

Sudan University of Science and Technology

College of post graduate studies

**Effect of Hemodialysis on the Albumin, Calcium and
Phosphorus in Patients with Renal Failure**

**تأثير الغسيل الدموي على مستويات الالبومين ، الكالسيوم و الفسفور في مرضى الفشل
الكلي**

**Desertion submitted in partial fulfillment for master degree (M.Sc) in clinical
chemistry**

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Dedication

الي حكمتي وعلمي
الي ادبي وحلمي
الي طريقي المستقيم
الي طريق الهداية
الي ينبوع الصبر والتفاؤل والامل
الي كل من في الوجود بعد الله ورسوله امي الغالية
الي سندي وقوتي وملاذي بعد الله
الي من اثروني على نفسهم
الي من علموني علم الحياة
الي من اظهروا لي ما هو اجمل من الحياة اخوتي
الي من كانوا ملاذي وملجئي
الي من تذوقت معهم اجمل اللحظات
الي من سأفتقدهم واتمنى ان يفتقدوني.

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Words can never help to express my feelings towards every one stand beside me to carry work, so I would like to thanks all those who offered me as stance and help me to complete this work.

Abstract:

This study was carried out to measure serum levels of the calcium, albumin and phosphorus in patients of renal failure under hemodialysis. Eighty samples were collected from patients in period between January to March 2015, chosen randomly from ALnaw teaching hospital , and forty apparently, healthy individuals as controls, to assess the effect of hemodialysis on calcium ,albumin and phosphorus level.

Measure serum calcium, albumin and phosphorus by using biosystem, and results were analyzed using statistical of package social science (SPSS), computer program.

The study showed that the serum levels of calcium, albumin were significantly decreased, (p-value =0.05), (p-value =0.03) in the Sudanese patients under hemodialysis group. And the serum levels of phosphorus were significantly increased, (p-value =0.00 in the patients under hemodialysis group

Mean \pm SD for controls versus cases

(7.8 \pm 1.1 versus 10.5 \pm 12.3) for calcium

(2.7 \pm 0.8 versus 4.5 \pm 5.7) for albumin

(5.0 \pm 1.2 versus 3.6 \pm 1.1) for phosphorus

Also In this study showed that there was no significant difference between the levels of calcium, albumin and phosphorus according to gender "male or femle".

The results as follow:

Mean \pm SD for male versus gender

(7.7 ± 1.2 versus 8.0 ± 0.9) mg/dl, p-value ≤ 0.2) for calcium

(2.7 ± 0.7 versus $2.6 \pm .9$) mg/dl, p-value ≤ 0.83) for albumin.

(5.1 ± 1.2 versus 4.8 ± 1.2) mg/dl, p-value ≤ 0.35) for phosphorus

According to causes of chronic kidney disease the results of this study showed that; hypertension, diabetes and family history are the most common causes in Sudan.

It is concluded that; the levels of calcium, albumin were significantly decreased, in the patients with renal failure under hemodialysis, And the serum levels of phosphorus were significantly increased, in the patients with renal failure under hemodialysis.

مستخلص الدراسة

اجريت هذه الدراسة لمقارنه مستويات الكالسيوم ،الالبومين و الفسفور في مرضي الفشل الكلوي الذين يخضعون للغسيل الدموي. ثمانون عينه اخذت من هؤلاء المرضى ف الفتره مابين شهر يناير وحتى نهايه مارس . تم اختيارهم بطريقه عشوائيه من مستشفى النو، مع خمسون من الاصحاء كمجموعه تحكم "مجموعه ضابطه" لنقيس مدي تاثير الغسيل الدموي علي مستويات الكالسيوم ،الالبومين و الفسفور .

تم قياس مستويات الانزيمات الكبدية بواسطه جهاز الكيمياء السريره بايوسستم ، وتم تحليل البيانات بواسطه برنامج الحزمه الاحصائيه للعلوم الاجتماعيه.

توصلت نتائج هذه الدراسة الي ان هناك انخفاض ملحوظ في مستويات الكالسيوم ،الالبومين في المرضى الذين يخضعون للغسيل الدموي ، كان الاحتمال الاحصائي للمقارنه 0.05 و 0.03 على التوالي . وان هنالك ارتفاع ملحوظ في مستوى الفسفور وكان الاحتمال الاحصائي للمقارنه 0.00. وكانت النتائج كالآتي:-

"المتوسط+الانحراف المعياري عنمجموعه التحكم مقارنه بالمرضي"

12.7±10.6 مقابل 1.1±7.8 مليجرام/ديسلتر .للكالسيوم

4.5± 5.9مقابل 0.8± 2.7 جرام/ديسلتر. للالبومين

1.4 ±3.7مقابل 1.3±5.0مليجرام/ديسلتر . للفسفور

في هذه الدراسة ايضا وجد انه لا يوجد تغيير ملحوظ في مستويات الكالسيوم ،الالبومين و الفسفور تبعا للجنس وكانت النتائج كالآتي:

"المتوسط+الانحراف المعياري عند المرضى الذكور مقارنه بالاناث "

0.9066 ±8.01 مقابل 1.26±7.7مليجرام/ديسلتر، الاحتمال الاحصائي ≥ 0.2 بالنسبه للكالسيوم .

0.9 ±2.7مقابل 0.8±2.7جرام/ديسلتر، الاحتمال الاحصائي ≥ 0.83 بالنسبه للالبومين .

1.2 ±4.9مقابل 1.3±5.1 مليجرام/ديسلتر، الاحتمال الاحصائي ≥ 0.35 بالنسبه للفسفور .

وفقلالامراض الكلوي المزمنه، نتائج هذه الدراسة خلصت الي ان امراض الضغط والسكري والعامل الجيني هما من اكثر الاسباب شيوعا في السودان .

لخصت هذه الدراسة الي ان مستويات الكالسيوم و الالبومين يحدث بها نقصان ملحوظ في مرضي الفشل الكلوي الذين يخضعون للغسيل الدموي. كما ان مستويات و الفسفور يحدث به زياده ملحوظه في مرضي الفشل الكلوي الذين يخضعون للغسيل الدموي.

Contents		
NO	Titles	Pages
1	Dedication	I
2	Acknowledgment	II
3	Abstract	III
4	مستخلص البحث	V
5	Contents	VI
6	List Of Tables	XI
7	List Of Figures	XII
8	Abbreviations	XIII
CHAPTER ONE		
1.1	Introduction	1
1.2	Rational	3
1.3	Objective	4
CHAPTER TWO		
2	Literature Review	5
2.1	The Renal	5
2.1.1	Renal Anatomy	5
2.1.2	Renal Function	6
2.1.3	Renal Failure	6
2.1.3.1	Acute Renal Failure	6

2.1.3.2	Chronic Renal Failure	7
2.1.4.2.1	Causes	7
2.1.4.2.2	Symptoms	8
2.1.4.2.3	Stage	9
2.1.4	Dialysis	10
2.1.4.1	Type of dialysis	10
2.1.4.1.1	Hemodialysis	10
2.1.4.1.2	Peritoneal dialysis	11
1.2.2	Albumin	11
2.1.3	Relationship between albumin and End Stage Renal Disease	14
2.1.4	Calcium	15
2.1.4.1	Clinical Applications	15
2.1.4.1.1	Hypocalcemia	15
2.1.4.1.2	Hypercalcemia	17
2.4	Phosphate	18
2.4.1	Phosphate Physiology	18
2.4.2	Clinical Applications	18
2.4.2.1	Hypophosphatemia	18
2.4.2.2	Hyperphosphatemia	19

2.4.5	Relationship between phosphorus , calcium and End Stage Renal Disease	20
CHAPTER THREE		
3.	Material And Methods	22
3.1	Material	22
3.1.1	Study Approach	22
3.1.2	Study Design	22
3.1.3	Study Area	22
3.1.4	Study Population	22
3.1.5	Sample Size	22
3.1.6	Inclusion And Exclusion Criteria	22
3.1.7	Ethical Consideration	23
3.1.8	Data Collection	23
3.1.9	Sample Collection And Processing	23
3.1.10	Requirement	23
3.2	Methods	25
3.2	Estimation of albumin:	25
3.2.1.2	Reagent preparation and stability	25

3.2.1.3	.2.2.3 Procedure:	25
3.2.1.4	3.2.2.4 Calculation	26
3.2.1.5	Reference values	26
3.2.2	Estimation of calcium	26
3.2.2.1	Principle of the reaction	26
3.2.2.2	Reagent preparation and stability	26
3.2.2.3	Procedure	27
3.2.2.4	Calculation	27
3.2.1.5	Reference values	27
3.2.3	Estimation of phosphorus	28
3.2.3.1	Principle of the reaction	28
3.2.3.2	Reagent preparation and stability	28
3.2.3.3	Procedure	28
3.2.3.4	Calculation	29
3.2.3.5	Reference values	29
3.3	Quality control	29
3.4	Data analysis	29
CHAPTER FOUR		

4.	Results	30
CHAPTER FIVE		
5.1	Discussion	42
5.2	Conclusion	47
5.3	Recommendation	48
CHAPTER SEX		
6.1	References	49
6.2	Appendices	53

List of tables:

Number	Description	Pages
4-1	ages, sex and family history of patients with renal failure	36
4.2	body mass index (BMI) in both the study groups	36
4-3	Distribution of patients according to other associated disease:	37
4-4	Mean of the levels of plasma albumin calcium and phosphorus in both of study group.	37
4-5	Mean of the levels of plasma albumin calcium and phosphorus of male and female patients of renal failure.	38

List of figures:

Number	Description	Pages
4-1	scatter plot shows the correlation between albumin level and duration of dialysis	39
4-2	scatter plot shows the correlation between calcium level and duration of dialysis	40
4-3	scatter plot shows the correlation between phosphorus level and duration of dialysis	41
4-4	scatter plot shows the correlation between albumin level and BMI (body mass index) of dialysis	42
4-5	scatter plot shows the correlation between calcium level and BMI (body mass index) of dialysis	43
4-6	scatter plot shows the correlation between phosphorus level and BMI (body mass index) of dialysis	44

