Ministry of Higher EducationAnd Scientific Research
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College of health and medical Techniques
Medical laboratory Techniques Department

Study of the potassium abnormalities in chronic kidney disease patients

A Research Project Submitted to the Department of Medical Laboratories Techniques, College of Health and Medical Techniques Al- Mustaqbal University in Partial Fulfillment of the Requirements for the Degree of Bachelor In Medical Laboratory Techniques

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بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

((وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ ﷺ))

صدق الله العلي العظيم

سورة التوبة - [الاية 105]

Certification

I certify that this Project Research was prepared under my supervision at Al- Mustaqbal University, College of Health and Medical Techniques Department of Medical Laboratories Techniques As a Requirement for the Degree of Bachelor of Medical Laboratories Techniques.

Supervisor:

In view of the available recommendations, I forward this thesis for debate by the examining committee.

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Committee Decision

We the examining committee certify that we have read this resear project and have examined the students in its content and at our opinion it is adequate for the requirements of the bachelor degree in medical laboratories techniques.

Member ***Member***
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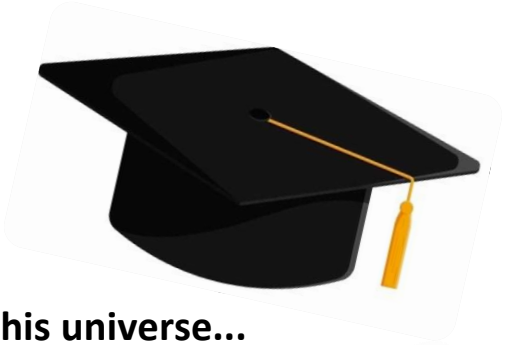
Dedication



To those who are peerless in this universe...
Those whom God commanded us to honor...
To those who sacrificed so much and gave what can never be repaid...
To the one who adorned my name with the most beautiful titles...
Who supported me unconditionally...
My pride and my glory: My Father.
To the one under whose feet God has placed Paradise...
Whose heart embraced me before her hands...
The prayer of dawn: My Mother.
To my steady pillars and the safety of my days...
My brothers, my sisters, and my companions on this journey...
This time, our arrows have hit their mark...
And our eyes glistened with the joy of triumph...
We wrote at the end of our lines: "We have attained what we patiently endured for."
This moment cannot be inherited or bought...
I paid for it with my years and my youth...
My sleepless nights and my fears; it is the longing of arrival.
To my ambitious soul...
Which began with a dream and culminated in success...
I dedicate this work:
First, to the souls of the martyrs and everyone who sacrificed themselves for the sake of the homeland and knowledge.
Second, to my family, the apple of my eye.
Third, to myself, and to the years I spent as a seeker of knowledge.
In the name of God Almighty:
"And the end of their prayer will be: Praise be to Allah, Lord of the Worlds."
Allah Almighty has spoken the truth.

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Abbreviation Table :

Term	Abbreviation
Angiotensin-Converting Enzyme Inhibitors	ACEI
Acute Kidney Injury	AKI
Blood Pressure	BP
Calcium	Ca
Complete Blood Count	CBC
Chronic Kidney Disease	CKD
Chronic Kidney Disease Mineral and Bone Disorder	CKD-MBD
Diabetes Mellitus	DM
Ethylenediaminetetraacetic Acid	EDTA
End-Stage Renal Disease	ESRD
Estimated Glomerular Filtration Rate	eGFR
Glomerular Filtration Rate	GFR
High-Density Lipoprotein	HDL
Hemoglobin	HGB
Hypertension	HT
Potassium	K
Low-Density Lipoprotein	LDL
Mineralocorticoid Receptor Antagonist	MRA
Maintenance Hemodialysis	MHD
Non-Steroidal Anti-Inflammatory Drugs	NSAIDS
Platelet	PLT
Parathyroid Hormone	PTH
Renin-Angiotensin-Aldosterone System	RAAS
Renin-Angiotensin-Aldosterone System Inhibitor	RAASi
Red Blood Cells	RBC
Standard Deviation	SD
White Blood Cells	WBC

Abstract:

Background: potassium abnormalities associated with hypertension or diabetic or both has shown increase the risk of mortality in patients on hemodialysis. We aimed to study the effect of renal failure on potassium serum level on dialysis patients**.**

Methods: This is an observational study conducted at Marjan Teaching Hospital (Dialysis Unit), Department of Internal Medicine. The study included a sample of 172 patients, of whom 75 had hyperkalemia, 66 had normal potassium levels, and 31 served as a control group. Samples were collected using a pre-designed questionnaire between December 2025 and February 2026..

Result: We study several parameters in chronic kidney disease (CKD) patients. The data shows that serum level of (potassium K) was elevated, while in some patients serum (potassium K) has no change.

Conclusion: Our study findings highlight the significant association between potassium abnormalities, and increased mortality risk in patients with chronic kidney disease (CKD) undergoing hemodialysis. Out of the 172 patients evaluated, a substantial proportion exhibited elevated potassium levels (75 patients). These electrolyte and metabolic disturbances can exacerbate the complications associated with CKD and potentially reduce the efficacy of dialysis treatment. Addressing these issues through appropriate management strategies is crucial to improving patient outcomes and prolonging survival in this vulnerable population.

المستخلص(Abstract)

الخلفية(Background)

أظهرت اضطرابات مستويات البوتاسيوم المرتبطة بمرتفع ضغط الدم، أو داء السكري، أو كليهما، زيادة في خطر الوفاة لدى المرضى الذين يخضعون لغسل الكلى (الديلزة الدموية). تهدف دراستنا إلى بحث تأثير الفشل الكلوي على مستويات البوتاسيوم في مصل الدم لدى مرضى الديلزة.

المنهجية(Methods)

هذه دراسة رصدية أجريت في مستشفى مرجان التعليمي (وحدة الديلزة)، قسم الأمراض الباطنية. شملت الدراسة عينة مكونة من 172 مريضاً، من بينهم 75 مريضاً يعانون من فرط بوتاسيوم الدم، و66 مريضاً لديهم مستويات بوتاسيوم طبيعية، و31 مريضاً مثلوا المجموعة الضابطة (المجموعة المرجعية). جُمعت البيانات باستخدام استبيان مُعد مسبقاً في الفترة ما بين ديسمبر 2025 وفبراير 2026.

النتائج(Results)

قمنا بدراسة عدة معايير لدى مرضى الكلى المزمن .(CKD) وتظهر البيانات أن مستوى البوتاسيوم في المصل كان مرتفعاً، بينما لم يطرأ أي تغيير على مستوى البوتاسيوم في المصل لدى بعض المرضى.

