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Evaluation of Some metabolic products before and after hemodialysis in chronic renal failure patients in Misurata, Libya

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Abstract :
Chronic renal failure is a gradual loss of kidney function leading to accumulation of urea, creatinine and other waste products in the blood. The current study was designed to measure the efficiency of dialysis in patients with chronic renal failure, by evaluating some metabolic products before and after hemodialysis. 60 samples of renal failure patients (30 males and 30 females) aged 14-70 years were taken from dialysis centres in Misurata city (Libya). The samples were divided based on the age of the patients into 4 age groups, and the results obtained were compared with the control group (30 individuals). The results of the study showed that the levels of urea, creatinine, uric acid and phosphorus were high before the dialysis process and decreased significantly after dialysis with a statistical significance of P-value < 0.05. When compared to the control group, the results were close to the normal level with a statistical significance of P-value < 0.05. The levels of urea, creatinine, uric acid and phosphorus were higher in males than females before and after dialysis. Calcium levels in females were slightly higher than males. The age group (14-27) recorded the lowest levels of creatinine, uric acid and phosphorus, while the age group (42-55) recorded the lowest levels of urea and the group between 14-27 recorded the highest levels of calcium after dialysis. The study concluded that hemodialysis increases the level of calcium and reduces the level of urea, creatinine, uric acid and phosphorus in the blood serum. The study recommends evaluating more comprehensive criteria for kidney failure and studying the disease from a genetic perspective.

Key words: Hemodialysis, metabolic products, chronic renal failure, Libya.

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تقييم بعض المنتجات الايضية قبل وبعد الغسيل الكلوي في مرضى الفشل الكلوي المزمن، مصراتة (ليبيا)

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الملخص:

الفشل الكلوي المزمن هو فقدان تدريجي لوظيفة الكلى يؤدي إلى تجمع اليوريا والكرياتينين وغيرها من الفضلات في الدم. صُممت الدراسة الحالية لقياس مدى كفاءة الغسيل الكلوي في المرضى المصابين بفشل الكلوي المزمن ، عن طريق تقييم بعض المنتجات الايضية قبل الغسيل الكلوي وبعده , تم اخذ 60 عينة من مرضى الفشل الكلوي (30 ذكر و30 انثى) تتراوح اعمارهم من 14–70 سنة ، من مراكز غسيل الكلى في مدينة مصراتة (ليبيا) ، وقسمت العينات بناء على عمر المرضى الى 4 فئات عمرية ، وتم مقارنة النتائج المتحصل عليها بمجموعة السيطرة (30 فرد) ، واظهرت نتائج الدراسة ان معدلات اليوريا والكرياتينين وحمض البوليك والفسفور تكون مرتفعة قبل عملية الغسيل الكلوي وتنخفض ما بعد الغسيل الكلوي بشكل كبير ودو اهمية احصائية P-value< 0.05، وعند مقارنتها بالمجموعة الضابطة كانت النتائج قريبة من المستوى الطبيعي وبدلالة احصائية P-value< 0.05، وكان مستوى اليوريا و الكرياتينين وحمض البوليك والفسفور مرتفعا في الذكور اكثر من الاناث قبل الغسيل الكلوي وبعده ، وكانت مستويات الكالسيوم في الاناث اعلى من الذكور بشكل طفيف ، وسجلت الفئة العمرية (14–27) اقل مستوى من الكرياتينين والحمض البوليك والفسفور ، بينما سجلت الفئة العمرية (42–55) اقل مستوى من اليوريا وسجلت الفئة الواقعة بين 14–27 اعلى مستوى من الكالسيوم بعد الغسيل الكلوي . خلصت الدراسة إلى أن غسيل الكلى يزيد من مستوى الكالسيوم ويقلل من مستوى اليوريا والكرياتينين وحمض البوليك والفسفور في مصل الدم، وتوصي الدراسة بتقييم معايير اكثر شمولية لمرض الفشل الكلوي ، ودراسة المرض من الناحية الوراثية .

الكلمات المفتاحية: الغسيل الكلوي، منتجات ايضية، الفشل الكلى المزمن، ليبيا.

Introduction:

The kidneys are vital organs of the urinary system in the body. They play a crucial role in maintaining the balance of internal body fluids, ensuring stability through precise processes such as the reabsorption

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of salts, water, and other substances like glucose, amino acids, and phosphate from the urine via the renal tubules, and returning them to the body for reuse. Additionally, the kidneys excrete metabolic waste products, such as urea, creatinine, and uric acid, out of the body (Clase *et al*., 2004). Kidney failure is characterized by a continuous deterioration in kidney function, leading to the accumulation of nitrogenous waste and metabolic byproducts. Over time, this results in the disruption of all kidney functions (Alghythan and Alsaeed, 2012).