Abbreviations:

abbreviation	Meaning
ESRD	End stage renal disease
CKD	Chronic kidney disease
PTH	Parathyroid hormone
RFTs	Renal function tests
DNA	deoxyribonucleic acid
GFR	Glomerular filtration rate
HD	Hemodialysis
RNA	ribonucleic acid (RNA)
Camp	Cyclic Adenosin Mono Phosphate
25-OH-D3	25-hydroxycholecalciferol
BMI	Body mass index
HPT	hyperparathyroidism
BUN	blood urea nitrogen
PD	peritoneal dialysis

Figure (4-9): scatter plot shows the correlation between albumin level and duration of dialysis: ($r = -0.220$, $p\text{-value} \leq 0.049$); (no correlation)

Figure (4-10): scatter plot shows the correlation between calcium level and duration of dialysis: ($r = -0.033$, $p\text{-value} \leq 0.769$); (no correlation)

Figure (4-11): scatter plot shows the correlation between phosphorus level and duration of dialysis: ($r = -0.168$, $p\text{-value} \leq 0.136$); (no correlation)

Figure (4-12): scatter plot shows the correlation between albumin level and BMI (body mass index) of dialysis: ($r = -0.051$, $p\text{-value} \leq 0.653$); (no correlation)

Figure (4-13): scatter plot shows the correlation between calcium level and BMI (body mass index) of dialysis: ($r = -0.091$, $p\text{-value} \leq 0.427$); (no correlation)

Figure (4-14): scatter plot shows the correlation between phosphorus level and BMI (body mass index) of dialysis: ($r = 0.096$, $p\text{-value} \leq 0.402$); (no correlation)

CHAPTER ONE

introduction

1.1 Introduction

The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of the spine. Every day, the two kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra fluid. The urine flows from the kidneys to the bladder through two thin tubes of muscle called ureters, one on each side of the bladder. The bladder stores urine that flows out through a tube called the urethra, located at the bottom of the bladder. In men the urethra is long, while in women it is short (Rockville *etal*; 2009).

Acute renal failure is a sudden, sharp decline in renal function as a result of an acute toxic or hypoxic insult to the kidneys. Generally, acute renal failure occurs as a consequence of lower urinary tract obstruction or rupture of the urinary bladder. Chronic Renal Failure (Chronic Kidney Disease) is a clinical syndrome that occurs when there is a gradual decline in renal function over time. (Michael*etal*; 2010).

Albumins are a family of globular proteins, the most common of which is serum albumin. Plasma levels of albumin may be increased or decreased depending on the disease state. Elevations of serum albumin concentration occur infrequently. Increases resulting from dehydration can be seen when plasma water decreases. Upon rehydration, the albumin level usually returns to normal. An example of disruption of these pressures is edema. There are several causes of extracellular edema, such as a decrease in plasma proteins that includes albumin. The cause may be an increased loss of proteins (nephrosis, wounds, etc) or failure to produce proteins (liver disease or malnutrition). (Burtis,*etal*; 1999)

Hypoalbuminemia in dialysis is primarily a consequence of reduced albumin synthesis rate in both HD and PD patients, and in the case of PD patients, of transperitoneal albumin losses as well. Continuous ambulatory peritoneal dialysis patients are able to increase albumin synthesis to replace losses. Thus, ESRD does not directly suppress albumin synthesis. (Kaysen; 1998).

Serum calcium is the name given to the level of calcium found in our blood which is determined by performing a special blood test. Serum calcium indicates whether there are deficiency in calcium or have abnormally high level of calcium in our blood stream. These conditions are termed as hypocalcaemia and hypercalcaemia respectively. Serum calcium definition should also indicate that abnormally high levels of calcium in the blood are sometimes caused due to hyperactivity of the parathyroid glands. Hypertension, high blood pressure, hypercalcaemia and the complications associated with this condition are the outcomes of abnormally high serum calcium. (Dickson, *et al*; 1994)

Phosphate compounds participate in many of the most important biochemical processes. The genetic materials deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are complex phosphodiesteres. Most coenzymes are esters of phosphoric or pyrophosphoric acid. The most important reservoirs of biochemical energy are ATP, creatine phosphate, and phosphoenolpyruvate. Phosphate deficiency can lead to ATP depletion, which is ultimately responsible for many of the clinical symptoms observed in hypophosphatemia. (Michael *et al*; 2010).

Hypocalcaemia and hyperphosphatemia with secondary hyperparathyroidism are characteristic of end-stage renal disease (ESRD). Although calcium levels critically affect almost all cellular processes, the impact of chronic hypocalcaemia and other abnormalities of calcium-phosphate homeostasis on the prognosis of ESRD patients is unknown. (Foley *et al*; 1996).

1.2 Rationale:

Renal failure is a devastating medical, social and economic problem in Sudan and it is fatal unless treated properly. Recent studies were done in Sudan to determine the mortality rate and causes of mortality. We found that the mortality rate was 7.44% per year and the leading cause of death was infections (45%) and cardiovascular (22%) diseases. (Mohamed Elhafiz; 2008). According to the latest WHO data published in April 2011 Kidney Disease Deaths in Sudan reached 8,782 or 2.38% of total deaths, ranked the renal failure in 7th top 20 causes of death in Sudan.

There is strong association between renal failure, hypoalbuminemia, hypocalcaemia and hyperphosphatemia which raises the question of whether the lower levels are related to chronic kidney disease factors or to the hemodialysis treatment. Some researchers have assumed that there is a correlation between the serum calcium, albumin and phosphorus levels and the severity of renal failure caused by glomerular lesions. From these points Many studies around the world were done and showed that serum calcium and albumin levels are lower and serum phosphorus is higher in patient under hemodialysis and returned that to many causes but they were not discovered the real cause.

Calcium was essential for myocardial contraction. So when decreased they because neuromuscular irritability and cardiac irregularities and this may lead to increase the risk of heart disease.

This study was conducted to high light the effect of hemodialysis on that calcium, albumin and phosphorus in Sudanese patients with renal failure patients under hemodialysis and further studies are needed to discover the real cause of this effect. (Michael *et al*; 2010).

2.3 Objectives:

General objectives:

To assess calcium, phosphorus and albumin in plasma of Sudanese patients with renal failure (dialysis patients).

Specific objectives:

1. To assess the level of serum calcium, albumin and phosphorus in Sudanese patients with renal failure (dialysis patients) compared to control group.
2. To assess the correlation between the duration of dialysis and serum calcium, albumin and phosphorus in patients with renal failure under hemodialysis.
3. To assess the correlation between the body mass index of dialysis patient and serum calcium, albumin and phosphorus in patients with renal failure under hemodialysis

CHAPTER TWO

Literature Review

2. Literature Review

2.1the renal

The kidneys are vital organs that perform a variety of important functions. The most prominent functions are removal of unwanted substances from plasma (both waste and surplus), homeostasis (maintenance of equilibrium) of the body's water, electrolyte and acid-base status, and participation in hormonal regulation. In the clinical laboratory, kidney function tests are used in assessment of renal disease, water balance, and acid-base disorders and in situations of trauma, head injury, surgery, and infectious disease. (edward,etal;2010).

2.1.1Renal Anatomy

The kidneys are paired, bean-shaped organs located retroperitoneally on either side of the spinal column. Macroscopically, a fibrous capsule of connective tissue encloses each kidney. When dissected longitudinally, two regions can be clearly discerned—an outer region called the cortex and an inner region called the medulla. It is a basinlike cavity at the upper end of the ureter into which newly formed urine passes. The bilateral ureters are thick-walled canals, connecting the kidneys to the urinary bladder. Urine is temporarily stored in the bladder until voided from the body by way of the urethra. Functional units of the kidney that can only be seen microscopically. Each kidney contains approximately 1 million nephrons. Each nephron is a complex apparatus comprised of five basic parts expressed diagrammatically.

- The glomerulus—a capillary tuft surrounded by the expanded end of a renal tubule known as Bowman's capsule. Each glomerulus is supplied by an afferent arteriole carrying the blood in and an efferent arteriole carrying the blood out. The efferent arteriole branches into peritubular capillaries that supply the tubule.

- The proximal convoluted tubule—located in the cortex.
- The long loop of Henle—composed of the thin descending limb, which spans the medulla, and the ascending limb, which is located in both the medulla and the cortex, composed of a region that is thin and then thick.
- The distal convoluted tubule—located in the cortex.
- The collecting duct—formed by two or more distal convoluted tubules as they pass back down through the cortex and the medulla to collect the urine that drains from each nephron. Collecting ducts eventually merge and empty their contents into the renal pelvis. The following section describes how each part of the nephron normally functions. (Michael *et al*; 2010).

2.1.2 Renal Functions

1. Urine formation
2. Fluid and electrolyte balance
3. Regulation of acid-base balance
4. Excretion of the waste products of protein metabolism
5. Excretion of drugs and toxins
6. Secretion of hormones
 - Renin
 - Erythropoietin
 - 1,25-Dihydroxy vitamin D₃
 - Prostaglandins. (Michael *et al*; 2010).

2.1.3 Renal Failure

2.1.3.1 Acute Renal Failure

Acute renal failure is a sudden, sharp decline in renal function as a result of an acute toxic or hypoxic insult to the kidneys, defined as occurring when the glomerular filtration rate (GFR) is reduced to less than 10 mL/minute. This

syndrome is subdivided into three types, depending on the location of the precipitating defect.

- **Prerenal failure:** The defect lies in the blood supply before it reaches the kidney. Causes can include cardiovascular system failure and consequent hypovolemia.
- **Primary renal failure:** The defect involves the kidney. The most common cause is acute tubular necrosis; other causes include vascular obstructions/inflammations and glomerulonephritis.
- **Postrenal failure:** The defect lies in the urinary tract after it exits the kidney. Generally, acute renal failure occurs as a consequence of lower urinary tract obstruction or rupture of the urinary bladder.(Michaie*et al*; 2010).

2.1.4.2 Chronic renal failure:-

Chronic renal failure describes abnormal kidney function and/or structure. There is evidence that treatment can prevent or delay the progression of chronic kidney disease, reduce or prevent the development of complications, and reduce the risk of cardiovascular disease (CVD).

The Chronic renal failure is based on the presence of kidney damage (i.e. albuminuria) or decreased kidney function (i.e. glomerular filtration rate (GFR) <60 ml/minute per 1.73 m^2) for three months or more, irrespective of clinical diagnosis. (Levey*et al*; 2012).