الاستنتاج(Conclusion)

تسلط نتائج دراستنا الضوء على الارتباط الوثيق بين اضطرابات البوتاسيوم وزيادة خطر الوفاة لدى مرضى الكلى المزمن الذين يخضعون للديلزة الدموية. ومن بين الـ 172 مريضاً الذين شملهم التقييم، أظهرت نسبة كبيرة منهم (75 مريضاً) ارتفاعاً في مستويات البوتاسيوم. يمكن لهذه الاضطرابات في الكهارل والتمثيل الغذائي أن تفاقم المضاعفات المرتبطة بمرض الكلى المزمن، وقد تقلل من فعالية علاج الديلزة. إن معالجة هذه المشكلات من خلال استراتيجيات إدارة مناسبة أمر بالغ الأهمية لتحسين نتائج المرضى وإطالة بقائهم على قيد الحياة في هذه الفئة الضعيفة صحياً.

وزارة التعليم العالي والبحث العلمي
جامـــــــعة المستقبل الاهلية
كلية التقنيات الصحية والطبية
قسم تقنيات المختبرات الطبية

دراسة اضطرابات البوتاسيوم لدى مرضى القصور الكلوي المزمن

مشروع بحثي مُقدَّم إلى قسم تقنيات المختبرات الطبية، كلية العلوم الصحية والتقنيات الطبية، جامعة المستقبل، استكمالاً لمتطلبات الحصول على درجة البكالوريوس في تقنيات المختبرات الطبية

من قبل الطلبة

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Chapter one

1.1 Introduction:

Potassium (K) is the most abundant intracellular ions in body fluids, with approximately 98% of its concentration found within cells. The primary physiological function of K ions is to regulate cellular metabolism, such as protein and glycogen synthesis, and acid-base balance. Furthermore, the difference in potassium concentration intra and extracellular creates a trans membrane potential that is responsible for neuromuscular function, normally, the potassium excretion through sweat is approximately 5 mEq/day, in stool between 5 to 10 mEq/day, and in urine around 92 mEq/day. The kidney maintains potassium homeostasis primarily through ion secretion through the distal convoluted tubule and the proximal collecting duct **(1)**.

Hyperkalemia is one of the most common metabolic complications of CKD patients, because it can cause electrophysiological disorders with severe clinical repercussions that may lead to

death. This electrolytic change is defined as the elevation in the serum level of potassium above the range of normality. The mechanisms that lead to elevate in potassium level typically involve a combination of factors, such as the increase in the intake of foods rich in potassium like spinach ,cucumbers and others ,or medical condition like chronic kidney disease (CKD) , uncontrolled DM , dehydration and others also some drugs like angiotensin-converting enzyme (ACEI) ,beta blockers are predisposing factors for an increased level of potassium, the incidence of hyperkalemia varies between 2-35% of CKD patients, depending on the rate of glomerular filtration rate (GFR) for the population studies , also patients who are long standing dialysis are more risk for chronic hyperkalemia and more risk for mortality rate as showing in table1 (2)

Diabetes mellitus is often one of the most leading causes of chronic kidney diseases and end stage kidney disease in the world. It has been reported as the most common diagnosis for the initiation of renal replacement therapy in the United States in 2020.

For many years, diabetic nephropathy has shown that there are slowly damages in the kidneys' filtering system. Early treatment could prevent this condition or can slow it and lower the chance of complications.

Each kidney consists of millions of small filters called nephrons. Over time, high blood sugar from diabetes can damage blood vessels in these kidneys as well as nephrons and they don’t work as well as the normal kidney does. Many people with diabetes can also develop high blood pressure. Often, there are no symptoms, and the kidney damage starts slowly to get worse. Kidney damage can start after 5 to 10 years before even the

symptoms start.

Hypertension is the global public health problem, and currently the leading factor in the global disease. It is often the major modifiable risk factor for heart disease, stroke and kidney failure. Uncontrolled hypertension is a common cause of chronic kidney disease.

The pathophysiology of the CKD shows that associated hypertension is multi-factorial which have different mechanisms contributing to hypertension. These pathogenic mechanisms can include sodium dysregulations, increase sympathetic nervous system and relate in renin angiotensin aldosterone system activity. Blood pressure (BP) should be measured every day because it is essential in establishing the diagnosis and the management of hypertension in CKD.

Table 1: acute and chronic hyperkalemia.

Acute hyperkalemia	Chronic Hyperkalemia
Caused by abnormal release of potassium from cells, it is usually due to trauma, metabolic acidosis ,or hemolytic states.	Caused by : impairment in potassium excretory way and increase in potassium load .
Requires immediate attention, ex, cardiac monitoring , medical interventions, or possibly dialysis	Requires continuous management to correct the underlying disturbances in potassium balance, ex-nonpharmacological drugs and pharmacological drugs interventions
Management goals: induce potassium redistribution and excretion, restore normal electrophysiology of the cell membrane, prevent cardiac arrhythmia	Management goals: induce potassium redistribution and excretion to prevent the development or recurrence of hyperkalemia; monitor potassium intake through diet

1.2 Mechanisms of hyperkalemia in CKD

Potassium excretion decreases as CKD progresses, therefore, eating food high in potassium (avocados and kale) greatly increases the challenge of keeping the (K) ion in the normal range in those with renal failure may be due DM, HT or heart disease. This population is frequently affected by metabolic acidosis, which results in the (K) ion moving from the intracellular to the extracellular space and raising serum potassium levels. Hyperkalemia in individuals undergoing kidney transplantation is linked to acidosis and the use of calcineurin inhibitors. **(5)**.

Serum potassium K ion levels may rise as a result of certain comorbidities, which are frequently present in CKD patients, for example, rapid reductions in GFR and tubular flow are the outcome of acute kidney injury, which is typically accompanied by tissue damage, hyper-catabolism, or high levels of potassium may be secondary to bleeding. In addition, Acute K ion increase can also happen following a blood transfusion. These illnesses lead to an increase in potassium levels in the blood, which is one of the most frequent reasons for emergency dialysis therapy and may

pose a risk to the patient's life. Two of the most prevalent comorbidities in individuals with chronic kidney disease (CKD) are diabetes mellitus and cardiovascular disease. These conditions are linked to the development of hyperkalemia, albeit by distinct pathways. Potassium transport to the intracellular space is reduced in diabetic patients due to insulin insufficiency and hyper- tonicity brought on by hyperglycemia. Other risk factors for hyperkalemia are also present, as seen in table 2 (6).

Table 2.

