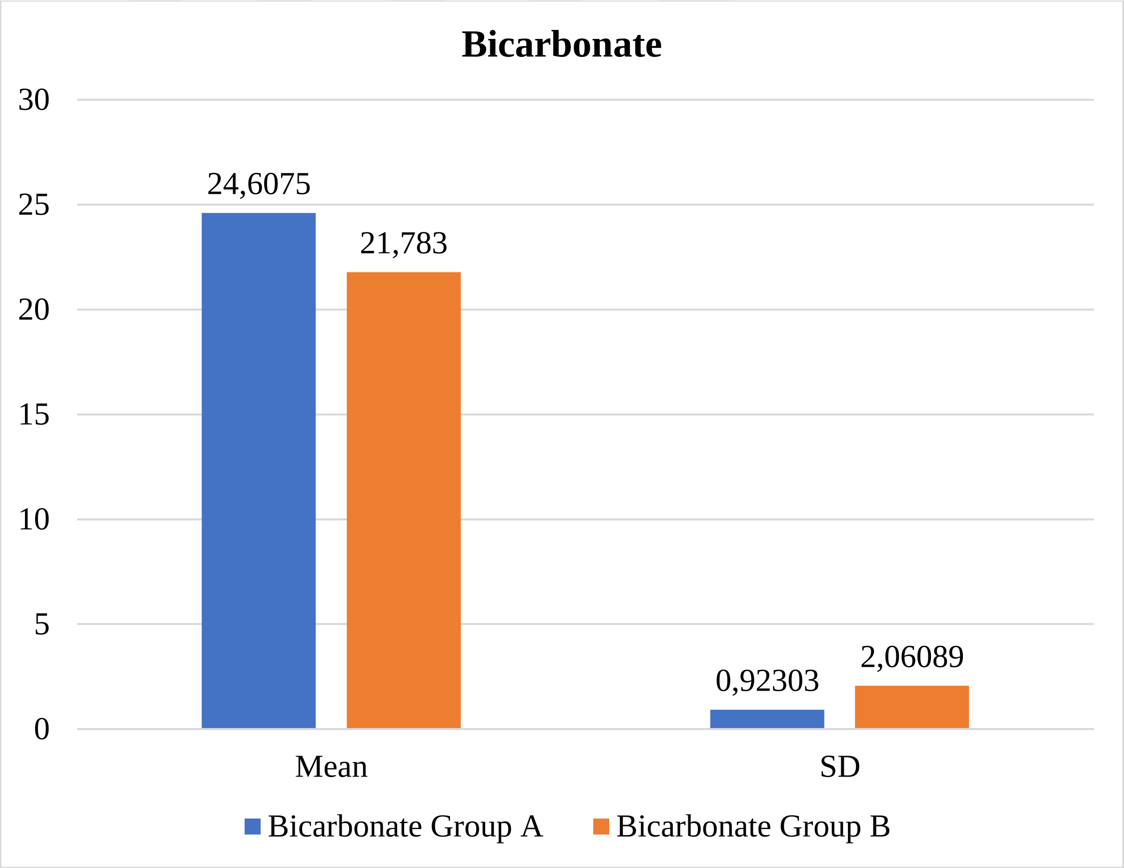

Figure 4.10 The results of bicarbonate levels

4.10 The Distance Covariance Test of Independence

The results of independence test were as in Table 4.2 and computed distance covariance test for independence. Which shows the value of F, the Levene Test and the t-test for Equality.

Table 4.2 The results of independence test

Indep Test					
		Levene Test		**t-test for Equality**	
		F	**Significance**	**T**	**df**
Age	Equal variances	0.955	0.330	-1.686	138
	Not Equal variances			-1.586	63.745
Sex	Equal variances	15.473	0.000	-1.743	138
	Not Equal variances			-1.801	77.210
Na	Equal variances	0.017	0.896	8.029	138
	Not Equal variances			8.194	75.107
K	Equal variances	16.460	0.000	-3.238	138
	Not Equal variances			-4.336	135.836
Cl	Equal variances	8.624	0.004	1.587	138
	Not Equal variances			1.000	39.054
Ca	Equal variances	21.875	0.000	7.409	138
	Not Equal variances			10.492	136.714
Creatinine	Equal variances	58.023	0.000	-16.990	138
	Not Equal variances			-26.731	102.330
Urea	Equal variances	49.309	0.000	-14.547	138
	Not Equal variances			-22.375	112.564
Mg	Equal variances	21.301	0.000	-1.023	138
	Not Equal variances			-1.387	137.209
PO_4	Equal variances	14.982	0.000	-4.547	138
	Not Equal variances			-6.224	137.766
Bicarbonate	Equal variances	28.655	0.000	8.326	138
	Not Equal variances			11.185	136.226

4.11 The Correlation between Urea and Creatinine with Parameters Group

The results of the correlation for all studied parameters and the urea and creatinine test were as in Table 4, which indicated that there were some correlations with varying degrees of correlation as explained in the results of the chemical parameters.