2.1.4.2.1 Causes:-

Poorly controlled diabetes

Poorly controlled high blood pressure

Chronic glomerulonephritis.

Polycystic kidney disease, Reflux nephropathy (damage caused by urine backflow from the bladder into the ureters and kidney), Nephrotic syndrome, Alport's disease, Kidney stones, and Prostate disease. (Benjamin; 2011).

2.1.4.2.2 Symptoms:-

Patients with chronic renal failure stages 1-3 (GFR >30 mL/min/1.73 m²) are generally asymptomatic. Typically, it is not until stages 4-5 (GFR < 30 mL/min/1.73 m²) that endocrine/metabolic derangements or disturbances in water or electrolyte balance become clinically manifest..

Lethargy

Weakness

Shortness of breath

Generalized swelling (edema)

Generalized weakness due to anemia

Loss of appetite

Fatigue

Congestive heart failure

Metabolic acidosis

High blood potassium (hyperkalemia)

Fatal heart rhythm disturbances (arrhythmias) including ventricular tachycardia and ventricular fibrillation.

Rising urea levels in the blood (uremia) may lead to brain encephalopathy, pericarditis (inflammation of the heart lining), or low calcium blood levels (hypocalcemia). (Benjamin; 2015).

2.1.4.2.3 Stage

Stage 1

Slightly diminished function; kidney damage with normal or relatively high GFR (≥ 90 ml/min/1.73 m²).

Stage 2

Mild reduction in GFR (60–89 ml/min/1.73 m²) with kidney damage: Kidney damage is defined as pathological abnormalities or markers of damage, including abnormalities in blood or urine test or imaging studies.

Stage 3

Moderate reduction in GFR (30–59 ml/min/1.73 m²) British guidelines distinguish between stage 3A (GFR 45–59) and stage 3B (GFR 30–44) for purposes of screening and referral.

Stage 4

Severe reduction in GFR (15–29 ml/min/1.73 m²) Preparation for renal replacement therapy

Stage 5

Established kidney failure (GFR < 15 ml/min/1.73 m²) permanent renal replacement therapy. (Waknine; 2012).

2.1.4 Dialysis:-

Dialysis cleanses the body of waste products in the body by use of filter systems.

2.1.4.1 Type of dialysis:-

There are two types of dialysis; 1) hemodialysis, and 2) peritoneal dialysis.

2.1.4.1.1 Hemodialysis:

Uses a machine filter called a dialyzer or artificial kidney to remove excess water and salt, to balance the other electrolytes in the body, and to remove waste products of metabolism. Blood is removed from the body and flows through tubing into the machine, where it passes next to a filter membrane. A specialized chemical solution (dialysate) flows on the other side of the membrane. The dialysate is formulated to draw impurities from the blood through the filter membrane. Blood and dialysate never touch in the artificial kidney machine. (Benjamin; 2015)

For this type of dialysis, access to the blood vessels needs to be surgically created so that large amounts of blood can flow into the machine and back to the body. Surgeons can build a fistula, a connection between a large artery and vein in the body, usually in the arm, that allows a large amount of blood flow into the vein. This makes the vein swell or dilate, and its walls become thicker so that it can tolerate repeated needle sticks to attach tubing from the body to the machine. Since it takes many weeks or months for a fistula to mature enough to be used, significant planning is required if hemodialysis is to be considered as an option.

If the kidney failure happens acutely and there is no time to build a fistula, special catheters may be inserted into the larger blood vessels of the arm, leg, or chest. These catheters may be left in place for weeks. In some diseases, the need for dialysis will be temporary, but if the expectation is that dialysis will continue for a prolonged period of time, these catheters act as a bridge until a fistula can be planned, placed, and matured. (Benjamin; 2015)

Dialysis treatments normally occur three times a week and last a few hours at a time. Most commonly, patients travel to an outpatient center to have dialysis, but home dialysis therapy is becoming an option for some.

Outpatient dialysis is available on some cruise ships. They are equipped with dialysis machines with trained health care professionals ready to care for those with kidney failure while traveling. (Benjamin ;2015)

2.1.4.1.2 Peritoneal dialysis:

Uses the lining of the abdominal cavity as the dialysis filter to rid the body of waste and to balance electrolyte levels. A catheter is placed in the abdominal cavity through the abdominal wall by a surgeon, and it is expected to remain in place for the long-term. The dialysis solution is then dripped in through the catheter and left in the abdominal cavity for a few hours and then is drained out. In that time, waste products leech from the blood flowing through the lining of the abdomen (peritoneum), and attach themselves to the fluid that has been instilled by the catheters. Often, patients instill the dialysate fluid before bedtime, and drain it in the morning. (Benjamin; 2015)

2.2 Albumin

Albumin is synthesized in the liver from 585 amino acids at the rate of 9–12 grams per day with no reserve or storage. It is the protein present in highest concentration in the plasma. Albumin also exists in the extravascular (interstitial) space. In fact, the total extravascular albumin exceeds the total intravascular amount by 30%, but the concentration of albumin (plasma albumin concentration.

Intravascular albumin mass/plasma volume) in the blood is much greater than its concentration is in the interstitial space. Albumin leaves the circulation at a rate of 4%–5% of total intravascular albumin per hour. This rate of movement is known as the transcapillary escape rate (TER), which measures systemic capillary efflux of

albumin. Albumin is responsible for nearly 80% of the colloid osmotic pressure of the intravascular fluid, which maintains the appropriate fluid balance in the tissue. Albumin also buffers pH and is a negative acute-phase reactant protein. Another prime function of albumin is its capacity to bind various substances in the blood. There are four binding sites on albumin, and these have varying specificity for different substances. Albumin transports thyroid hormones;

Other hormones, particularly fat-soluble ones; iron; and fatty acids. For example, albumin binds unconjugated bilirubin, salicylic acid (aspirin), fatty acids, calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions, and many drugs and serum albumin levels can affect the half-life of drugs. This binding characteristic is also exhibited with certain dyes.

Providing method for the quantitation of albumin. Several recent studies have focused on the significance of the clinical applicability of glycated albumin as a more sensitive indicator of short-term hyperglycemic control than glycosylated hemoglobin in diabetes because of the shorter in vivo half-life of glycated albumin. Affinitychromatographic methods based on specific interaction of boronic acids with glycated proteins have also been applied to determine serum concentrations of glycated albumin.

Decreased concentrations of serum albumin may be caused by the following:

- An inadequate source of amino acids that occurs in malnutrition and malabsorption
- Liver disease, resulting in decreased synthesis by the hepatocytes. Note that the increase in globulins that occurs in early cirrhosis, however, balances the loss in albumin to give a total protein concentration within acceptable limits.
- Protein-losing enteropathy or gastrointestinal loss as interstitial fluid leaks out in inflammation and disease of the intestinal tract as in diarrhea

- Kidney loss to the urine in renal disease. Albumin is normally excreted in very small amounts. This excess excretion occurs when the glomerulus no longer functions to restrict the passage of proteins from the blood as in nephrotic syndrome.
- Skin loss in the absence of the skin barrier such as in burns or exfoliative dermatitis
- Hypothyroidism
- Dilution by excess: polydipsia (drinking too much water) or excess administration of intravenous fluids
- Acute disease states
- Mutation resulting from an autosomal recessive trait causing analbuminemia (absence of albumin) or bisalbuminemia (the presence of albumin that has unusual molecular characteristics) demonstrated by the presence of two albumin bands instead of the single band usually seen by electrophoresis. Both are rare.
- Redistribution by hemodilution, increased capillary permeability (increased interstitial albumin), or decreased lymph clearance. In sepsis, there is a profound reduction in plasma albumin associated with marked fluid shifts. Abnormally high albumin levels are seldom clinically important. Increased serum albumin levels are seen only with dehydration or after excessive albumin infusion.(Michaels *et al*; 2010).

2.2.1 Relationship between albumin and End Stage Renal Disease

Hypoalbuminemia is a major risk factor for morbidity and mortality in the ESRD population. The Core Indicators Project notes that the serum albumin value is a measure of the patient's nutritional status. Since 1994 every outcome parameter of the Core Indicators Project has shown improvement except for the serum albumin measurement. While the serum albumin level is a measure of the visceral protein pool size, a decrease in albumin synthesis is due to more than poor nutritional intake (in part related to inadequate dialysis). Acute-phase reactants and the plasma volume status are other major factors that impact on serum albumin determination. Plasma volume expansion, albumin redistribution, exogenous loss (in peritoneal dialysis patients), and decreased albumin synthesis all contribute to hypoalbuminemia. Understanding the cause of hypoalbuminemia will allow us to target treatment modalities directed at correcting the hypoalbuminemia. It is still unknown if the serum albumin can be effectively raised in the chronic dialysis patient. Also unknown is whether an increase in the serum albumin level can alter long-term morbidity and mortality. We should not be using serum albumin as an indicator of adequate dialysis or nutritional status since the causes of hypoalbuminemia are multifactorial. It is recommended that the serum albumin level be eliminated as an indicator of nutritional status in the ESRD patient. (Semin Dial; 2000)

2.3 Calcium

Calcium (chemical symbol Ca, atomic number 20) is the fifth most plentiful chemical element in the Earth's crust, occurring in various rocks, minerals, coral, and shells of marine animals. Soft gray in color, it is classified as an alkaline earth metal. It is the most abundant mineral in the human body and an important component of a healthy diet. It is essential for building strong bones and teeth, muscle contraction, oocyte activation, blood clotting, nerve impulse transmission, heartbeat regulation, and fluid balance within cells. It is used as a reducing agent for the extraction of several metals; an agent for generating metal alloys; and a deoxidizer, desulfurizer, or decarbonizer for various alloys. Calcium carbonate is used in construction materials; calcium oxide is used for treating water, sewage, and acidic soils; and calcium hydroxide is used for processing water for beverages and neutralizing acids in the tanning industry. (Krieket *al*; 2010).

2.3.1 Clinical Applications

hypocalcemic and hypercalcemic disorders, Although both total and ionized Calcium measurements are available in many laboratories, ionized Calcium is usually a more sensitive and specific marker for Calcium disorders. (larry *etal*; 2010).