Chronic renal failure is defined as a decline in kidney function, where the kidneys lose part of their physiological capacity and efficiency, leading to increased blood acidity and elevated levels of urea and nitrogenous compounds (Alpers, 2004). This deterioration in kidney function is characterized by its gradual progression, starting slowly and then progressing until it reaches a stage where most of the kidney nephrons are destroyed and replaced by fibrotic tissues (Ali *et al*., 2017) The main causes of chronic renal failure include diabetes, high blood pressure, glomerulonephritis, congenital and hereditary diseases, polycystic kidney disease, and autoimmune diseases (Akkari, 2013; Schnackenberg, 2002).

Although diabetes and hypertension are among the leading causes of kidney failure, it takes several years for diabetes to lead to the deterioration and weakening of kidney function. This process goes through multiple stages, starting with an increased glomerular filtration rate and stress, eventually leading to chronic renal failure (Levey *et al*., 2005). In the case of hypertension, it causes, over the long term, hardening of the small arteries in the kidney filters, leading to reduced kidney function and decreased blood flow to the kidneys (Barotfi, 2005). Additionally, patients with kidney failure often suffer from disturbances in mineral metabolism, which can lead to bone structure problems. Therefore, it is essential to periodically monitor the levels of calcium and phosphorus in the patient's body (Kathleen *et al*., 2017).

Early detection can allow for the implementation of therapeutic interventions and avoid unnecessary exposure to nephrotoxic agents, which may slow the progression of chronic kidney disease to its end stage. Hemodialysis is usually resorted to in cases of chronic renal failure when the function of both kidneys weakens. It has been medically proven that the earlier dialysis is initiated, the greater the chance for the patient's body to respond and improve, as

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regular dialysis and kidney transplantation are effective methods despite their financial cost (Shi *et al*., 2013; Wang *et al*., 2011).

The efficiency of the kidneys is measured by analyzing the level of creatinine, which rises in the blood in cases of kidney failure, along with blood urea levels (Kim, 2014). In recent years, uric acid has been studied as a causal factor in chronic kidney disease. Multiple studies have shown that uric acid is a causative agent that can lead to the deterioration of kidney function. High levels of uric acid in the blood can alter the nature of kidney tissues, and elevated levels contribute to the gradual decline in kidney function (Christin *et al*., 2015).

Several studies have been conducted on patients with chronic renal failure. A study by Shekhar et al. in 2021 showed a significant decrease in the levels of urea, creatinine, uric acid, and potassium in serum in post-dialysis samples, with statistical significance when compared to pre-dialysis samples. It also showed a significant increase in sodium and calcium levels in post-dialysis samples. A study conducted by Abdulrazzaq et al. in 2018 indicated that urea levels increased to 182.25 mg/dL with advancing age (20–40 years). Creatinine and uric acid levels also increased compared to healthy females, while calcium levels decreased. The effect of disease duration in patients younger than five years and older than five years was not significant. A study conducted by Andrews et al. in 2020 aimed to evaluate renal biochemical markers, such as urea, creatinine, and electrolytes, in 68 patients with chronic renal failure. The results revealed a statistically significant difference in the levels of blood urea, serum creatinine, sodium, and potassium before and after dialysis. A study by Nisha et al. in 2017 noted that the mean creatinine levels were lower in the age group of 61 to 80 years. A statistically significant difference was observed in the mean creatinine values across all age groups when compared to each other. This study showed that dialysis had a significant effect on the level of serum creatinine, which decreased to near-normal values. It also strongly suggests that various factors, such as age, gender, and physical condition, affect the level of serum creatinine.

Kidney failure in Libya has experienced a significant and steady rise, with its prevalence rate increasing from 200 patients per million in 2003 to 2,417 patients in 2009. According to the Libyan Organ Donation Support Organization, there are approximately 5,500 patients suffering from kidney failure in Libya, with 100 deaths recorded in 2023 alone due to this disease. Akkari predicted in a

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study conducted in 2013 that the incidence rate would reach 7,667 patients in 2024. Given the severity of chronic kidney failure and its rapid spread in recent years, this study was conducted to assess the levels of certain metabolic products (urea, creatinine, uric acid, calcium, and phosphorus) before and after dialysis and to compare the post-dialysis results with those of a control group.

Materials and methods

Experimental design:

This study was conducted on 60 patients suffering from kidney failure (30 women and 30 men). Samples were collected from dialysis centres in Misurata, Libya, along with an additional 30 samples representing a healthy control group. The samples were collected over a period of three months, from the beginning of August to the end of October 2024. Participants were divided into three different age groups:

- Group 1: Ages between 14–27
- Group 2: Ages between 28–41
- Group 3: Ages between 42–55

The health status of the patients was also taken into consideration, and personal data were collected after obtaining consent from the participants in this research. Five different tests were conducted to measure the levels of urea, creatinine, uric acid, phosphorus, and calcium in the blood.