Table 4.3 The results of the correlation between the chemical parameters

Correlations			
		Urea	**Creatinine**
Age	Pearson Correlation	0.107	0.034
	Significance(2-tailed)	0.210	0.688
	N	140	140
Sex	Pearson Correlation	.026	.043
	Significance(2-tailed)	.765	.617
	N	140	140
Na	Pearson Correlation	-.460**	-.464**
	Significance(2-tailed)	.000	.000
	N	140	140
K	Pearson Correlation	.469**	.436**
	Significance(2-tailed)	.000	.000
	N	140	140
Cl	Pearson Correlation	-.110	-.109
	Significance(2-tailed)	.197	.201
	N	140	140
Ca	Pearson Correlation	-.564**	-.496**
	Significance(2-tailed)	.000	.000
	N	140	140
Creatınıne	Pearson Correlation	.859**	1
	Significance(2-tailed)	.000	
	N	140	140
Urea	Pearson Correlation	1	.859**
	Significance(2-tailed)		.000
	N	140	140
Mg	Pearson Correlation	.217**	.236**
	Significance(2-tailed)	.010	.005
	N	140	140
PO_4	Pearson Correlation	.632**	.640**
	Significance(2-tailed)	.000	.000
	N	140	140
Bıcarbonate	Pearson Correlation	-.720**	-.844**
	Significance(2-tailed)	.000	.000
	N	140	140
* Correlation at 0.05(2-tailed); ** Correlation at 0.01(2-tailed)			

5. DISCUSSION AND CONCLUSIONS

5.1 Discussion

Athletes often use creatine as a dietary supplement in the hope that it would improve their muscular performance. Creatine may be linked to an increased risk of developing renal impairment, as shown by the research that has been done so far. There was one case report of acute renal failure, which was found in a male who was 20 years old. It is possible that this is a deceptive sign of impaired kidney function due to the fact that creatine supplementation might raise creatinine levels. Other measures of renal function, such as serum creatinine and creatinine clearance, should be included in studies that are planned in the future (Yoshizumi and Tsourounis 2004).

The gradual decrease of kidney function that characterizes chronic renal failure necessitates the patient's participation in a protracted treatment program that takes the form of renal replacement therapy. One of the treatments for renal failure is called haemodialysis. This therapy removes waste products from the body, such as creatinine, urea, and excess water. Random samples were taken from seventy different patients. Before dialysis, the blood urea levels of 53% of patients were over 200 mg/dL, however after dialysis, the urea levels of 66% of patients were below 200 mg/dL. Regarding serum creatinine, 57% of patients had values between 7-12 mg/dL before dialysis, but after dialysis, the values were lowered below 7 mg/dL in 58% of patients. This indicates that dialysis is effective in lowering serum creatinine levels (Amin *et al.* 2014).

Electrolyte abnormalities are one of the most serious problems associated with renal illness, so be sure not to forget about them. When dealing with renal illness, it is vital to do strategic monitoring of electrolytes. When I think of chronic renal illness, one of the things that comes to me is the buildup of electrolytes as being something that requires our attention. Chronic kidney disease and acute renal failure may both cause an imbalance in a number of electrolytes in the body. Some of the electrolytes that might be affected are phosphorus, potassium, and magnesium. First, I'm going to talk about potassium and magnesium, and then I'll list several drugs that could make hyperkalemia and hypermagnesemia more difficult to treat (Weir et al. 2014).

Patients who are malnourished and have chronic renal failure and are taking PN are at an increased risk of having electrolyte problems, namely hypophosphatemia. When nutrition assistance is initiated for these individuals, electrolyte levels should be constantly checked, and supplementation should be started as soon as levels begin to fall under the normal range (Duerksen and Papineau 1998).

The kidneys are responsible for a significant portion of the acid-base and electrolyte balance control that occurs in the body. Derangements in electrolytes and acid-base balance are unavoidable as kidney function is gradually lost, and they are one of the factors that lead to unfavorable patient outcomes. Medical professionals are increasingly put in the position of having to deal with issues of this kind as a result of the widespread prevalence of chronic kidney disease (CKD). A correct diagnosis and treatment will reduce the likelihood of problems occurring and may even save a patient's life. In this review, we explain what we now know about the illness process, clinical presentation, diagnosis, and treatment techniques, incorporating the most recent information available on the subject. Despite the fact that electrolyte and acid-base derangements are major contributors to morbidity and mortality in patients with chronic kidney disease and end-stage renal disease, it is possible to effectively manage these conditions by promptly instituting a combination of preventive measures and pharmacological therapy. Exciting new developments, as well as a number of future outcome studies, will give more information that may help guide therapy and enhance patient outcomes (Dhondup and Qian 2017).

5.2 Conclusion

The mean age indicated, a significant differences between the group of patients and the control group at P = 0.094 and these results indicate that the disease may affect people of different ages that the infection may be more severe in old age. As for gender, the results indicated that men are more likely to develop kidney disease than women. The results of the Bison correlation test between age with urea, and age with creatinine indicated that there was no correlation. The mean sodium levels were highly significant between the patient group and the control group at P = 0.000. This indicates that sodium levels are clearly affected in patients with kidney disease. The results of the correlation between age with urea and creatinine to the presence of some correlation. The potassium averages also found that there are statistically significant differences that have clinical significance and may increase the early diagnosis of renal failure, and that the results were statistically significant between the two groups. The results of the association between age with urea and creatinine indicate an association. The results of the averages of chlorine indicate that there are no statistically significant differences and that their levels do not change in a way that can be used in diagnosing the disease, but it is possible to increase the chances of following up on the disease. The results of the correlation between age with urea and creatinine indicate that there is no correlation. The results of calcium concentrations, indicated that there were slight statistically significant differences and their levels did not change from the normal level in a way that can be used in diagnosing the disease and studying the development of the disease. The results of the association between age with urea and creatinine to the presence of the association. Urea and creatinine tests are important in the diagnosis of renal failure patients, and the results of the statistical analysis in our study were that the results between the patient group and the control group were statistically significant at P = 0.000. It refers to highly significant differences of clinical importance in the diagnosis and follow-up of patients, as well as the importance of testing through their association with electrolyte treatments. Magnesium: The results indicated that there were no statistically significant differences between the study groups. The results of the association between age with urea and creatinine to the presence of the association.

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APPENDICES

APPENDIX 1. ELISA analyzer (Human)

APPENDIX 2. Centrifuge (Hettich, Germany)

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