2.3.1.1 Hypocalcemia

When Parathyroid Hormone is not present, as with primary hypoparathyroidism, serum Calcium levels are not properly regulated. Bone tends to “hang on” to its storage pool and the kidney increases excretion of Calcium. Because PTH is also required for normal vitamin D metabolism, the lack of vitamin D's effects also leads to a decreased level of Calcium. Parathyroid gland aplasia, destruction, or removal are obvious reasons for primary hypoparathyroidism. Because

hypomagnesemia has become more frequent in hospitalized patients, chronic hypomagnesemia has also become recognized as a frequent cause of hypocalcemia. When total Calcium is the only result reported, hypocalcemia can appear with hypoalbuminemia. Common causes are associated with chronic liver disease, nephrotic syndrome, and malnutrition. In general, for each 1 g/dL decrease in serum albumin, there is a 0.2 mmol/L (0.8 mg/dL) decrease in total Calcium levels.²² About one half of the patients with acute pancreatitis develop hypocalcemia. The most consistent cause appears to be a result of increased intestinal binding of Calcium as increased intestinal lipase activity occurs. Vitamin D3 deficiency and malabsorption can cause decreased absorption, which leads to increased PTH production or secondary hyperparathyroidism. Patients with renal disease caused by glomerular failure often have altered concentrations of Calcium, phosphorus, albumin, Mg^{2+} , and H^+ (pH). In chronic renal disease, secondary hyperparathyroidism frequently develops as the body tries to compensate for hypocalcemia caused either by hyperphosphatemia, PO_4^- binds and lowers ionized Calcium or altered vitamin D metabolism. Monitoring and controlling ionized Calcium concentrations may avoid problems due to hypocalcemia, such as osteodystrophy, unstable cardiac output or blood pressure, or problems arising from hypercalcemia, such as renal stones and other calcifications.

Rhabdomyolysis, as with major crush injury and muscle damage, may cause hypocalcemia as a result of increased PO_4^- release from cells, which bind to Calcium ions.²² Pseudohypoparathyroidism is a rare hereditary disorder in which PTH target tissue response is decreased (end organ resistance). PTH production responds normally to loss of Calcium however, without normal response (decreased cAMP [cyclic adenosine 3', 5'-phosphate] production), Calcium is lost in the urine or remains in the bone storage pool. Patients often have common physical features,

including short stature, obesity, shortened metacarpals and metatarsals, and abnormal calcification.(Michael*etal*; 2010).

2.3.1.2 Hypercalcemia

Primary hyperparathyroidism is the main cause of hypercalcemia. Hyperparathyroidism, or excess secretion of Parathyroid Hormone, may show obvious clinical signs or may be asymptomatic. The patient population seen most frequently with primary hyperparathyroidism is older women. Although either total or ionized Calciummeasurements are elevated in serious cases, ionized Calciumis more frequently elevated in subtle or asymptomatic hyperparathyroidism. In general, ionized Calciummeasurements are elevated in 90% to 95% of cases of hyperparathyroidism, whereas total Calciumis elevated in 80% to 85% of cases.

Malignancy, with hypercalcemia sometimes being the sole biochemical marker for disease. many tumors produce Parathyroid Hormone -related peptide (PTH-RP), which binds to normal Parathyroid Hormone receptors and causes increased Calciumlevels. Assays to measure PTH_RP are available because this abnormal protein is not detectedby most PTH assays. Because of the proximity of the parathyroid gland to the thyroid gland, hyperthyroidism can sometimes cause hyperparathyroidism. A rare, benign, familial hypocalciuria has also been reported. Thiazide diuretics increase calcium reabsorption, leading to hypercalcemia. Prolonged immobilization may cause increased bone resorption. Hypercalcemia associated with immobilization is further compounded by renal insufficiency.(Michael *etal*; 2010).

2.4 Phosphate

2.4.1 Phosphate Physiology

Found everywhere in living cells, phosphate compounds participate in many of the most important biochemical processes. The genetic materials deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are complex phosphodiesteres. Most coenzymes are esters of phosphoric or pyrophosphoric acid. The most important reservoirs of biochemical energy are ATP, creatine phosphate, and phosphoenolpyruvate. Phosphate deficiency can lead to ATP depletion, which is ultimately responsible for many of the clinical symptoms observed in hypophosphatemia. Alterations in the concentration of 2,3-bisphosphoglycerate (2,3-BPG) in red blood cells affect the affinity of hemoglobin for oxygen, with an increase facilitating the release of oxygen in tissue and a decrease making oxygen bound to hemoglobin less available. By affecting the formation of 2,3-BPG, the concentration of inorganic phosphate indirectly affects the release of oxygen from hemoglobin.

Understanding the cause of an altered phosphate concentration in the blood is often difficult because transcellular shifts of phosphate are a major cause of hypophosphatemia in blood. That is, an increased shift of phosphate into cells can deplete phosphate in the blood. Once phosphate is taken up by the cell, it remains there to be used in the synthesis of phosphorylated compounds. As these phosphate compounds are metabolized, inorganic phosphate slowly leaks out of the cell into the blood, where it is regulated principally by the kidney.(edwardetal;; 2010).

2.4.2 Clinical Applications

2.4.2.1 Hypophosphatemia

Hypophosphatemia occurs in about 1% to 5% of hospitalized patients.

The incidence of hypophosphatemia increases to 20% to 40% in patients with the following disorders: diabetic ketoacidosis, chronic obstructive pulmonary disease (COPD), asthma, malignancy, longterm treatment with total parenteral nutrition (TPN), inflammatory bowel disease, anorexia nervosa, and alcoholism. The incidence increases to 60% to 80% in ICU patients with sepsis. In addition, hypophosphatemia can also be caused by increased renal excretion, as with hyperparathyroidism, and decreased intestinal absorption, as with vitamin D deficiency or antacid use. Although most cases are moderate and seldom cause problems, severe hypophosphatemia (≤ 1.0 g/dL or 0.3 mmol/L) requires monitoring and possible replacement therapy. There is a 30% mortality rate in those who are severely hypophosphatemic versus a 15% rate in those with normal or mild hypophosphatemia.²⁴ (edward *etal*;; 2010).

2.4.2.2 Hyperphosphatemia

Patients at greatest risk for hyperphosphatemia are those with acute or chronic renal failure.²⁴ an increased intake of phosphate or increased release of cellular phosphate may also cause hyperphosphatemia. Because they may not yet have developed mature ParathyroidHormone and vitamin D metabolism, neonates are especially susceptible to hyperphosphatemia caused by increased intake, such as from cow's milk or laxatives. Increased breakdown of cells can sometimes lead to hyperphosphatemia, as with severe infections, intensive exercise, neoplastic disorders, or intravascular hemolysis. Because immature lymphoblasts have about four times the phosphate content of mature lymphocytes, patients with lymphoblastic leukemia are especially susceptible to hyperphosphatemia.(edward *etal*;; 2010).

2.4.3 Relationship between phosphorus, calcium and End Stage Renal Disease

there are several reason why renal failure can cause hypocalcemia .in renal failure ,the absorption of calcium in the gastrointestinal tract will decrease , renal failure can cause decrease excretion of phosphorus and high phosphorus in blood can further worsen hypocalcemia , renal failure patient often have acidosis which can promote the discharge of calcium from the kidney .correction of the abnormal calcium and phosphate homeostasis should begin well before patients reach renal failure and dialysis. The primary problem in this regard is the inability of the failing kidney to excrete phosphate. The high serum phosphate results in a raised parathyroid hormone (PTH), which lowers the Calcium and results in a vicious cycle. For this reason, management of the serum phosphate is central to the prevention and management of renal bone disease and secondary hyperparathyroidism (HPT). Furthermore, as renal function continues to decline, the activation of vitamin D by the kidney is impaired and the low levels of activated vitamin D fail to suppress PTH, thereby compounding the secondary hyperparathyroidism present in chronic and end-stage patients. Unfortunately, dialysis does not adequately remove phosphate, and therapy, therefore, should be aimed at normalizing serum phosphate with phosphate binders and dietary restriction of phosphate intake. (Loghman-Adham; 1999)

This is essential. Phosphate binders should be taken with every meal. In order to further suppress the PTH level, serum Calcium should be slowly raised with the use of Calcium supplements between meals, to a serum level at the upper limit of normal. It is important to note that calcium carbonates are used as phosphate binders, and they have the added advantage of helping to correct hypocalcemia. In some centers, the elevated phosphate is initially reduced with the use of aluminum

hydroxide, although the aluminum has long-term problems in its own right. (Janssen MJ; etal1996)

As levels of activated vitamin D are reduced in chronic and end-stage patients, synthetic vitamin D analogues are used to correct hypocalcemia by increasing Calcium reabsorption from the gut. Unfortunately, they also increase phosphate reabsorption from the gut and, thus, should not be used until phosphate control has been achieved. The vitamin D also lowers the PTH level. (Drueke T 2001)

CHAPTER THREE

Material and methods

3. Materials and Method

3.1 Material

3.1.1 Study approach

A quantitative method was used to measure calcium, phosphorus and albumin in Sudanese patients with renal failure in Khartoum state, during the period from January to March 2015.

3.1.2 Study design:

This is a cross- sectional, control, and hospital case based study.

3.1.3 Study area:

This study was conducted in Alnaw hospital in Khartoum state, (Capital of Sudan).

3.1.4 Target population:

The study included patients with renal failure (males and females) under hemodialysis.

3.1.5 Sample size:

A total of 80patients with renal failure were enrolled in this study, plus (40) non patients apparently healthy volunteers' (age and sex matched with the test group) were included to serve as control.

3.1.6 Inclusion and Exclusion criteria:

Sudanese patients with end stage renal failure and apparently healthy volunteers were included while patient with hepatitis positive were excluded.

3.1.7 Ethical consideration:

Written consent was taken regarding acceptance to participate in the study and reassurance of confidentiality. Before the specimen was collected, the donor knew that this specimen was collected for research purpose.

3.1.8 Data collection:

The Clinical data were obtained from history, clinical examination and hospital follow up records and were recorded on a questionnaire sheet.

3.1.9 Sample collection and processing:

After informed consent and use of a local antiseptic for the skin (70%), 3 ml of venous blood was collected from the forearm of each patient and control by syringe (3ml) using venipuncturing directly into centrifuge tube which contained anticoagulant for serum preparation. Serum was separated from blood cells after centrifugation for 5 minutes at 5000 r.p.m, at room temperature and the sera were used immediately for estimation of calcium, phosphorus and albumin

3.1.10 Requirement

Sterile needle

70% alcohol, Cotton

Plan and heparinize container

Constant temperature

Cuvette, Test tubes.

