Assessment of nutrients and vitamins in children with chronic kidney disease on hemodialysis and peritoneal dialysis in Wasit Governorate

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ABSTRACT:

The aim of this study was to evaluate nutrients and vitamins in pediatric patients with chronic kidney disease who are undergoing peritoneal dialysis and hemodialysis. Chronic kidney disease in children has emerged as a major health problem worldwide. Chronic kidney disease (CKD) causes kidney dysfunction that is described as a continuum. The major health consequences of chronic kidney disease include not only progression to kidney failure, but also increased risk of cardiovascular disease This chronic condition in children is accompanied by a decline in nutritional status, which poses a risk of developing stunted growth in children. The study was conducted in the dialysis unit of Al-Zahraa Teaching Hospital in Wasit governorate and the Child Protection Teaching Hospital -Medical City in Baghdad. During the period from November 2023 to April 2024. This study aimed to examination of risk factors (height, weight, age, sex, inheritance of the disease in the family, medical history, symptoms of the disease, other diseases, treatment methods) for CKD in general. As well as studying the effect of (zinc, selenium, copper, sodium, potassium, phosphorus, calcium, manganese, magnesium, vitamin A and vitamin E) for the purpose of predicting poor nutritional status in children with CKD. This study was done on (80) Iraqi children (30) of them suffering from kidney failure and (50) of them was control with age range (1 day -17) years old . hemodialysis (HD) was performed for 22 children with CKD , and peritoneal dialysis (PD) was performed for 8 patients with chronic kidney disease. This study involved dividing patients into three Groups according to the age at which the disease begins, from (1 day-5 years) ,(6-11) years and (12-17) years, included 15 females and 15 male . Samples were collected based on the incidence of chronic kidney disease and type of treatment, as well as the diagnosis of all patients according to international standard by the physician. The results of our study regarding diagnostic signs of poor nutritional status in children on peritoneal dialysis showed a significant decrease in parameters (calcium and zinc) and a significant increase in phosphorus in affected individuals with a $p < 0.05$. A non-significant decrease in (zinc, manganese, magnesium, vitamin A and vitamin E) and a non-significant increase in (sodium, potassium, and copper) in infected people When $p \geq 0.05$. Also, the results of our study in children on hemodialysis showed a significant decrease in vital indicators (sodium, potassium, calcium, selenium, manganese, and magnesium) and a significant increase in (phosphorus, copper, vitamin A, and vitamin E) in people with $P < 0.05$. A non-significant decrease in zinc in infected people When $p \geq 0.05$. Conclusions: In children suffering from chronic kidney disease and on peritoneal dialysis and hemodialysis, the level of nutrients and new vitamin A values showed A non-significant decrease in the blood serum of children on peritoneal dialysis compared to healthy people at the level of $p \geq 0.05$This is an indication that PD does not have a significant effect at the level of nutrients and vitamins. Likewise, in children on hemodialysis, the values of the nutrients and new vitamins showed a significant decrease at $p < 0.05$. This is an important indicator of the importance of these vital indicators in detecting malnutrition in children and the development of stunted growth.

Key Words: Chronic Kidney Disease in children, Hemodialysis, Peritoneal dialysis, nutrients**,** Vitamin A, Vitamin E.

1. Introduction:

Chronic kidney disease in children is a non-communicable disease characterized by a progressive loss of kidney function over time that gradually progresses to end-stage kidney disease (ESRD) . Children with CKD including those with end-stage renal disease , develop various secondary complications that significantly and adversely affect their development and quality of life (1) .

Inflammation and oxidative stress increase in kidney disease in parallel with disease progression. Children with CKD face significant challenges to maintaining adequate nutrition and growth. Poor nutritional status directly contributes to poor growth. Poor growth in CKD is a marker of disease severity and quality of care. Chronic kidney disease of childhood presents specific clinical features that are quite characteristic of pediatric age such as the impact of the disease on growth (2).

Aim of the study is to study the relationship between chronic kidney disease and nutrients and vitamins, as well as for the purpose of predicting cases of poor growth and nutrition in children with chronic kidney disease and finding solutions to reduce them.

2. Material and Methods:

2.1 Study design:

The present study was included a comparison of a group of (80) samples: (30) patient samples, (50) control samples. The study was conducted in the dialysis unit of Al-Zahraa Teaching Hospital in Wasit governorate and the Child Protection Teaching Hospital -Medical City in Baghdad. During the period from November 2023 to April 2024, and their ages ranged from (1 day -17) years old . The study included hemodialysis was performed for 22 children with CKD , and peritoneal dialysis was performed for 8 patients with CKD, and 50 samples of healthy people (control group). This study involved dividing patients into three Groups according to the age at which the disease begins, from (1 day-5 years) ,(6-11) years and (12-17) years, included 15 females and 15 male.