Sample collection:

Two venous blood samples were drawn from each patient (one before dialysis and one after dialysis) using sterile syringes and transferred to anticoagulant tubes. The serum was separated using a centrifuge at 4000 rpm for 10 minutes. Using the Mindray device, the required test results were extracted.

Statistical analysis:

The data were statistically analyzed using the SPSS program. Results were considered statistically significant if the p-value was less than 0.05, using the Chi-square test according to established statistical principles and standards.

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Results:

This study, as shown in Table (1), revealed that 18.3% of individuals suffering from chronic kidney failure were between the ages of 14–27, 23.3% were between 28–41, and 31.7% were from the age group of 42–55, which constitutes the largest proportion of those affected by chronic kidney failure.

Table (1): Classification of chronic kidney failure Patients by age

Age	Number	%
14 – 27	11	18.3
28 – 41	14	23.3
42 – 55	19	31.7
56 ---	16	26.7
Total	60	100

Creatinine level:

From Table (2) and Figure (1), we observe significant differences in creatinine levels before and after dialysis (P-value = 0.000). The mean creatinine level in patients before dialysis was 8.12 with a standard deviation of 1.97, while the mean creatinine level in patients after dialysis was 2.59 with a standard deviation of 0.97.

Table (2): Creatinine, urea and uric acid levels before and after dialysis in patients compared to healthy individuals

Creatinine	Number	Mean	Standard Error	Standard Deviation	Test Statistic	P-value
After	60	8.12	0.25	1.97		
Before	60	2.59	0.13	0.97	27.050	0.000
control	30	0.79	0.04	0.24	1767	0.000
Urea	**Number**	**Mean**	**Standard Error**	**Standard Deviation**	**Test Statistic**	**P-value**
After	60	130.93	4.50	34.88		
Before	60	37.50	2.29	17.72	26.116	0.000
control	30	26.60	1.50	8.23	1259	0.002
uric acid	**Number**	**Mean**	**Standard Error**	**Standard Deviation**	**Test Statistic**	**P-value**
After	60	6.28	0.18	1.43		
Before	60	2.09	0.18	1.38	25.203	0.000
control	30	5.89	0.32	1.76	81	0.000

When comparing the creatinine levels in healthy individuals with those after dialysis, we observe significant differences in creatinine levels (P-value = 0.000). The mean creatinine level in healthy individuals was 0.79 with a standard deviation of 0.24, while the

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mean creatinine level in patients after dialysis was 2.59 with a standard deviation of 0.97. Additionally, the measurements show a variation in creatinine accumulation between males and females. Males recorded higher levels than females before dialysis, while females had lower creatinine levels after dialysis compared to males. The age group analysis shows that the age group between 14–27 recorded the best improvement in creatinine accumulation after dialysis (Figure 2 , 3).