Biosystem(spectrophotometer)

Automatic pipette

Blue and yellow tip.

Disposable plastic dropper.

Centrifuge.

3.2 Method

3.2.1 Estimation of albumin:

3.2.1.1 Principle of the reaction:

Albumins in the sample react with bromocresol green in acid media forming a coloured complex that can be measured by spectrophotometry

3.2.1.2 Reagent preparation and stability:

The reagent and Standard are provide ready to use and are stable up to expiry date when sealed and store at 2-8 °c.

3.2.1.3 Procedure:

The reagents were first brought to room temperature then the following amount were pipetting according to the table below.

	Blank	Standard	Sample
Working reagent(ml)	1.0	1.0	1.0
Sample		—	0.01
standard(ml)		0.01	—
D.W (ml)	0.01	—	—

- Reagents were mixed and incubated for 1 min at room temperature.
- the absorbance (A) of the Standard and the sample Road at 600 nm against blank

3.2.1.4 Calculation:

Albumin (g/dl) = (A° sample/A° stander) * conc. Stander* DF

A =absorbance

Conc= concentration

DF = dilution factor

Reference values:

Serum or plasma

Newborn, 2 to 4 day: 2.8-4.4 g/dl

4 day to 14 years: 3.8-5.4 g/dl

Adult: 3.5-5.5 g/dl

> 60 years: 3.4-4.8 g/dl

3.2.2..Estimation of calcium:

3.2.2.1. Principle of the reaction:

Calcium in the sample reacts with methylthymol blue in alkaline media forming a coloured complex that can be measured by spectrophotometry. Hydroxyquinoline is included in the reagent to avoid magnesium interference.

3.2.1.2 Reagent preparation and stability:

The standards are provided ready to use and Working reagent: mix equal volumes of reagent A and reagent B are stable for 2 days at 2-8 °C

3.2.2.3 Procedure:

The reagent were first brought to room temperature then the following amount were pipetting according to the table below.

	Blank	Standard	Sample
Working reagent(ml)	1.0	1.0	1.0
Sample		—	0.01
standard(ml)		0.01	—

- Reagents were mixed and incubated for 2 min at room temperature.
- the absorbance (A) of the Standard and sample Read at 610 nm against blank

3.2.2.4 Calculation:

The calcium concentration in the sample is calculated using the following general formula.

$$(A^{\circ} \text{ sample} / A^{\circ} \text{ stander}) * \text{Conc. Stander} * \text{DF}$$

A = absorbance

Conc = concentration

DF = dilution

Reference values:

Serum or plasma: 8.6-10.5mg/dl = 2.15-2.58 mmol/l

Urine: 100-300 mg/24h = 2.5-7.5 mmol/24h

3.2.3. Estimation of phosphorus:

3.2.3.1. Principle of the reaction:

Inorganic phosphorus in the sample react with molybdate in acid media forming phosphomolybdate complex that can be measured by spectrophotometry

3.2.3.2 Reagent preparation and stability:

The reagent and Standard (S) are provided ready to use and use stable up to expiry date when sealed and store at 2-8 c.

3.2.3.3 Procedure:

The reagents were first brought to room temperature then the following amount were pipetting according to the table below.

	reagent Blank	sample Blank	Standard	Sample
Working reagent(ml)	1.0		1.0	1.0
reagent(A)		1.0		
Sample		0.01	—	0.01
standard(ml)		—	0.01	—
D.W (ml)	0.01		—	—

- Mixed and incubated for 5 min at room temperature.
- The absorbance (A) of the sample Blank Road at 340 nm against DW
- The absorbance (A) of the sample and of the standard Road at 340 nm against reagent blank.

3.2.3.4 Calculation:

The phosphorus concentration in the sample is calculated using the following general formula.

$$\text{Phosphorus (mg/dl)} = (A^{\circ} \text{ sample} / A^{\circ} \text{ stander}) * \text{conc. Stander} * \text{DF}$$

A =absorbance

Conc= concentration

DF = dilution factor

Reference values:

Serum or plasma:

- Adult : 2.5-4.5 mg/dl =.81-1.45 mmol/l
- Children : 24.0-7.0 mg/dl =1.29-2.26 mmol/l

Urine: 0.4-1.3 g/24h = 12.9-42 mmol/h

3.3 Quality control

The precision and accuracy of all methods used in this study were checked by commercially prepared control sample before it application for the measurement of test and control samples.

3.4 Data analysis

data was analyzed using SPSS computer program, the mean and standard deviation of albumin ,calcium and phosphorus were obtained and the independent 't.test' used for comparison (p value of ≤ 0.05) was consider significant

CHAPTER FOUR

Results

4.Result

The results of the biochemical determinant serum of calcium, albumin and phosphorus in patient with renal failure are given in tables and figures:

Table(4-1) illustrated the ages, sex and family history of patients with renal failure. The result showed that the patients whose ages over fifty years were more susceptible for renal failure with the percentage of 81% compared to those with age below fifty years (19%).

The number of males in patients was 46(57%), while the numbers of females was 34(43%).

Patients whose have family history disease constitute 34% while those who has no family history of disease constitute 66%.

Tables (4-2) represent the mean of body mass index (BMI) in both the study groups. BMI expressed as body weight (Kg) per height (m^2), indicated that about the most of patients under dialysis are obese ($29 \pm 4.1kg/m^2$), while the mean of control group is ($25 \pm 31kg/m^2$).

Table (4-3) show that hypertension and diabetes were significantly related to chronic renal failure the frequency of hypertension among renal failure patients is 47 patients (59%), while diabetes was found in 37 patients (46%).

Tables (4-4) represent the mean of the level of plasma albumin calcium and phosphorus in both of study group.

the level plasma albumin were significant decrease in patient with renal failure compared to control group , (mean \pm SD: $2.718 \pm .8660$ versus 4.502 ± 5.7845 g/dl $p=0.03$) .

the level of plasma calcium were significant decrease in patient with renal failure compared to control group , (mean \pm SD: $7.837 \pm .1.1305$ versus 10.564 ± 12.3731 mg/dl $p=0.05$) .

the level of plasma phosphorus were significant increase in patient with renal failure compared to control group , (mean \pm SD: 5.024 ± 1.2604 versus 3.676 ± 1.1413 mg/dl $p=0.00$) .

Table (4-5) shows no significant different between the mean of the levels of plasma albumin calcium and phosphorus of male and female patients of renal failure.

Albumin: (mean \pm SD: 2.7 ± 0.7 versus 2.6 ± 0.9 mg/dl $p=0.83$).

Calcium: (mean \pm SD: 7.7 ± 1.2 versus 8.0 ± 0.9 mg/dl, $p=0.2$).

Phosphorus (mean \pm SD: 5.1 ± 1.2 versus 4.8 ± 1.2 mg/dl $p=0.35$).

Figure (4-1): scatter plot shows the correlation between albumin level and duration of dialysis. Showed no correlation between albumin level and increase duration of dialysis ($r= -0.220$, $p\text{-value}=0.049$ s).

Figure (4-2): scatter plot shows the correlation between calcium level and duration of dialysis. Showed insignificant correlation between calcium level and increase duration of dialysis ($r= -0.033$, $p\text{-value}=0.769$).

Figure (4-3): scatter plot shows the correlation between phosphorus level and duration of dialysis. Showed insignificant correlation between phosphorus level and increase duration of dialysis ($r = -0.168$, $p\text{-value} = 0.136$).

Figure (4-4): scatter plot shows the correlation between albumin level and BMI (body mass index) of dialysis. Showed insignificant correlation between albumin level and increase body mass index of dialysis ($r = -0.051$, $p\text{-value} = 0.653$).

Figure (4-5): scatter plot shows the correlation between calcium level and BMI (body mass index) of dialysis. Showed insignificant correlation between calcium level and increase body mass index of dialysis ($r = -0.091$, $p\text{-value} = 0.427$).

Figure (4-6): scatter plot shows the correlation between phosphorus level and BMI (body mass index) of dialysis. Showed insignificant correlation between phosphorus level and increase body mass index of dialysis ($r = 0.096$, $p\text{-value} = 0.402$).

Table (4-1)

Ages, gender and Family history of patients with renal failure disease:

Variable	Number	%
Age 25-50 years	15	19%
Age 51-80 years	65	81%
Sex Male	46	57%
Sex Female	34	43%
Family history disease Yes	27	34%
Family history disease No	53	66%

Table (4-2)

Mean of body mass index (BMI), of patients with renal failure group and control group

Variable	Patients N=80	Control N=40	p-value
BMI (kg/m ²)	29±4.1kg/m ² (19-30)	25±3kg/m ² (19-30)	=0.02

Results given in mean ±SD

Range between brackets.

P-value ≤0.05 consider significant.

Table (4-3)

Distribution of patients according to other associated disease:

Disease	Frequency	Percentage
Hypertension	47	59 %
Diabetes	37	46%
Hepatitis	20	20%

Table (4.4):

The mean of plasma albumin, calcium and phosphorus in patient with renal failure group and controlgroup:-

Sample	Number	mean± SD	p-value
Patient albumin (g/dl)	80	2.718±.8660	<u>0.03</u>
Control albumin (g/dl)	40	4.502±5.7845	
Patient calcium(mg/dl)	80	7.837±.1.1305	0.05
Control calcium mg/dl)	40	10.564±12.3731	
Patient phosphorus (mg/dl)	80	5.024±1.2604	0.00
Control phosphorus (mg/dl)	40	3.676 1.1413	

- Results given mean \pm Sd.
- P-value ≤ 0.05 consider significant.

Table (4.5):

Comparison of the mean of plasma albumin, calcium and phosphorus concentration in male and female:-

Sex	Number	mean \pm SD	p-value
Male albumin (g/dl)	46	2.736 \pm .7720	<u>0.83</u>
Female albumin (g/dl)	34	2.694 \pm .9908	
male calcium (mg/dl)	46	7.707 \pm 1.2648	0.2
Female calcium (mg/dl)	34	8.015 \pm .9066	
Male phosphorus(mg/dl)	46	5.135 \pm 1.2922	0.35
Female phosphorus(mg/dl)	34	4.874 \pm 1.2189	

- Results given mean \pm Sd.
- P-value \leq 0.05 consider significant.