Samples were collected based on data recorded for all patients: height, weight, age, sex , other diseases, inheritance of the disease in the family, questions about medical history, symptoms of the disease and treatment methods. nutrients and vitamins in the blood were measured (Zinc, selenium, copper, sodium, potassium, phosphorus, calcium, manganese, magnesium, vitamin A and vitamin E).

2.2 Blood Sample:

5 ml of venous blood samples were withdrawn in gel tube and clot activator for check the level of nutrients and vitamins.

Determination of (Zinc, selenium, copper, sodium, potassium, phosphorus, calcium, manganese, magnesium): Atomic Absorption Spectroscopy (AAS) device works based on the principle that atoms absorb light.

Determination of (vitamin A , vitamin E) ELISA Kit: The SandwichELISA principle is utilized in this ELISA kit.

Statistical Analysis: The statistical method used one way analysis of variance (ANOVA). The appropriate statistical method for testing hypotheses is F Statistics, accepting or rejecting the test hypothesis based on the probability value method associated with the F Statistics, based on the statistical significance level of 5% or 1%. A t-test was also used to compare two sets of readings for the same sample, where the effect of this factor or indicator can be inferred.

3. Results and discussion:

Table(1): It shows a comparison between the control group and peritoneal dialysis patients and between the control group and hemodialysis patients in terms of nutrients and vitamins in children :

Nutrients and vitamins	Mean of control n=50	Mean of patient n=8	Peritoneal dialysis F	Peritoneal dialysis P .value	Mean of control n=50	Mean of patient n=22	Hemodialysis F	Hemodialysis P .value
Sodium (mmol\L)	140.56	141.10	0.06	0.813	140.56	128.97	5.20	0.026
Potassium (mmol\L)	4.41	4.71	2.30	0.135	4.41	3.97	5.56	0.021
Phosphorus(mmol\L)	1.82	2.74	109.43	0.000	1.82	4.34	121.98	0.000
Calcium (Mg\dl)	9.39	2.46	786.74	0.000	9.39	8.53	5.49	0.022
Zinc (ug/dl)	5.20	0.25	0.16	0.693	5.20	0.19	0.45	0.506
Selenium (ng\ml)	0.150	0.121	13.37	0.001	0.150	0.120	31.65	0.000
Copper (g\dl)	47.96	61.10	1.77	0.189	47.96	132.3	22.04	0.000
Manganese (mg\dL)	6.19	5.88	1.22	0.274	6.19	4.52	80.83	0.000
Magnesium (mmol\L)	1.71	1.66	0.55	0.461	1.71	1.25	85.75	0.000
Vitamin A (µg\dL)	695.5	578.7	0.09	0.084	695.5	395.6	49.27	0.000
Vitamin E (mg\dL)	12.50	11.55	0.88	0.353	12.50	8.49	37.37	0.000

Table (1) shows the distribution of values for nutrients and vitamins used in studying the nutritional status of children with chronic kidney disease on PD and HD and comparing these results with the control.

According to the nutrients and vitamins, The statistical tests for PD, the test value showed that (P.value) was less than the level of significance (0.05) in (phosphorus, calcium, selenium), which means that there are significant differences between these values for PD and control groups. The test value also showed that (P.value) is greater than The level of significance is (0.05) in (sodium, potassium, zinc, magnesium, manganese, as well as vitamin A and vitamin E), which means that there are no significant differences between the PD and control groups. And in HD , the test value showed that (P.value) was less

than the level of significance (0.05) in (Sodium , Potassium , Phosphorus , Calcium , Selenium Copper , Manganese , Magnesium , Vitamin A ,Vitamin E), which means that there are significant differences between these values for HD and control groups. The test value also showed that (P.value) is greater than The level of significance is (0.05) in Zinc, which means that there are no significant differences between the HD and control groups.

Table (2): Comparison between the two groups before hemodialysis and after hemodialysis in children with CKD with regard to nutrients and vitamins:

Nutrients and vitamins	Mean Before n=22	Mean After n=22	T	P.value
Sodium (mmol\L)	121.48	128.98	-8.80	0.000
Potassium (mmol\L)	5.42	3.97	9.07	0.000
Phosphorus (mmol\L)	5.89	4.33	7.00	0.000
Calcium (Mg\dl)	6.84	8.52	-4.55	0.000
Zinc (ug/dl)	0.23	0.19	5.98	0.000
Selenium (ng\ml)	0.15	0.11	0.95	0.354
Copper (g\dl)	519.14	132.29	10.79	0.000
Manganese (mg\dL)	5.54	4.52	6.60	0.000
Magnesium (mmol\L)	1.57	1.25	6.92	0.000
Vitamin A (µg\dL)	119.20	395.62	-9.61	0.000
Vitamin E (mg\dL)	2.65	8.49	-14.59	0.000

Table (2) shows the distribution of values of nutrients and vitamins used in studying the nutritional status of children with chronic kidney disease before HD compared with after HD.