Risk Factors for Elevated serum potassium level in in CKD	
Risk Factor	**Due To**
Potassium intake	Increased dietary potassium intake from salt substitute, potassium-rich heart-healthy diets, and herbal supplements
Metabolic acidosis	Potassium shift from the intracellular to the extracellular space
Diabetes	Insulin deficiency and hyper-tonicity caused by hyperglycemia contribute to an inability to disperse high acute potassium load into the intracellular space
Heart failure	Reduction in renal perfusion, use of RAASi or MRA
Coronary artery and peripheral vascular disease	Use of RAASi, oxidative stress, Atherosclerosis
Advanced age	Decreases in plasma renin activity and plasma aldosterone levels with age, as well as frequent use of NSAIDS in this population

1.3 Aim of study:

To evaluate the effect of chronic kidney disease on serum potassium levels.

Chapter Two

2.1 Patient and Method:

The study was conducted from December 11, 2025, to February 30, 2026, in the intensive care unit (dialysis unit) of Marjan Teaching Hospital. Inclusion criteria included patients with chronic kidney disease who had elevated potassium levels, defined as a gradual loss of kidney function occurring over months to years when urea and creatinine levels are elevated.**Sampling**

Samples were obtained from 31 healthy people as control group. Their mean age was 50.06±13.7 years (14 male and 17 female).

First group consist of 75 patients with CKD and hyperkalemia.

A. 31 patients have hyperkalemia with hypertension (HT) and diabetic (DM).
B. 20 patients have hyperkalemia with DM.
C. 24 patients have hyperkalemia with HT.

Second group consist of 66 patients with CKD and normal potassium level.

A. 28 patients have normal K with HT and DM.
B. 19 patients have normal K with DM.
C. 19 patients have normal K with HT.

Information from patient were collected according to interviewing questionnaire decided by researcher it was include age, sex, medical history.

2.2 Measurement tool:

Blood sample was taken to determine CBC, Ferritin

For Complete blood count use EDTA tube in CBC devise take 2-5 minutes

HS ASOT The blood sample is separated by a centrifuge, in order to obtain a blood serum, as the analysis is performed on the blood serum, not the blood itself.

Urea and creatinine collection within the 24-hour urine collection after asking patient to empty bladder first thing in the morning, period take 30 min

Ferritin analysis is performed on the blood serum, not the blood itself, uses gel tube and takes 45 min.

Electrolyte blood sample using test tube then added AgNo3 to separate it and take 15 min.

2.3 Statistical analysis:

In this study, the data were presented as Mean ± SD, and we used a T-test to determine the statistical significance. The different were considered statistically significance when P-value is
<0.05, whereas, when the P-value >0.05 the difference considered non-significance.

2.4 Research Methodology and Tools Summary

Tools and Materials

Item	Purpose/Function
Pre-designed questionnaire	Data collection (interviews, medical history, etc.)
EDTA test tubes	Complete Blood Count (CBC) collection
Centrifuge	Separation of blood sample to obtain blood serum
Test tubes for electrolytes	Electrolyte sample collection
AgNo3 (Silver Nitrate)	Separation of electrolyte sample
Gel tubes	Ferritin analysis
CBC device	Complete Blood Count (CBC) analysis

Summary of Methodology

- **Study Design:** Observational study conducted at the Dialysis Unit, Marjan Teaching Hospital, Department of Internal Medicine.
- **Study Period:** December 2025 to February 2026.
- **Study Population:** 172 patients in total (75 with hyperkalemia, 66 with normal potassium levels, and 31 in the control group).
- **Data Collection:** Information was collected through an interview-based questionnaire including age, sex, and medical history.
- **Laboratory Analysis:** Blood samples were collected and processed to obtain serum. Analysis included Complete Blood Count (CBC), Urea, Creatinine, Potassium, Chloride, Sodium, and Ferritin. Statistical analysis was performed using a T-test, with a P-value < 0.05 considered statistically significant.

Chapter Three

3.1 Result:

3.1.1 Estimation of Urea level in patients on hemodialysis.

To confirm that the patient has CKD, blood urea test was conducted to identify the blood urea levels.

As shown in table 1a, compared to control, the urea level in patients with CKD combined with hyperkalaemia is increased significantly P<0.0001. The data also shown hypertension up and diabetes did not make significant difference when compared between these group. Similarly**, table 1b,** showed similar changed pattern compared to **table 1a.**

The data also shows that, in general, hyperkalaemia dose not significantly affected the urea level compared to patient has CKD with normal potassium level.

Table 1 (A) Shows the comparison of urea account between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05.
*P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Hyperkalemia + HT	P – value
22.297 ± 6.03873 mg/dl	**142.991 ±36.48862** mg/dl	***
Control	**Hyperkalemia + DM**	**P_ value**
22.297 ± 6.03873 mg/dl	**138.2961 ± 49.05529 mg/dl**	***
Control	**Hyperkalemia + HT + DM**	**P_ value**
22.297 ± 6.03873 mg/dl	**131.65774 ± 49.75898 mg/dl**	***

Comparison of urea levels between healthy individuals and CKD patients with hyperkalemia

Table 1 (B) Shows the comparison of urea account between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05**.**

Control	**Normal K+ HT**	**P – value**
22.297 ± 6.03873 mg/dl	**143.0731 ± 40.5472 mg/dl**	*******
Control	**Normal K + DM**	**P_ value**
22.297 ± 6.03873 mg/dl	**146.81± 39.75796 mg/dl**	*******
Control	**Normal K+ HT + DM**	**P_ value**
22.297 ± 6.03873 mg/dl	**139.07142 ± 35.8216 mg/dl**	*******

Comparison of urea levels between healthy individuals and CKD patients with normal potassium levels

3.1.2 Estimation of creatinine level in patients on hemodialysis.

To confirm that the patient has CKD, blood creatinine test was conducted to identify the blood creatinine levels.

As shown in table 2(A), compared to control, the creatinine level in patients with CKD combined with hyperkalaemia is increased significantly P<0.0001. The data also showed hypertension up and diabetes did not make significant difference when compared between

these group. Similarly**, table 2(B), showed similar changed pattern compared to table 2(A).**

The data also shows that, in general, hyperkalaemia does not significantly affected the creatinine level compared to patients who have CKD with normal potassium level.