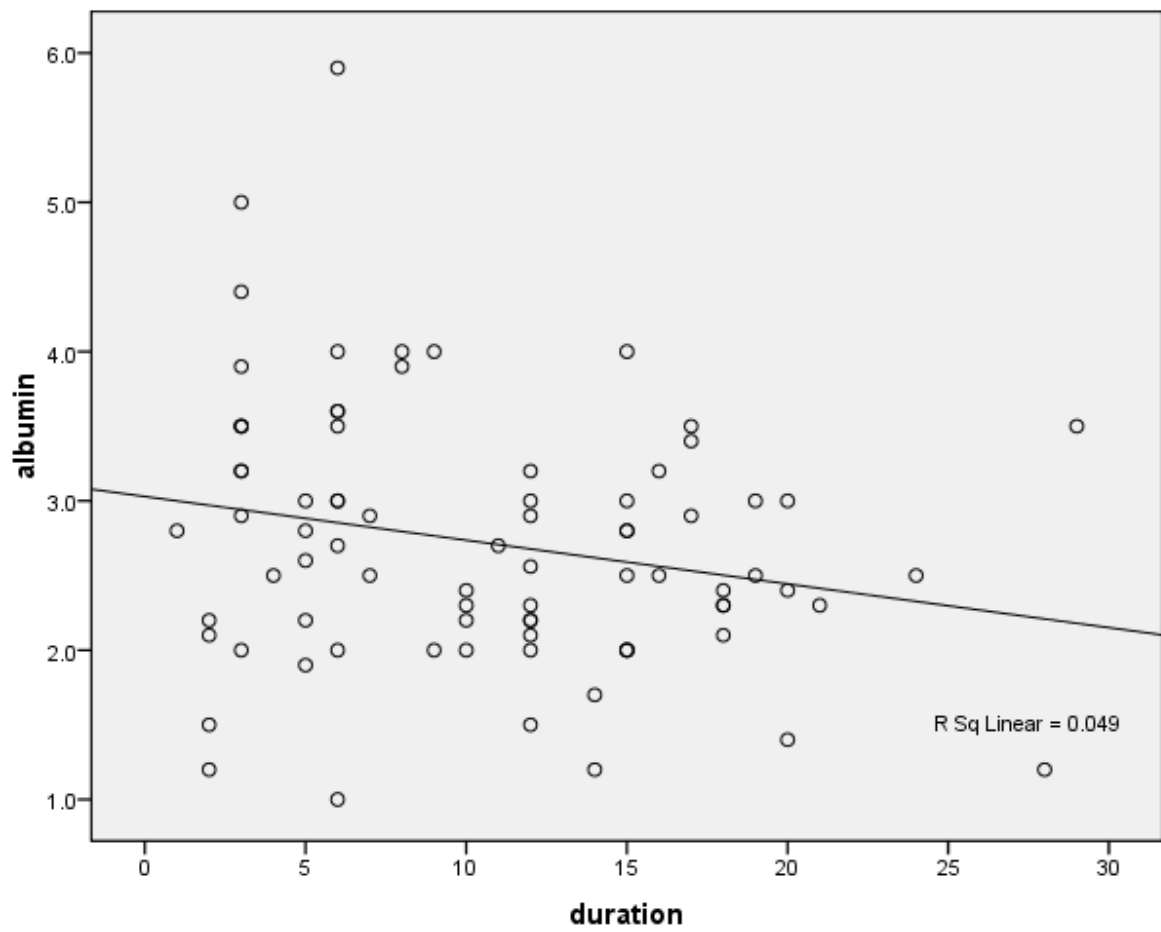


Figure (4-1): scatter plot of correlation between albumin levels and duration of dialysis: ($r = -0.220$, $p\text{-value} = 0.049$).

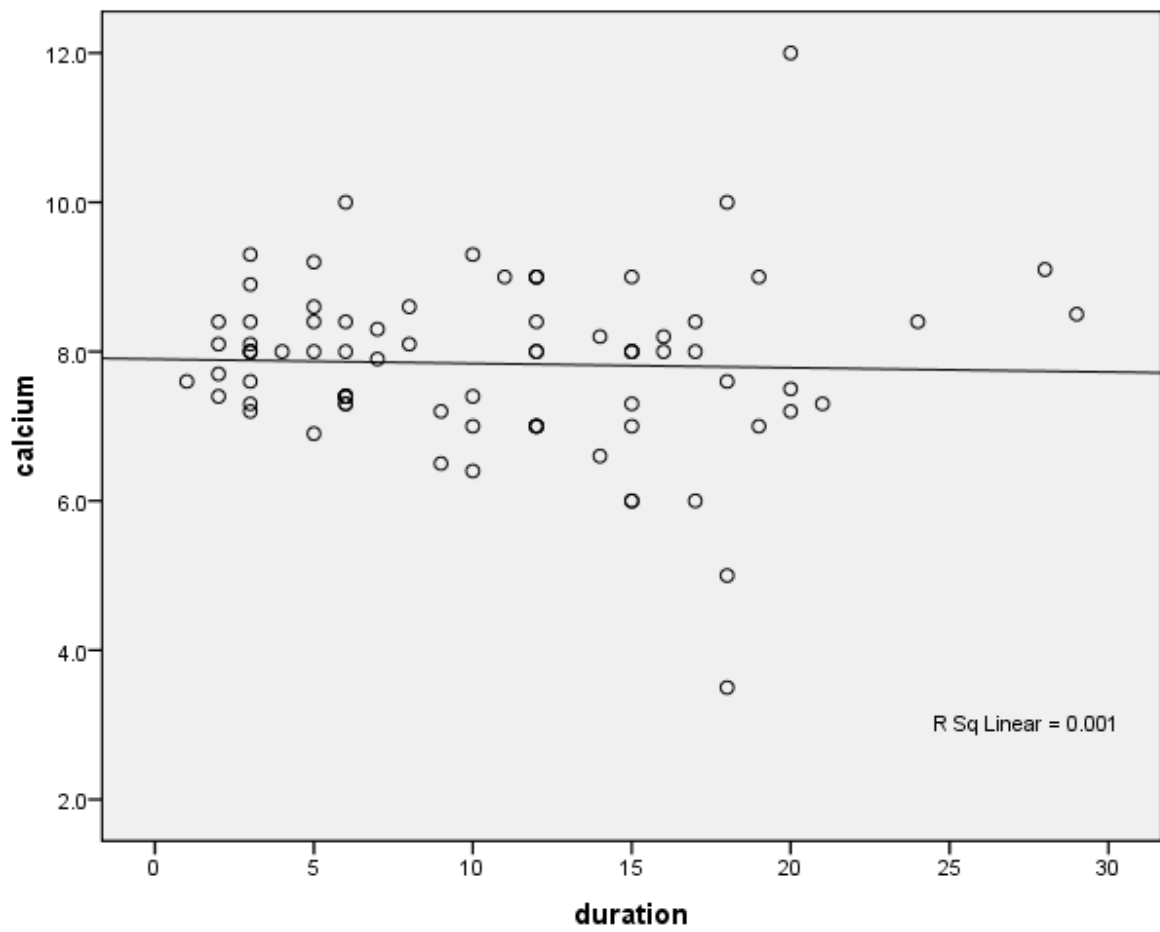


Figure (4-2): scatter plot of correlation between calcium levels and duration of dialysis: ($r = -0.033$, $p\text{-value} = 0.769$).

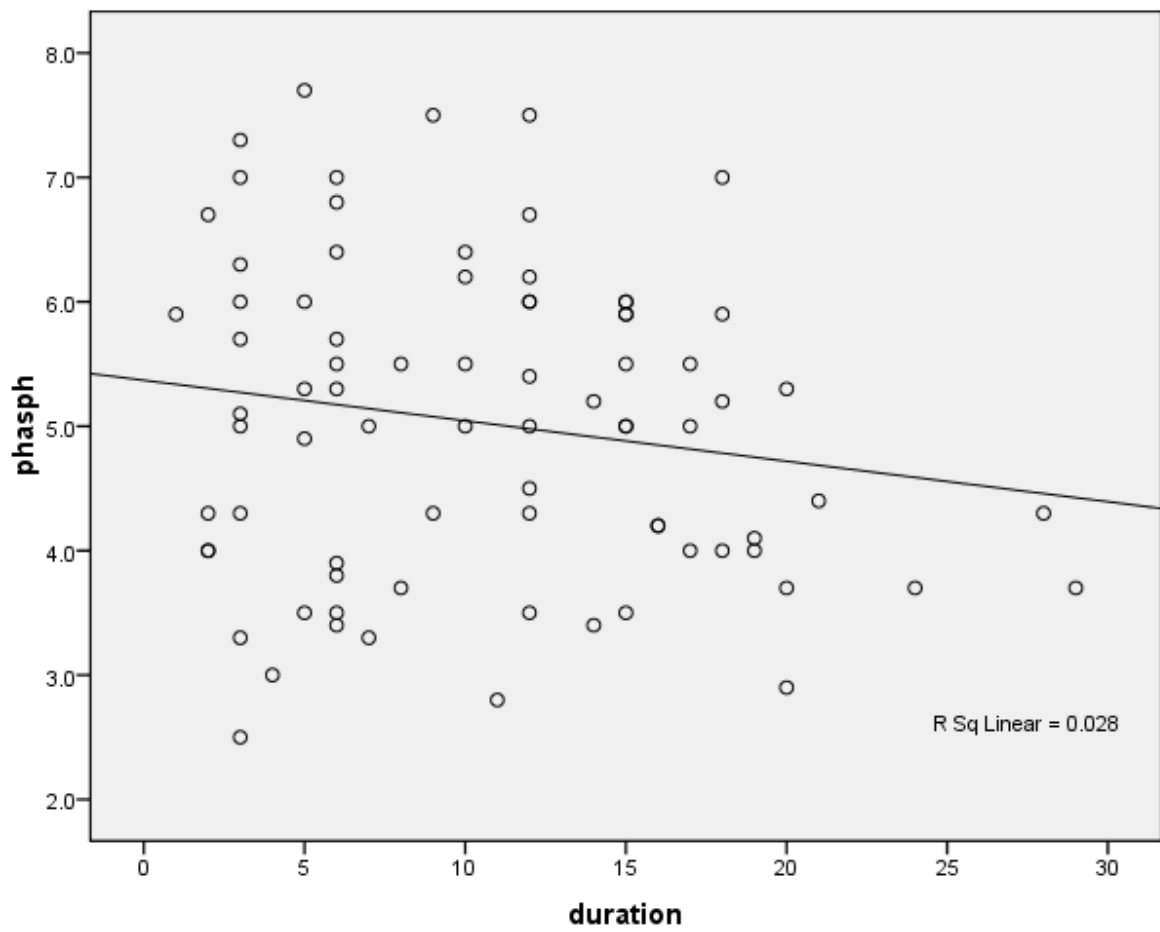


Figure (4-3): scatter plot of correlation between phosphorus levels and duration of dialysis: ($r = -0.168$, $p\text{-value} = 0.136$)