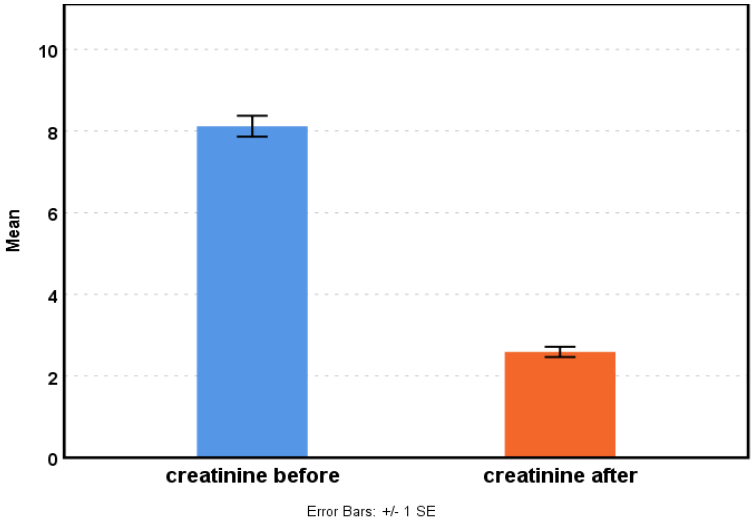

Figure 1. Creatinine level before and after dialysis in patients

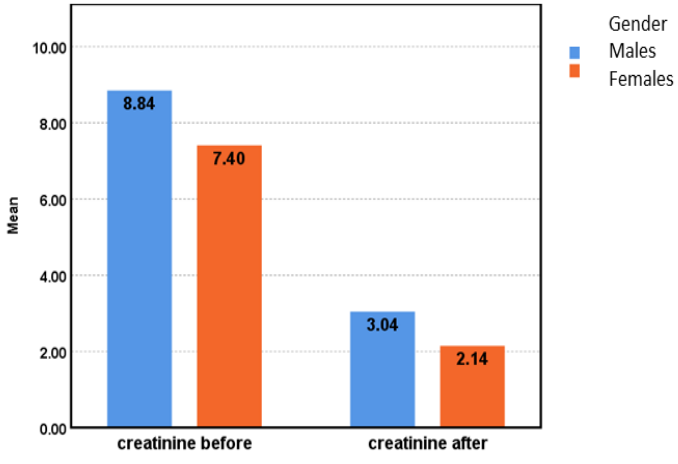

Figure 2. Creatinine between male and female patients before and after dialysis

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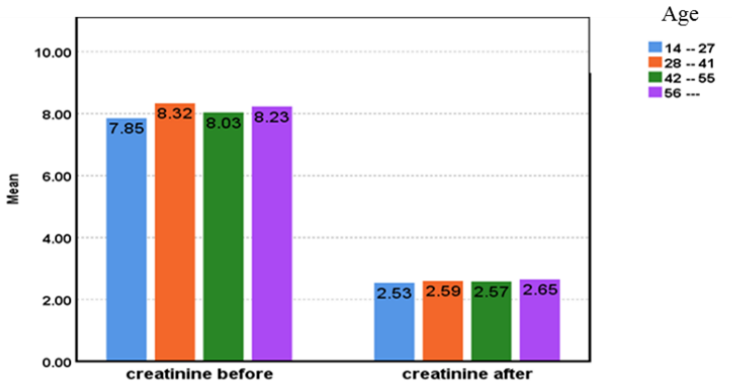

Figure 3. Creatinine by age groups before and after dialysis

Urea level:

From Table (2) and Figure (4), there were significant differences in urea levels before and after dialysis (P-value = 0.000). The mean urea level and standard deviation in patients before dialysis were (130.93, 34.88), while the mean urea level and standard deviation after dialysis were (37.5, 17.52). When comparing urea levels in healthy individuals with those in patients after dialysis, significant differences in urea levels were observed (P-value = 0.000). The mean urea level and standard deviation in healthy individuals were (26.60, 8.23). The measurements also show variations in urea accumulation between males and females. Males recorded higher levels than females before dialysis, while females had lower urea levels after dialysis. Age group analysis revealed that the 42–55 age group showed the most significant improvement in urea accumulation after dialysis (Figures 5, 6).

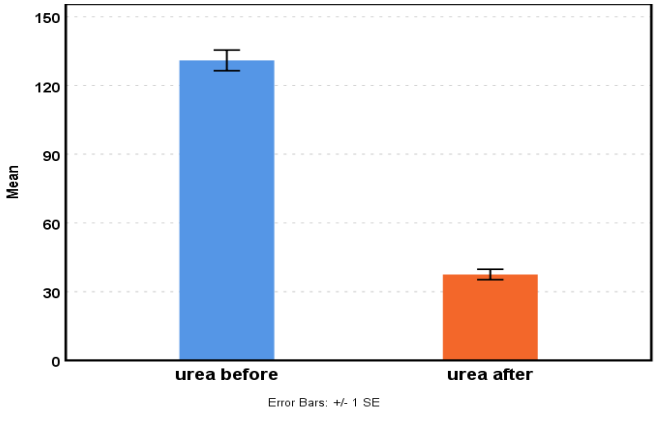

Figure 4. Urea level before and after dialysis in patients

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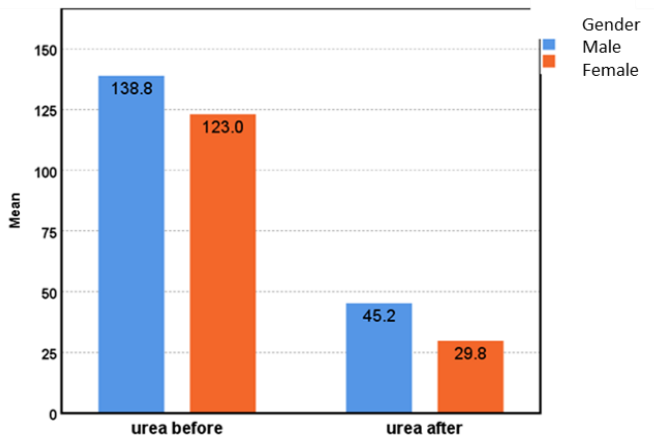