Table 2 (A) Shows the comparison of creatinine account between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The

data represents Mean ±SD. The difference is considered statistically significant when the P-value

<0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	**Hyperkalemia + HT**	**P – value**
0.81219±0.10280211 mg/dl	**6.12026±1.4274556 mg/dl**	*******
Control	**Hyperkalemia + DM**	**P_ value**
0.81219±0.10280211 mg/dl	**5.9559444±2.6952022 mg/dl**	*******
Control	**Hyperkalemia + HT + DM**	**P_ value**
0.81219±0.10280211 mg/dl	**7.3046129±2.6126623 mg/dl**	*******

Comparison of creatinine levels between healthy individuals and CKD patients with hyperkalemia

Table 2 (B) Shows the comparison of creatinine account between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P – value
0.81219±0.10280211 mg/dl	5.843157895±2.62791819 mg/dl	***
Control	**Normal K + DM**	**P_ value**
0.81219±0.10280211 mg/dl	5.23945±2.25189902 mg/dl	***
Control	**Normal K+ HT + DM**	**P_ value**
0.81219±0.10280211 mg/dl	5.967464286±1.934471169 mg/dl	***

Comparison of creatinine levels between healthy individuals and CKD patients with normal potassium levels

3.1.3 Estimation of Potassium level in patients on hemodialysis .

To evaluate the abnormalities in potassium levels in CKD patients, blood potassium test was conducted to identify the blood potassium levels.

As shown in table 3(A), compared to control, the potassium (K) level in patients with CKD combined with hyperkalaemia is increased significantly P<0.0001. The data also shown hypertension up and diabetes did not make significant difference when compared between these groups. While, **table 3(B),** compared to control**,** normal K level showed no significant changed pattern p>0.05 . The data also shown hypertention has no significant change and diabetic did not make significant change when compared between these groups**.**

The data also shows that, in general, hyperkalaemia dose have significantly affected the potassium level compared to patient has CKD with normal potassium level.

Table 3 (A) Shows the comparison of potassium level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P- value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant

(N.S)>0.05.

Control	Hyperkalemia + HT	P – value
4.06± 0.53 mg/dl	6.57±0.92 mg/dl	***
Control	Hyperkalemia + DM	P_ value
4.06± 0.53 mg/dl	6.45± 0.97 mg/dl	***
Control	Hyperkalemia + HT + DM	P_ value
4.06± 0.53 mg/dl	7.00± 1.6 mg/dl	***

Comparison of potassium levels between healthy individuals and CKD patients with hyperkalemia

Table 3 (B) Shows the comparison of potassium level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P – value
4.06± 0.53 mg/dl	3.96± 0.48 mg/dl	N.S
Control	Normal K + DM	P_ value
4.06± 0.53 mg/dl	3.9± 0.60 mg/dl	N.S
Control	Normal K+ HT + DM	P_ value

4.06± 0.53 mg/dl	**4.03± 0.54mg/dl**	**N.S**

Comparison of potassium levels between healthy individuals and CKD patients with normal potassium levels

3.1.4 Estimation of Chloride level in patients on hemodialysis .

To evaluate the high chloride level in CKD patients, blood chloride test was conducted to identify the blood chloride levels.

As shown in table 4(A) , compared to control, the chloride level in patients with CKD combined with hyperkalaemia is increased significantly P<0.0001in patients with diabetic and hyperkalemia with diabetic + hyperkalemia. The data also shown patients with hypertension has p>0.001. while, **table 4(B),** compared to control, normal K level showed significant changed pattern p>0.0001. The data also shown hypertention has no significant change and diabetic did not make significant change when compared between these groups **.**

The data also shows that, in general, hyperkalaemia dose have significantly affected the chloride level compared to patient has CKD with normal potassium level.

Table 4 (A) Shows the comparison of chloride level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05.
*P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) .

Control	Hyperkalemia + HT	P - value
100.46± 2.96 mg/dl	**104.9±6.447 mg/dl**	****
Control	**Hyperkalemia + DM**	**P_ value**
100.46± 2.96 mg/dl	**105.7± 4.7 mg/dl**	*****

Control	Hyperkalemia + HT + DM	P_ value
100.46 ± 2.96 mg/dl	106.58± 4.7 mg/dl	***

Comparison of chloride levels between healthy individuals and CKD patients with hyperkalemia

Table 4 (B) Shows the comparison of chloride level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
100.46± 2.96 mg/dl	104.6± 3.9 mg/dl	***
Control	Normal K + DM	P_ value
100.46± 2.96 mg/dl	106.5± 4.6 mg/dl	***
Control	Normal K+ HT + DM	P_ value
100.46± 2.96 mg/dl	105.35± 3.56 mg/dl	***

Comparison of chloride levels between healthy individuals and CKD patients with normal potassium levels

3.1.5 Estimation of Sodium level in patients on hemodialysis.

To evaluate the low sodium level in CKD patients, blood sodium test was conducted to identify the blood sodium levels.

As shown in table 5(A) , compared to control, the sodium level in patients with CKD combined with hyperkalaemia has no significantly P>0.05 . The data also shown in hypertension and diabetes did not make significant difference when compared between

these group. Similarly**, table 5(B),** showed similar changed pattern compared to **table 5(A).** The data also shows that, in general, hyperkalaemia dose not significantly affected the sodium level compared to patient has CKD with normal potassium level.

Table 5(A) Shows the comparison of sodium level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) **.**

Control	Hyperkalemia + HT	P - value
134.47± 4.57 mg/dl	**135.47±4.4 mg/dl**	**N.S**
Control	**Hyperkalemia + DM**	**P_ value**
134.47± 4.57 mg/dl	**136.76± 4.7 mg/dl**	**N.S**
Control	**Hyperkalemia + HT + DM**	**P_ value**
134.47± 4.57 mg/dl	**136.1± 4.86 mg/dl**	**N.S**

Comparison of sodium levels between healthy individuals and CKD patients with hyperkalemia

Table 5(B) Shows the comparison of sodium level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05**.**

Control	Normal K+ HT	P - value
134.47± 4.57 mg/dl	**135.3± 4.14 mg/dl**	**N.S**
Control	**Normal K + DM**	**P_ value**

134.47± 4.57 mg/dl	**136± 4.6 mg/dl**	**N.S**
Control	**Normal K+ HT + DM**	**P_ value**
134.47± 4.57 mg/dl	**135.78± 4.79 mg/dl**	**N.S**

Comparison of sodium levels between healthy individuals and CKD patients with normal potassium levels

3.1.6 Estimation of platelet count test in patients on hemodialysis.

To evaluate thrombocytopenia in CKD patients , blood CBC test was conducted to identify the blood PLT levels.

As shown in table 6a, compared to control, the PLT level in patients with CKD combined with hyperkalaemia has no significantly P>0.05. The data also shown in hypertension and diabetes did not make significant difference when compared between these group. Similarly, table 6b, showed similar changed pattern compared to table 6a.