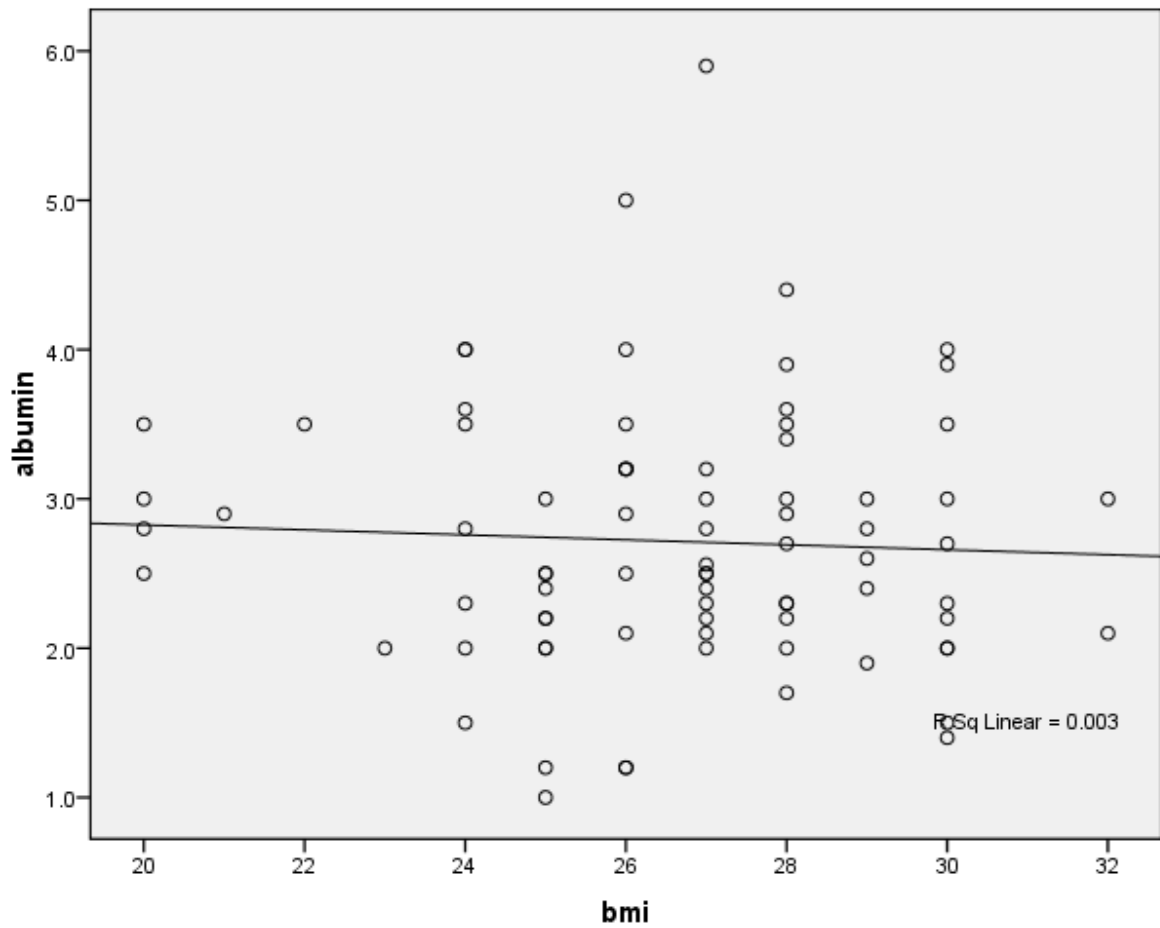


Figure (4-4): scatter plot of correlation between albumin levels and BMI (body mass index) of dialysis: ($r = -0.051$, $p\text{-value} = 0.653$).

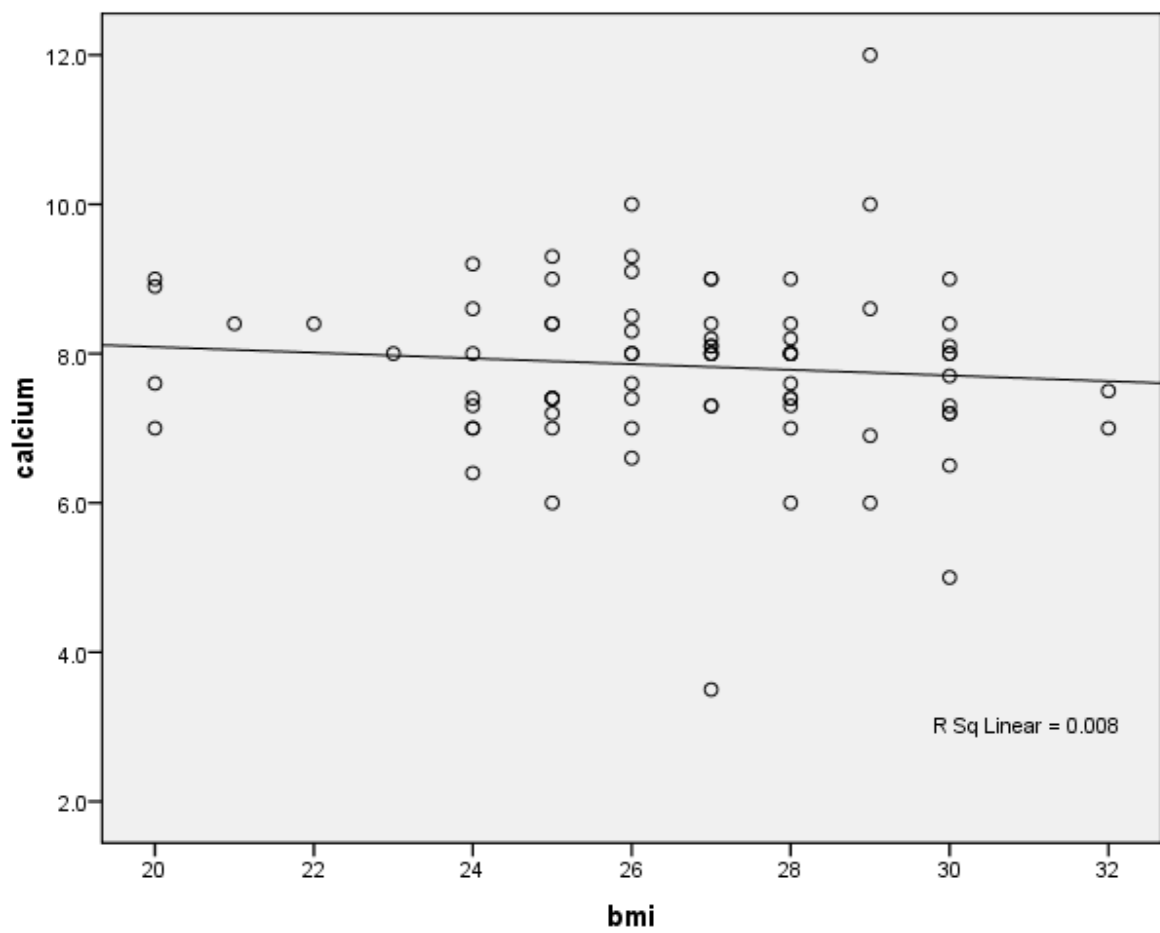


Figure (4-5): scatter plot of correlation between calcium levels and BMI (body mass index) of dialysis: ($r = -0.091$, $p\text{-value} = 0.427$).