Figure 5. Urea between males and females before and after dialysis patients

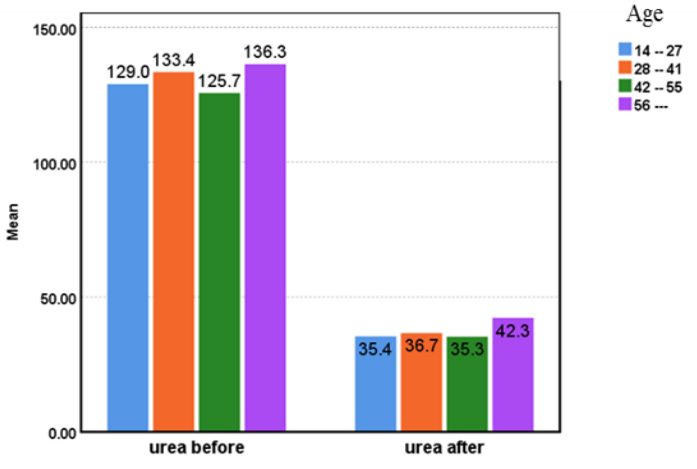

Figure 6. Urea by age groups before and after dialysis

Uric acid level:

From Table (2) and Figure (7), it was observed that the mean uric acid level and standard deviation in patients before dialysis were 6.28 and 1.43, respectively, while after dialysis, they were 2.09 and 1.38, at a significance level of P-value = 0.000. When comparing uric acid levels in healthy individuals with those in patients after dialysis, statistically significant differences were observed (P-value = 0.000). The mean uric acid level in healthy individuals was 5.89, with a standard deviation of 1.76.

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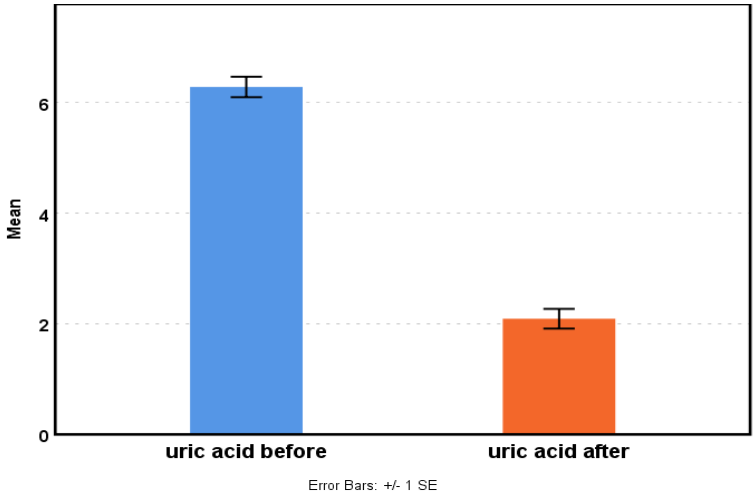

Figure 7. Uric acid level before and after dialysis in patients

The measurements also revealed variations in uric acid accumulation between males and females. Males exhibited higher uric acid levels than females before dialysis, while females had significantly lower uric acid levels after dialysis compared to males. Age group analysis indicated that the 14–27 age group showed the most significant improvement in uric acid levels after dialysis (Figures 8 , 9).

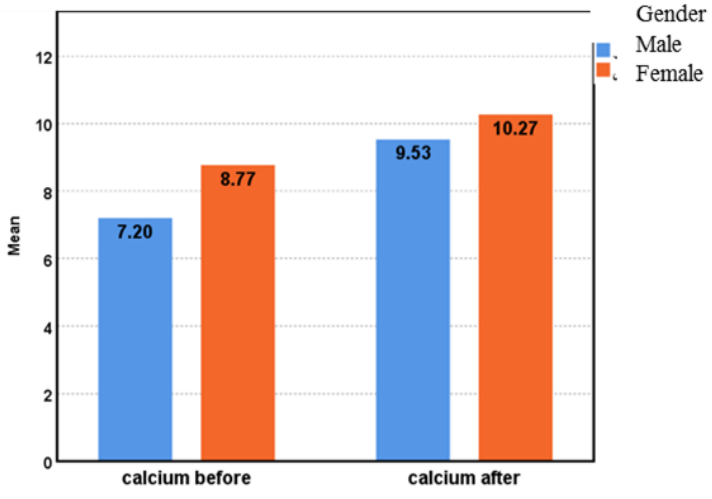

Figure 8. Uric acid level between males and females before and after dialysis patients