The data also shows that, in general, hyperkalaemia dose not significantly affected the PLT level compared to patient has CKD with normal potassium level.

Table 6 (A) Shows the comparison of PLT level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05.
*P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P - value
214 ± 72.34mg/dl	**184.65±51.02 mg/dl**	**N.S**
Control	**Hyperkalemia + DM**	**P_ value**

214 ± 72.34 mg/dl	**199.5± 71.23** mg/dl	**N.S**
Control	**Hyperkalemia + HT + DM**	**P_ value**
214 ± 72.34 mg/dl	**222.93± 114.77** mg/dl	**N.S**

Comparison of platelet (PLT) count between healthy individuals and CKD patients with hyperkalemia

Table 6(B) Shows the comparison of PLT level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
214 ± 72.34 mg/dl	**209.10± 57.14 mg/dl**	**N.S**
Control	**Normal K + DM**	**P_ value**
214 ± 72.34 mg/dl	**219.7± 64.9 mg/dl**	**N.S**
Control	**Normal K+ HT + DM**	**P_ value**
214 ± 72.34 mg/dl	**185.46± 61.9 mg/dl**	**N.S**

Comparison of platelet (PLT) count between healthy individuals and CKD patients with normal potassium levels

3.1.7 Estimation of white blood cells in patients on hemodialysis .

To evaluate the infection in CKD patients , blood CBC test was conducted to identify the blood WBC levels.

As shown in table 7a, compared to control, the WBC level in patients with CKD combined with hyperkalaemia with HT is increased significantly P<0.0001. The data also shown , compared to control, patients with hyperkalaemia with DM is increased significantly P<0.001 and increased significantly P<0.05 in diabetes with hypertension

.**Table 7b,** compared to control **,** normal K with HT showed increased significantly P<0.001 , and no significant P>0.05 in patients normal K with DM and HT+DM .

The data also shows that, in general, hyperkalaemia dose have significantly affected the WBC level compared to patient has CKD with normal potassium level.

Table 7(A) Shows the comparison of WBC level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P - value
5.77± 1.8 mg/dl	3.04±0.54 mg/dl	***
Control	Hyperkalemia + DM	P_ value
5.77± 1.8 mg/dl	8.15± 3.13 mg/dl	**
Control	Hyperkalemia + HT + DM	P_ value
5.77± 1.8 mg/dl	7.85± 3.96 mg/dl	*

Comparison of white blood cell (WBC) count between healthy individuals and CKD patients with hyperkalemia

. **Table 7(B)** Shows the comparison of WBC level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
5.77± 1.8 mg/dl	2.65± 5.8 mg/dl	**
Control	Normal K + DM	P_ value
5.77± 1.8 mg/dl	6.25± 2.60 mg/dl	N.S
Control	Normal K+ HT + DM	P_ value
5.77± 1.8 mg/dl	6.28± 3.15 mg/dl	N.S

Comparison of white blood cell (WBC) count between healthy individuals and CKD patients with normal potassium levels

3.1.8 Estimation of Red blood cells in patients on hemodialysis .

To evaluate the anemia in CKD patients , blood CBC test was conducted to identify the blood RBC levels.

As shown in table 8 a, compared to control, the RBC level in patients with CKD combined with hyperkalaemia is increased significantly P<0.0001. The data also shown hypertension up and diabetes did not make significant difference when compared between these group. Similarly, table 8b, showed similar changed pattern compared to table 8a.

The data also shows that, in general, hyperkalaemia dose not significantly affected the RBC level compared to patient has CKD with normal potassium level.

Table 8 (A) Shows the comparison of RBC account between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P- value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Hyperkalemia + HT	P - value
4.75± 1.06 mg/dl	3.04±0.54 mg/dl	***
Control	Hyperkalemia + DM	P_ value
4.75± 1.06 mg/dl	3.53± 0.65 mg/dl	***
Control	Hyperkalemia + HT + DM	P_ value
4.75± 1.06 mg/dl	3.28± 0.61 mg/dl	***

Comparison of red blood cell (RBC) count between healthy individuals and CKD patients with hyperkalemia

Table 8(B) Shows the comparison of RBC level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
4.75± 1.06 mg/dl	3.07± 2.76 mg/dl	**
Control	Normal K + DM	P_ value
4.75± 1.06 mg/dl	3.21± 0.64 mg/dl	***
Control	Normal K+ HT + DM	P_ value
4.75± 1.06 mg/dl	3.12± 3.15 mg/dl	**

Comparison of red blood cell (RBC) count between healthy individuals and CKD patients with normal potassium levels

3.1.9 Estimation of Hemoglobin in patients on hemodialysis .

To evaluate the anemia in CKD patients , blood CBC test was conducted to identify the blood HGB levels.

As shown in table 9a, compared to control, the HGB level in patients with CKD combined with hyperkalaemia with HT and HT + DM is increased significantly P<0.001. The data also shown , compared to control, patients with hyperkalaemia with DM has no significantly P>0.05 .Table 9b, compared to control , normal K with HT + DM showed increased significantly P<0.001 , and no significant P>0.05 in patients normal K with DM and HT .

The data also shows that, in general, hyperkalaemia dose have significantly affected the HGB level compared to patient has CKD with normal potassium level.

Table 9(A) Shows the comparison of HGB level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05.
*P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P – value
10.36± 1.37 mg/dl	9.33±1.59 mg/dl	**
Control	Hyperkalemia + DM	P_ value
10.36± 1.37 mg/dl	9.87± 1.39 mg/dl	N.S
Control	Hyperkalemia + HT + DM	P_ value
10.36± 1.37 mg/dl	9.19± 1.70 mg/dl	**

Comparison of hemoglobin (HGB) levels between healthy individuals and CKD patients with hyperkalemia

Table 9(B) Shows the comparison of HGB level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P – value
10.36± 1.37 mg/dl	10.4± 10 mg/dl	N.S
Control	Normal K + DM	P_ value
10.36± 1.37 mg/dl	9.58± 1.47 mg/dl	N.S
Control	Normal K+ HT + DM	P_ value
10.36± 1.37 mg/dl	9.02± 1.48	**

Comparison of hemoglobin (HGB) levels between healthy individuals and CKD patients with normal potassium levels

3.1.10 Estimation of Calcium in patients on hemodialysis .

To evaluate the hypocalcmia in CKD patients , blood calcium test was conducted to identify the blood calcium levels.