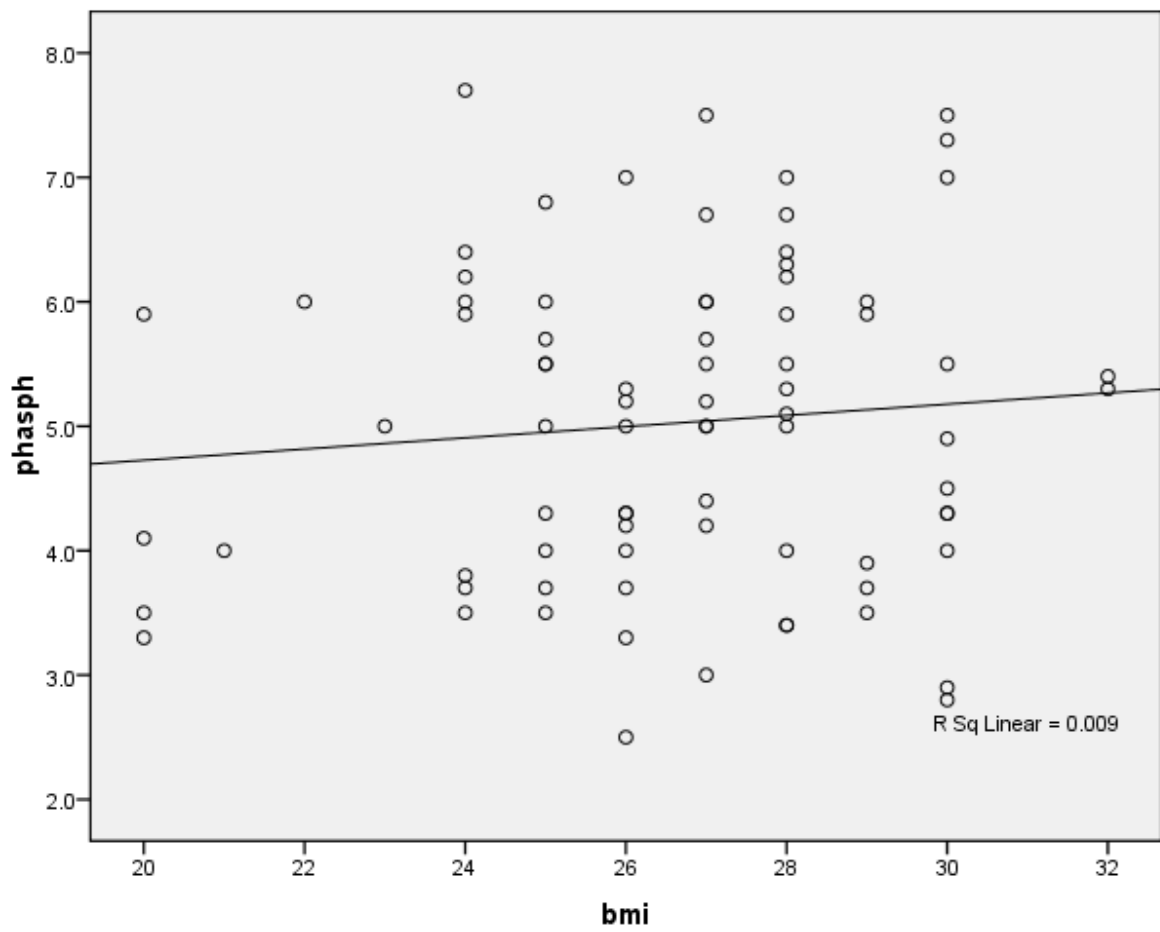


Figure (4-6): scatter plot of correlation between phosphorus levels and BMI (body mass index) of dialysis: ($r= 0.096$, $p\text{-value}=0.402$).

CHAPTER FIVE

Discussion

5.1Discussion

5.1 Discussion:

Kidney failure is a condition in which the kidneys fail to remove metabolic end product from the blood, so when kidney failure is reached the end stage it must need dialysis. (Benjamin; 2015).

Hemodialysis affects many substances in the blood by increasing, decreasing or removing them. This study conducted to study the effect of hemodialysis on levels of calcium, albumin and phosphorus. They were chosen for the assessment the effect of dialysis on levels of parameter.

Preliminary investigation and findings obtained from specially designed questionnaire revealed that the majority of patients under dialysis participated in this study were in the average ages of about 55 years. This agreed with previous published results of many authors. (Coresh et al; 2003), whose finding confirmed that, after the age of 30 years, glomerular filtration rate (GFR) progressively declines at an average rate of 8 mL/min/173 m² per decade , and the risk of renal failure increased with age. This result also was reported by; (Christian; 2014) showed that the average age of a British person with the renal failure is 77 years.

Sex distribution in patients under hemodialysis of this study revealed that 54% were males. This agree with the previous study which documented in the field of nephrology, showed that women seem to be somewhat protected from developing end stage renal failure; the cumulative incidence of the disease remains low during the reproductive ages and begins to rise 10 years later. (Iseki; 1996).

The findings of this study showed that, there was a significant difference in the body mass index (BMI; determined by dividing the weight in kilograms by the

height in meter square.) between patients and control, the patients with renal failure susceptible to be more obese than control group. This made the BMI is independent factor of renal failure. This agreed with previous study which found positive correlation between increased (BMI) and risk of renal failure disease. (Elisabeth *et al*; 2005). Another study examined the relationship between increased weight (BMI) and renal function evaluated by the estimated glomerular filtration rate, Increased BMI was consistently associated with reduced glomerular filtration rate. (Ryuichi; 2008)

Social clinical history index of patients under the study indicated that apposite family history of renal failure of first degree relatives found to be in 34% of cases. These findings may indicate that hereditary play a role in the pathogenesis of renal failure patients. This result agreed with previous study showed that, there is a high prevalence of family history –end stage renal disease among US population, about 23%. (William *et al*; 2007)

Other study showed the same result also; family history of renal disease is one of the most important risk factors associated with development of nephropathy. (Scott *et al*; 2005)

The findings of this study showed that, there was a significant difference in the body mass index (BMI; determined by dividing the weight in kilograms by the height in meter square.) between patients and control, the patients with renal failure susceptible to be more obese than control group. This made the BMI is independent factor of renal failure. This agreed with previous study which found positive correlation between increased (BMI) and risk of renal failure disease. (Elisabeth *et al*; 2005). Another study examined the relationship between increased weight (BMI) and renal function evaluated by the estimated glomerular filtration

rate, Increased BMI was consistently associated with reduced glomerular filtration rate. (Ryuichi; 2008)

In this study some of diseases presented in patients with renal failure as appeared in **table (4-2)**, more than half (59%) of patients in these study were present with hypertension. It is well documented that the persistence of hypertension is one of leading cause of chronic renal failure.

Also (46%) of patients under dialysis participated in this study were present with diabetes.

This agreed with previous study showed that high risk groups that should be screened for chronic kidney disease include patients who have a family history of the disease and patients who have diabetes, hypertension.(National Kidney Foundation; 2002)

Also this result was in agreement with findings done by (Oyetunde; 2014), revealed that both hypertension and diabetes were significantly related to chronic renal failure with incidence of (43%).The results showed that diabetes, hypertension and chronic renal failure were significantly correlated ($p\text{-value} < 0.05$).

Also the result agreed with study done by(Janice;2002) which showed that, The key risk factors for kidney disease are hypertension and diabetes, which are both becoming more prevalent in the United states,(40% among patients with renal failure.

In this study the levels of albumin was significantly lowered in patients under dialysis. This result agreed with result carried by many authors (Kaysen;*etal*1998). This found that serum levels of albumin in patients with renal failure on

hemodialysis; were decreased. It was hypothesized that this reduction could be caused in dialysis patients is primarily a consequence of reduced albumin synthesis rate in both hemodialysis and peritoneal dialysis patients. End Stage Renal Disease does not directly suppress albumin synthesis. The cause of decreased albumin synthesis is primarily a response to inflammation (the acute phase response), although it is possible that inadequate nutrition may also contribute. The cause of the inflammatory response is not immediately evident. There is no evidence that shifts of albumin to the extravascular space or that dilution of the plasma by volume expansion plays any role in causing hypo albuminemia in End Stage Renal Disease patients. Also the result agreed with result carried by (Indridason *et al* 2002) (Keith *et al*; 2008). (Finne *et al*; 2006). which found that hypo albuminemia in End Stage Renal Disease patients.

In this study the comparison of levels of calcium between case and control showed that significant decreasing of levels of calcium in patients with renal failure under hemodialysis when compared with control.

The result agreed with result carried by (Geoffrey; 2002). This found that serum levels of calcium in patients with renal failure on hemodialysis; were decreased due to the activation of vitamin D by the kidney is impaired and the low levels of activated vitamin D fail to suppress PTH, thereby compounding the secondary hyperparathyroidism present in chronic and end-stage patients.

The finding of this study showed that, there was significant increasing of levels of phosphorus in patients with renal failure under hemodialysis when compared with control. (5.0 ± 1.2 versus 3.6 ± 1.1) mg/dl $p=0.00$.

This result agreed with previous study showed that serum levels of phosphorus in patients with renal failure on hemodialysis; were increased. Hyperphosphatemia occurs universally in end-stage renal disease (Geoffrey; 2002).

In this results study showed that, there was no significant difference between albumin calcium and phosphorus according to gender

This result agreed with previous study done by (Olafur; 1998) showed that there was no significant difference of albumin calcium and phosphorus according to gender.

In this study findings showed that, there was insignificant correlation between body mass index (BMI) and albumin, ($r = -0.051$, $p\text{-value} = 0.653$), calcium ($r = 0.091$, $p\text{-value} = 0.427$) and phosphorus ($r = 0.096$, $p\text{-value} = 0.402$).

This result agreed with result carried by (Palomares; 2006).which found that insignificant correlation between body mass index (BMI) of dialysis and albumin calcium and phosphorus.

The finding this study showed that no significant correlation between duration of dialysis and albumin ($r = -0.22$ $p\text{-value} = 0.049$).

This result agreed with result carried by (Paul, et al; 2000).which found that no correlation between duration of dialysis of dialysis and albumin.

Also In this study as appeared in **figures (4-5 &4-6)**, which showed no correlation between duration of dialysis and calcium and phosphorus. Calcium ($r = -0.033$, $p\text{-value} \leq 0.769$) and phosphorus ($r = -0.168$, $p\text{-value} \leq 0.136$).

This result agreed with study done by (ASN; 2014), whose showed that insignificant correlation between calcium, phosphorus and duration of dialysis. This result disagree with previous study which found that, there was strong positive correlation between calcium, phosphorus and duration of dialysis (American journal; 1998).

5. 2 Conclusion

From the results and findings in these study,it is concluded the following:

1. Calcium and albumin are significantly decreased in the blood of hemodialysis patients with renal failure.
2. Phosphorus is significantly increased in the blood of hemodialysis patients with renal failure.
3. Hypertension and diabetes are the most common causes of chronic renal failure in Sudan.
4. the gender has no effect on the concentration of calcium, phosphorus and albumin

5.3 Recommendation

It is recommended that:

- dialysis patient should receive calcium supplement to avoid and minimize bone fraction
- Further studies estimation of vitamin D3 and PTH (parathyroid hormone).
- Further studies should be conducted to determine the real cause of this effect.

CHAPTER

SEX

References

6.1 References:

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6.2 Appendices:

6.2.1 QUESTIONNAIRE

TOPIC: the effect of hemodialysis on albumin ,calcium and phosphorus in renal failure patients under hemodialysis.

A:general information:

1-name..... 3- hospital.....

3-age..... 4-sex.....

B: type of renal failure:

1-acute renal failure 2-chronic renal failure

C: hemodialysis:

1-yes 2-NO

IF yes duration of dialysis.....

Weight

Height

D: present history of disease:

Liver disease heart disease

Bone disease others

E: past history of disease:

1-hypertention 2-liver disease

3-renal disease 4-diabetes

F: family history of renal failure yes.....no.....

g: investigation

1-serum albuming/dl

2-serum calcium.....mg/dl

3-serum phosphorus mg/dl