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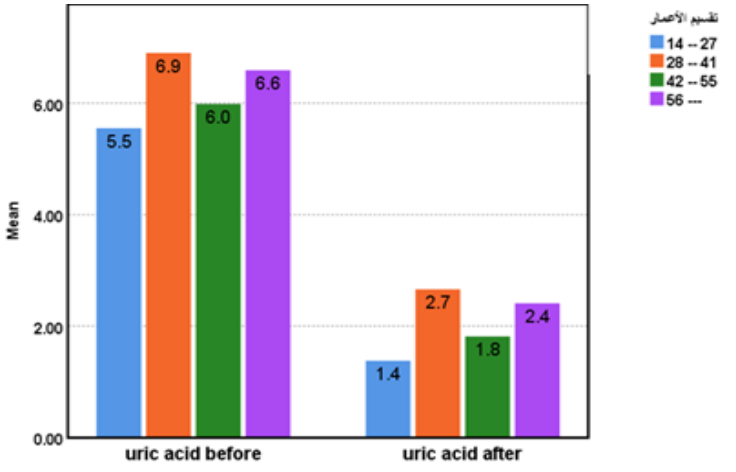

Figure 9. Uric acid level according to age groups before and after dialysis

Calcium level:

From Table (3) and Figure (10), it is observed that the mean calcium level in patients before dialysis was 7.98 with a standard deviation of 1.08, whereas the mean calcium level after dialysis was 9.90 with a standard deviation of 0.95, indicating a statistically significant difference (P-value = 0.000). When comparing the calcium levels in healthy individuals with those in patients after dialysis, significant differences were also observed (P-value = 0.000). The mean calcium level in healthy individuals was 9.05 with a standard deviation of 0.49, compared to 9.90 with a standard deviation of 0.95 in patients after dialysis.

Table (3): Calcium and phosphor levels before and after dialysis in patients compared to healthy individuals

Calcium	Number	Mean	Standard Error	Standard Deviation	Test Statistic	P-value
After	60	7.98	0.14	1.08	-14.926	
Before	60	9.90	0.12	0.95		0.000
control	30	9.05	0.09	0.49	5.6	0.000
Phosphor	Number	Mean	Standard Error	Standard Deviation	Test Statistic	P-value
After	60	4.71	0.20	1.51	10.440	
Before	60	2.81	0.10	0.78		0.000
control	30	3.29	0.13	0.69	604	0.011

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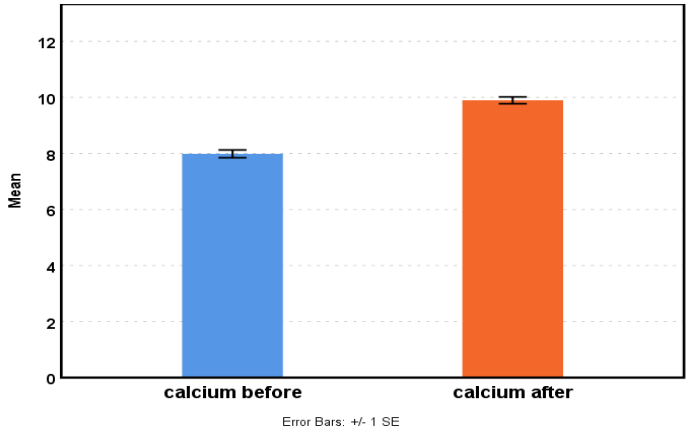

Figure 10. Calcium level before and after dialysis in patients

The measurements also reveal variations in calcium accumulation between males and females. Males exhibited lower calcium levels than females before dialysis, while females showed higher calcium levels after dialysis compared to males. Age group analysis indicates that the 14–27 age group demonstrated the most significant improvement in calcium levels after dialysis (Figures 11 , 12).

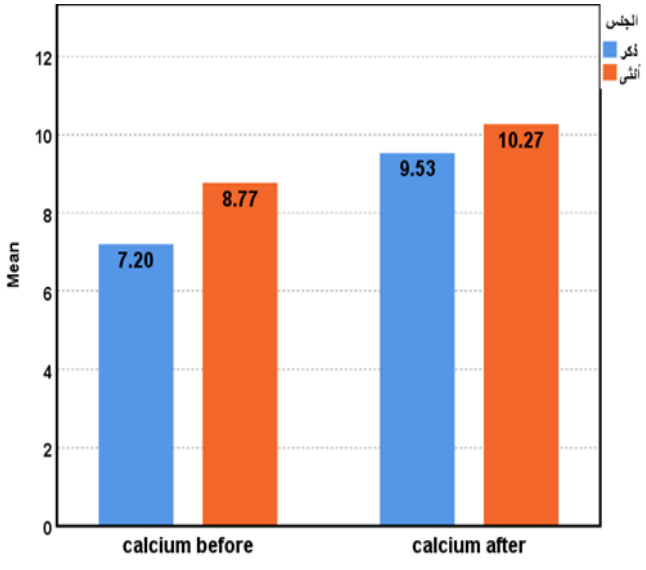

Figure 11. Calcium level between male and female patients before and after dialysis