As shown in table 10a, compared to control, the calcium level in patients with CKD combined with hyperkalaemia with HT + DM is increased significantly P<0.0001. The data also shown , compared to control, patients with hyperkalaemia with HT has no significantly P>0.05 and increased significantly P<0.001 in patients with DM .**Table 10b**, compared to control , normal K with HT + DM showed increased significantly P<0.0001 , and no significant P>0.05 in patients normal K with HT and increased significantly P<0.001 in patients with DM .

The data also shows that, in general, hyperkalaemia dose have significantly affected the calcium level compared to patient has CKD with normal potassium level.

Table 10(A) Shows the comparison of calcium level between health individuals and

patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P- value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05**.**

Control	Hyperkalemia + HT	P - value
8.75± 0.91 mg/dl	8.28±1.04 mg/dl	N.S
Control	Hyperkalemia + DM	P_ value
8.75± 0.91 mg/dl	7.88± 0.87 mg/dl	**
Control	Hyperkalemia + HT + DM	P_ value
8.75± 0.91 mg/dl	7.81± 0.88 mg/dl	***

Comparison of calcium levels between healthy individuals and CKD patients with hyperkalemia

Table 10(B) Shows the comparison of calcium level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
8.75± 0.91 mg/dl	8.09± 9.22 mg/dl	N.S
Control	Normal K + DM	P_ value
8.75± 0.91 mg/dl	7.74± 1.07 mg/dl	**

Control	Normal K+ HT + DM	P_ value
8.75± 0.91 mg/dl	**7.77± 0.84 mg/dl**	***

Comparison of calcium levels between healthy individuals and CKD patients with normal potassium levels

3.1.11 Estimation of low density lipoprotein in patients on hemodialysis .

To evaluate the hyperlipidemia in CKD patients , blood lipid profile test was conducted to identify the blood LDL levels.

As shown in table 11a, compared to control, the LDL level in patients with CKD combined with hyperkalaemia with HT + DM and hyperkalemia with DM are increased significantly P<0.05 . The data also shown , compared to control, patients with hyperkalaemia with HT is increased significantly P<0.001 .**Table 11b**, compared to control , normal K with HT + DM and normal K with DM are increased significantly P<0.001 , and no significant P>0.05 in patients normal K with HT**.**

The data also shows that, in general, hyperkalaemia dose have significantly affected the LDL level compared to patient has CKD with normal potassium level.

Table 11(A) Shows the comparison of LDL level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05.

*P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P - value
120.52± 45.46 mg/dl	**147.13±43.41** mg/dl	**
Control	**Hyperkalemia + DM**	**P_ value**

120.52± 45.46 mg/dl	**157.36± 68.35** mg/dl	*
Control	**Hyperkalemia + HT + DM**	**P_ value**
120.52± 45.46 mg/dl	**145.40± 36.82 mg/dl**	*

Comparison of LDL levels between healthy individuals and CKD patients with hyperkalemia

Table 11(B) Shows the comparison of LDL level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
120.52± 45.46 mg/dl	**95.5± 199.4 mg/dl**	**N.S**
Control	**Normal K + DM**	**P_ value**
120.52± 45.46 mg/dl	**161.36± 56.93 mg/dl**	**
Control	**Normal K+ HT + DM**	**P_ value**
120.52± 45.46 mg/dl	**155.34± 39.57 mg/dl**	**

Comparison of LDL levels between healthy individuals and CKD patients with normal potassium levels

3.1.12 Estimation of High density lipoprotein in patients on hemodialysis.

To evaluate the hyperlipidemia in CKD patients , blood lipid profile test was conducted to identify the blood HDL levels.

As shown in table 12a, compared to control, the HDL level in patients with CKD combined with hyperkalaemia with HT + DM and hyperkalemia with DM are increased significantly P<0.0001 . The data also shown , compared to control, patients with

hyperkalaemia with HT is increased significantly P<0.001 .**Table 12b**, compared to control , normal K with HT + DM and normal K with DM are increased significantly P<0.0001 , and increased significant P<0.05 in patients normal K with HT**.**

The data also shows that, in general, hyperkalaemia dose have significantly affected the HDL level compared to patient has CKD with normal potassium level.

Table 12(A) Shows the comparison of HDL level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05.
*P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P - value
69.27± 11.77 mg/dl	**57.31±13.22** mg/dl	**
Control	**Hyperkalemia + DM**	**P_ value**
69.27± 11.77 mg/dl	**51.71± 14.34** mg/dl	***
Control	**Hyperkalemia + HT + DM**	**P_ value**
69.27± 11.77 mg/dl	**54.16± 10.97 mg/dl**	***

Comparison of HDL levels between healthy individuals and CKD patients with hyperkalemia

Table 12 (B) Shows the comparison of HDL level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
69.27± 11.77 mg/dl	58.58± 18.71 mg/dl	*
Control	Normal K + DM	P_ value
69.27± 11.77 mg/dl	50.37± 12.42 mg/dl	***
Control	Normal K+ HT + DM	P_ value
69.27± 11.77 mg/dl	52.98± 9.21 mg/dl	***

Comparison of HDL levels between healthy individuals and CKD patients with normal potassium levels

3.1.13 Estimation of Triglyceride in patients on hemodialysis .

To evaluate the hyperlipidemia in CKD patients, blood lipid profile test was conducted to identify the blood triglyceride levels.

As shown in table 13a, compared to control, the triglyceride level in patients with CKD combined with hyperkalaemia has no significantly P>0.05. The data also shown in hypertension and diabetes did not make significant difference when compared between these group. Similarly, **table 13b**, showed similar changed pattern compared to **table 13a.**

The data also shows that, in general, hyperkalaemia dose not significantly affected the triglyceride level compared to patient has CKD with normal potassium level.

Table 13(A) Shows the comparison of triglyceride level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P- value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P - value
136.14± 61.64 mg/dl	115.18±32.28 mg/dl	N.S

Control	Hyperkalemia + DM	P_ value
136.14± 61.64 mg/dl	127.75± 48.37 mg/dl	N.S
Control	Hyperkalemia + HT + DM	P_ value
136.14± 61.64 mg/dl	146.44± 40.50 mg/dl	N.S

Comparison of triglyceride levels between healthy individuals and CKD patients with hyperkalemia

Table 13 (B) Shows the comparison of triglyceride level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
136.14± 61.64 mg/dl	153.46± 60.63 mg/dl	N.S
Control	Normal K + DM	P_ value
136.14± 61.64 mg/dl	145.0± 68.13 mg/dl	N.S
Be Control	Normal K+ HT + DM	P_ value
136.14± 61.64 mg/dl	146.45± 54.95mg/dl	N.S

Comparison of triglyceride levels between healthy individuals and CKD patients with normal potassium levels

3.1.14 Estimation of Cholesterol in patients on hemodialysis .

To evaluate the hyperlipidemia in CKD patients , blood lipid profile test was conducted to identify the blood cholesterol levels.

As shown in table 14a, compared to control, the cholesterol level in patients with CKD combined with hyperkalaemia with DM is increased significantly P<0.0001 . The data also shown , compared to control, patients with hyperkalaemia with HT is increased significantly P<0.05 and patients hyperkalemia with HT+ DM have no significant P>0.05 .**Table 14b**, compared to control , normal K with HT and normal K with DM have no significantly P>0.05 , and increased significant P<0.001 in patients normal K with HT+ DM .

The data also shows that, in general, hyperkalaemia dose have significantly affected the cholesterol level compared to patient has CKD with normal potassium level.

Table 14(A) Shows the comparison of cholesterol level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P- value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	**Hyperkalemia + HT**	**P - value**
176.46± 21.29 mg/dl	**193.82±31.82** mg/dl	*
Control	**Hyperkalemia + DM**	**P_ value**
176.46± 21.29 mg/dl	**91.67± 69.83 mg/dl**	***
Control	**Hyperkalemia + HT + DM**	**P_ value**
176.46± 21.29 mg/dl	**154.22± 149.09** mg/dl	**N.S**

Comparison of cholesterol levels between healthy individuals and CKD patients with hyperkalemia

Table 14 (B) Shows the comparison of cholesterol level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001,

***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P - value
176.46± 21.29 mg/dl	190.12± 32.53 mg/dl	N.S
Control	Normal K + DM	P_ value
176.46± 21.29 mg/dl	192.07± 39.13 mg/dl	N.S
Control	Normal K+ HT + DM	P_ value
176.46± 21.29 mg/dl	197.03± 28.97 mg/dl	**

Comparison of cholesterol levels between healthy individuals and CKD patients with normal potassium levels

3.1.15 Estimation of Ferritin in patients on hemodialysis .

To reflect body iron store in CKD patients , blood ferritin test was conducted to identify the blood ferritin levels

As shown in table 15a, compared to control, the ferritin level in patients with CKD combined with hyperkalaemia with DM and hyperkalemia with DM + HT are increased significantly P<0.0001 . The data also shown , compared to control, patients with hyperkalaemia with HT has no significantly P>0.05 .**Table 15b**, compared to control , normal K with HT and normal K with DM and normal K with HT + DM have no significantly P>0.05.

The data also shows that, in general, hyperkalaemia dose have significantly affected the ferritin level compared to patient has CKD with normal potassium level.

Table 15(A) Shows the comparison of ferritine level between health individuals and patients with CKD hyperkalemia, hyperkalemia association with hypertension (HT), hyperkalemia association with diabetes mellitus (DM), and hyperkalemia association with HT and DM. The data represent as Mean ±SD. The difference is considered statistically significant when the P- value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S)>0.05.

Control	Hyperkalemia + HT	P – value
93.6± 78.32 mg/dl	**97.77± 94.08** mg/dl	**N.S**
Control	**Hyperkalemia + DM**	**P_ value**
176.46± 21.29 mg/dl	**187.11± 21.24** mg/dl	*******
Control	**Hyperkalemia + HT + DM**	**P_ value**
176.46± 21.29 mg/dl	**195.80± 29.17** mg/dl	*******

Comparison of ferritin levels between healthy individuals and CKD patients with hyperkalemia

Table 15 (B) Shows the comparison of ferritin level between health individuals and patients with normal K association with hypertension (HT) , normal K association with DM , normal K association with DM and HT . The data represent as Mean ±SD. The difference is considered statistically significant when the P-value <0.05. *P<0.05, **P<0.001, ***P<0.0001, no significant (N.S) P>0.05.

Control	Normal K+ HT	P – value
176.46± 21.29 mg/dl	**119.60± 85.80 mg/dl**	**N.S**
Control	**Normal K + DM**	**P_ value**
176.46± 21.29 mg/dl	**109.42± 111.39 mg/dl**	**N.S**
Control	**Normal K+ HT + DM**	**P_ value**
176.46± 21.29 mg/dl	**140.60± 138.67 mg/dl**	**N.S**

Comparison of ferritin levels between healthy individuals and CKD patients with normal potassium levels

Chapter Four

4.1 Discussion:

Serum potassium is typically regulated between (3.5-5.0 mmol/L). The kidneys are essential to potassium homeostasis. patients who have CKD are more possible than the health control to experience hyperkalemia . Hyperkalemia is the result of a combination of clinical factors superimposed on low renal function, such as , diabetes ,hypertension and using of renin-angiotensin-aldosterone inhibitor (RAAi) medications. **(7)**.

Our study aimed to compare between hyperkalemia and normal potassium in CKD patients suffering from DM, HT , or both and how renal failure effect on potassium levels on dialysis patients And is changing in potassium level could effect the blood level of some biochemical parameters that were included in this study**.** This is incidence study conducted in Baqubah teaching hospital (dialysis unit) for internal medicine. A sample of 172 patients was enrolled in this study, we collected sample in the period from December 2023 to February 2024**.**

Mänttäri *et al.* found that ,14.6% of CKD cases had high urea level in diabetic patients. This may caused diminished in kidneys function and patients end with renal failure, and 28.1% 0f patients have high creatinine level compared with 200 chronic CKD patients with age and sex matched. This information was compared with health control.

In our study ,table 1 we found that patients with normal potassium level associated with hypertension (HT), diabetes mellitus (DM), or both have significantly higher urea levels compared to the control group and hyperkalemia patients .

the data also showed in table 2 that patients with hyperkalemia associated with hypertension (HT), diabetes mellitus (DM), or both have significantly higher creatinine levels compared to the control group and normal potassium level group .

Brookes *et al.* **(7)** shown the prevalence of potassium abnormalities, including hyperkalaemia (found in 6.86% of CKD inpatient events) and normokalaemia (found in 2.94% of events) at the time of admission.

(12).

There is a rational pathophysiological explanation for the correlation between diabetes and hyperkalemia. It is suggested that insulin shortage or resistance, which impairs potassium transport intracellularly, or hyporeninaemic hypoaldosteronism, which is more commonly seen in diabetic patients, interact with serum potassium levels. (15).

In a recent community-based study conducted in Australia, hyperkalemia prevalence was predicted to be somewhat higher at 9.9% among CKD patients on RAASi medicines.

In our study, table 3 as expected, patients with hyperkalemia associated with HT, DM, or both had significantly higher potassium levels compared to the control group. However, patients with normal potassium levels did not show any significant differences compared to the control group.