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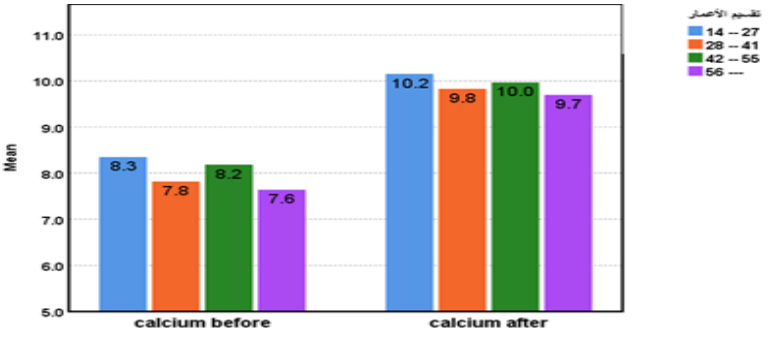

Figure 12.Calcium level according to age groups before and after dialysis

Phosphorus level:

From Table (3) and Figure (13), a significant difference (P-value = 0.000) is observed between the mean phosphorus level in patients before hemodialysis, which was 4.71 with a standard deviation of 1.51, and the mean phosphorus level after hemodialysis, which was 2.81 with a standard deviation of 0.78. When comparing the phosphorus levels in healthy individuals with those in patients after hemodialysis, significant differences are also noted (P-value = 0.000). The mean phosphorus level in healthy individuals was 3.29 with a standard deviation of 0.69, compared to 2.81 with a standard deviation of 0.78 in patients after hemodialysis.

The measurements further reveal variations in phosphorus accumulation between males and females. Males exhibited lower phosphorus levels than females before dialysis, while females had lower phosphorus levels after hemodialysis compared to males. Age group analysis indicates that the 14–27 age group showed the most significant improvement in phosphorus levels after hemodialysis (Figures 14 , 15).

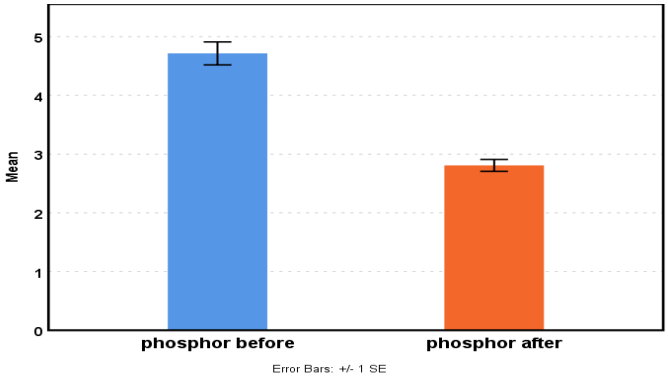

Figure 13. Phosphorus level before and after dialysis in patients

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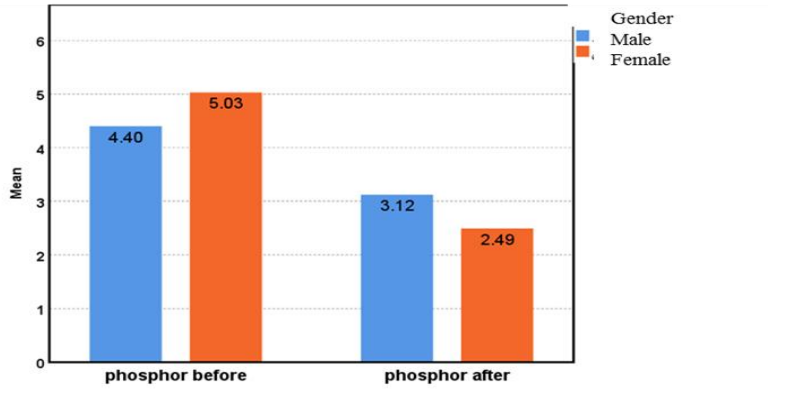

Figure 14. Phosphorus level between males and females before and after dialysis patients

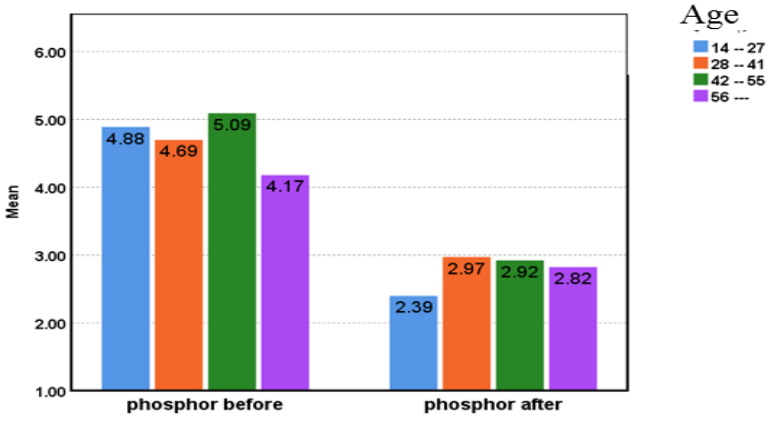

Figure 15. Phosphorus level according to age groups before and after dialysis

Discussion:

Chronic kidney disease is among the most critical global health issues, with incidence rates expected to rise over time due to the increasing prevalence of diabetes, cardiovascular diseases, and hypertension. In this study, some biochemical parameters were evaluated in 60 patients before and after dialysis. This study showed that the highest incidence of kidney failure was in the age group of 56 and above. This result is consistent with the findings of Deighan *et al*. in 2000 and Jumaah in 2013. The reason may be that most patients suffer from diabetes or hypertension, which are the most common causes of chronic kidney failure.

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Creatinine levels are a key indicator of health status and mortality risk in end-stage kidney failure patients. Elevated serum creatinine results from a reduced number of functioning nephrons, which lowers the glomerular filtration rate and impairs the kidneys' ability to excrete water and solutes (Guyton and Hall, 1996). This study found that creatinine levels decrease significantly after dialysis but do not normalize, consistent with Jumaah (2013) and Attika and Lubna (2015). Males exhibit higher creatinine accumulation than females, while females show a more significant post-dialysis reduction, aligning with Nisha *et al*. (2017). The 14–27 years age group had the lowest creatinine levels before and after dialysis, likely due to early-stage disease, contrasting with Nisha *et al*. (2017), who reported lower levels in the 61–80 years group. These variations are influenced by factors such as age, gender, and physical condition (Amin *et al*., 2014).

Urea is a byproduct of protein metabolism in the blood of patients suffering from kidney failure and causes uremia (Entedhar and Nawal, 2016). The study found that urea levels are high before dialysis but decrease afterward, consistent with Sarhat and Mortada (2016), Saran *et al*. (2020), Meerashiraekar *et al*. (2012), and Mustafa *et al*. (2010). Females had lower urea levels than males both before and after dialysis, aligning with Khaled *et al*. (2015). The 14–27 years age group showed the lowest urea levels after dialysis, contrasting with Nisha *et al*. (2017), who reported the lowest levels in the 61–80 years group. These differences may stem from factors like body size, metabolic rates, and dietary patterns, as declining kidney function leads to the buildup of urea and other chemicals, worsening as the disease progresses (Merzah and Hasson, 2015).

Elevated serum uric acid levels occur in kidney failure patients due to the kidneys' impaired excretion (Meri *et al*., 2022). The study found that uric acid levels are high before dialysis but decrease afterward, likely linked to endothelial dysfunction—a nitric oxide deficiency in the endothelium—which is a key risk factor for kidney disease progression (Baylis, 2008). These results align with Johnson *et al*. (2013) and Al-Rubae *et al*. (2010). Males showed higher uric acid accumulation than females, consistent with Khaled et al. (2015). The 28–41 years age group had the highest pre-dialysis levels, while the 14–27 years group had the lowest. Hyperuricemia is often associated with factors like painkiller use (Johnson *et al*., 2013).

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When it comes to calcium levels, there was a modest change before and after dialysis. This study showed that calcium levels are below normal in all patients before dialysis, while they rise to near-normal levels after dialysis, which is consistent with the findings of Sarhat and Mortada (2016) and Kim (2014). The study indicates that calcium levels are highest in the age group between 14–27 years, while they are lower in the age group of 56 and above, suggesting a decline in biological functions due to ageing, as well as bone problems in some patients. The study also shows that calcium levels in females are higher than in males both before and after dialysis. Khaled *et al*. mentioned that the increase in calcium is due to changes in bone retention and parathyroid hormone metabolism.

This study found that phosphorus levels are elevated before dialysis but decrease significantly afterwards, consistent with Sarhat and Mortada (2016) and Singh *et al*. (2008). Elevated serum phosphorus before dialysis results from reduced glomerular filtration and increased retention of inorganic phosphate. Significant changes occur when the glomerular filtration rate falls below 30 mL/min (Delmez and Slatopolsky, 1992). Males showed higher phosphorus levels than females before dialysis, while females had lower levels afterwards, aligning with Khaled *et al*. (2015). Among age groups, the 14–27 years group had the lowest phosphorus levels after dialysis, while the 42–55 years group had the highest levels before dialysis, likely due to dietary and medication differences (Poudel *et al*., 2011).

Conclusion:

This study highlights the influence of age, gender, and disease progression on biochemical parameters in patients with chronic kidney failure. Dialysis significantly improves these levels, but does not restore them to normal. These findings are consistent with numerous studies, emphasizing the need for tailored treatment strategies based on demographic and clinical factors.

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