Alqubaty *et al*. (8) reported that, the significantly lower serum level of chloride among DM or HT patients compared to others who are non-diabetic or normal blood pressure is consistent with the significantly higher chloride levels among patients who are uncontrolled DM and HT **(9)**.

In our study, table 4 there were significant differences (elevated) in chloride levels in any of the patient groups (hyperkalemia or normal potassium) compared with control group, regardless of their potassium levels or associated conditions (HT or DM or both).

Alqubaty *et al*. (8) reported that, the values of serum blood sodium were comparably equal in DM patients and who are non-diabetic patients in UK (united kingdom) who suffer from CKD.

In our study, table 5 we found that there is slightly differences in sodium levels between the control group and any of the patient groups (hyperkalemia or normal potassium), regardless of

Hayes *et al*. **(16)** noted that hypokalemia was associated with renal progression but the association with hard renal outcome, such as reaching ESRD was unclear.

Prior research has reported modest rates of hyperkalaemia in individuals with normal

kidney function and noticeably higher rates in a number of CKD cohorts, particularly in patients with diabetes mellitus (DM), in those with more advanced stages of the disease. **(16, 17)**.

In addition to its link with hypertension, hypokalaemia is also a risk factor for tubulointerstitial fibrosis and renal cyst formation **(18)**.

Molla *et al.* **(19)** aimed to screen serum electrolyte levels and estimated glomerular filtration rate (eGFR) among Ethiopian Public Health Institute (EPHI) staff members for an early detection of

CKD and to identify the factors associated with it. They found 9.5% had hyperkalemia (serum potassium level > 5.0 mmol/L)

Ramadan *et al.* **(20)** demonstrated a noteworthy decrease in the potassium and sodium levels in the serum of DM individuals. Chinese patients with type 2 diabetes had non-significantly higher serum potassium levels than controls **(21)**, and nonsignificant variation in sodium and potassium levels was reported among Indian diabetic patients compared to non-diabetics **(22)**.

Significant variations in serum potassium levels have been shown in other studies, Parmar SK ***et al*** and Saito ***et al*** reported a decreasing pattern in serum potassium levels with raised fasting blood glucose **(23, 24)**.

An increased risk of developing hyperkalemia has also been found in hypertensive patients on antihypertensive therapy **(25)**.

Molla ***et al***. (19) reported that, 8.5% of CKD cases had hypocalcemia (serum calcium level < 2.15 mmol/L).

In our study, table 10 patients with hyperkalemia associated with DM or both HT and DM had significantly lower Ca levels compared to the control group.

We found in table 6, that there is no significant difference in PLT count between hyperkalemia with DM , HT or both and control group ,and there was no much difference in PLT between normal K with DM , HT or both and controlled group .

In our study, as regard Lipid profile tables (11, 12 , 13, 14), Low-density lipoprotein (LDL) levels were significantly higher in most patient groups compared to the control group. High-density lipoprotein (HDL) levels were significantly lower in all patient groups compared to

the control group. There were no significant differences in triglyceride levels between the control group and any of the patient groups. Cholesterol levels showed mixed results, with some patient groups having significantly higher or lower levels compared to the control group.

Mänttäri *et al*. found that in 2.702 dyslipidemic patients, there was a significant correlation between rising LDL levels and a deterioration in renal function. Additionally, they discovered an elevated LDL/HDL ratio (>4.4) that was linked to a more severe decline in renal function. Nonetheless, two significant shortcomings of this study are the use of creatinine as the only indicator of renal function and the very little follow-up duration of five years. Similar conclusions were achieved by **Muntner *et al*., (29)** evaluating over 2000 subjects. In particular, high triglyceride and low HDL levels were independent risk factors for renal dysfunction. Conversely, cholesterol-LDL values were not predictive for increased risk of kidney injury, but the short follow-up period of 2.9 years could be an important limitation.

In a 14-year follow-up period, **Schaeffner *et al*. (30)** demonstrated a significant association between abnormal cholesterol parameters, such as low HDL levels, and development of renal dysfunction.

Shoji *et al* (31) contrasted 223 age- and sex-matched healthy controls with 210 chronic HT patients. Compared to the controls, the HT patients had greater triglycerides and decreased total cholesterol . In addition, compared to the controls, HT patients had reduced HDL and LDL but increased VLDL and IDL.

Ferritin levels were considerably greater in our study's participants with hyperkalemia linked to DM or both HT and DM than in the control group.

In our study, table 15 patients with hyperkalemia associated with DM or both HT and DM had significantly higher ferritin levels compared to the control group.

Hasuike *et al*. (32) have suggested that high ferritin levels are related to an unfavorable prognosis in different MHD patient populations.

Dimitrijevic *et al*. (33) reported that, ferritin levels on admission were higher in AKI recovery group (284 (IQR 153-525) ng/mL) compared with the non-recovery group (127.4 (IQR 30-243) ng/mL), $p < 0.001$. Serum ferritin levels and the renal recovery significantly positively correlated ($r = 0.72$, $p < 0.001$).

Chapter Five

5.1 Conclusion:

Our study findings highlight the significant association between potassium abnormalities, elevated lipid profiles, and increased mortality risk in patients with chronic kidney disease (CKD) undergoing hemodialysis. Out of the 172 patients evaluated, a substantial proportion exhibited elevated potassium levels (75 patients) or abnormal lipid profiles. These electrolyte and metabolic disturbances can exacerbate the complications associated with CKD and potentially reduce the efficacy of dialysis treatment. Addressing these issues through appropriate management strategies is crucial to improving patient outcomes and prolonging survival in this vulnerable population.

5.2 Recommendations:

1. Implement regular monitoring and evaluation of serum potassium levels and lipid profiles in CKD patients undergoing hemodialysis.

2. Develop standardized protocols for the management of hyperkalemia and dyslipidemia in dialysis patients, including dietary modifications, medication adjustments, and potential changes in dialysis regimens.

3. Promote patient education and adherence to dietary restrictions, medication regimens, and lifestyle modifications to maintain optimal potassium and lipid levels.

4. Collaborate with dietitians and nutritionists to develop tailored meal plans that address potassium and lipid management while meeting the specific nutritional needs of dialysis patients.

5. Encourage multidisciplinary team coordination, involving nephrologists, dialysis nurses, and other healthcare professionals, to ensure comprehensive and consistent care for CKD patients undergoing hemodialysis.

6. Conduct further research to investigate the long-term effects of potassium and lipid abnormalities on patient outcomes, dialysis adequacy, and potential interventions to mitigate these risk factors.

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