According to nutrients and vitamins, statistical tests for before HD and after HD the value test showed significant because the probability values associated with each test (P.value) for (sodium, potassium, phosphorus, calcium, zinc, copper, manganese, magnesium, vitamin A, vitamin E) are less than the level of significance (0.05), which means that there are significant differences before After HD, which did not showed significant at the level of (0.05) for selenium, the test also showed that the (P.value) was much greater than the (P.value) level (0.05), which means that there is no significant difference between These values are in HD . Also, some T-test results showed a negative sign, which means that the effect of HD was through an increase in the percentages or averages of parameter readings compared to what they were after HD.

Table (3): Comparison between the two groups before peritoneal dialysis and after peritoneal dialysis in children with CKD with regard to nutrients and vitamins.

Nutrients and vitamins	Mean Before n=8	Mean After n=8	T	P.value
Sodium(mmol\L)	134.03	141.10	-4.06	0.005
Potassium (mmol\L)	5.06	2.74	7.43	0.000

Phosphorus (mmol\L)	4.57	2.74	7.99	0.000
Calcium (Mg\dl)	3.29	2.46	2.02	0.083
Zinc (ug/dl)	0.188	0.246	-10.18	0.000
Selenium (ng\ml)	0.076	0.121	-5.12	0.001
Copper(g\dl)	678.80	61.10	9.27	0.000
Manganese (mg\dL)	4.27	5.87	-7.74	0.000
Magnesium (mmol\L)	1.23	1.65	-8.33	0.000
Vitamin A (µg\dL)	67.48	578.72	-9.31	0.000
Vitamin E (mg\dL)	1.59	11.54	-17.09	0.000

Table (3) shows the distribution of values of nutrients and vitamins used in studying the nutritional status of children with chronic kidney disease before HD compared with after HD.

According to nutrients and vitamins, statistical tests for before PD and after PD the value test showed significant because the probability values associated with each test (P.value) for (sodium, potassium, phosphorus, zinc, selenium , copper, manganese, magnesium, vitamin A, vitamin E) are less than the level of significance (0.05), which means that there are significant differences before After PD, which did not showed significant at the level of (0.05) for calcium, the test also showed that the (P.value) was much greater than the (P.value) level (0.05), which means that there is no significant difference between These values are in PD. Also, some T-test results showed a negative sign, which means that the effect of PD was through an increase in the percentages or averages of parameter readings compared to what they were after PD.

4. Discussion :

Sodium, potassium, phosphorus, calcium :

In PD, a non-significant increase in the levels of sodium and potassium, a significant increase in the level of phosphorus, and a significant decrease in the level of calcium were observed in this study compared to the control. The reason for this is attributed to regulating fluid exchange during PD, as this helps maintain balance and correct fluid and salt intake in the body, and patients also do not suffer from interruption of urine flow (3). The reason for high phosphorus is also due to mineral and bone disorders resulting from chronic kidney disease. There may also be a disorder in the secretion of parathyroid hormone, which raises its levels in the blood due to increased intestinal absorption of phosphate (4).

In HD, a significant decrease in the levels of sodium, potassium, and calcium was observed in this study, and a significant increase in the level of phosphorus compared to the control. The reason for this is attributed to Hyponatremia is associated with increased mortality in CKD with or without CKD. Increasing evidence suggests that hyponatremia is not only a sign of serious underlying disease, but also a direct contributor to mortality (5). There are also several reasons for low sodium and potassium including insufficient kidney function, nutrients removal during dialysis, as well as increased water consumption, which causes decreased excretion due to CKD problems (6).

In this study, it was observed that there was a significant increase in the levels of (sodium and calcium) and a significant decrease in the levels of (phosphorus, potassium) after HD compared to before HD. The reason for this is that during the HD process, excess fluids and harmful substances are removed from the blood. This results in a loss of large amounts of fluid, leading to high sodium concentration (7). The increase in calcium levels is due to an increase in the hormone PTH. The dialysis process may also affect calcium balance in the body due to the removal of fluids and substances (8). Also, the dialysis solutions used in the dialysis process may contain low levels of potassium, which may lead to low potassium and phosphorus after the procedure (9).

In this study, we noticed an increase in sodium levels and a decrease in levels (potassium, phosphorus, and calcium) after PD compared to before peritoneal dialysis. The reason for this is that some of the peritoneal solutions used in peritoneal dialysis contain low levels of potassium, phosphorus, and calcium, which leads to a decrease in these levels. nutrients in the blood after a period of peritoneal dialysis. Hypokalemia is also associated with increased peritonitis and these decreased levels are due to malnutrition and decreased urine volume (10).

Zinc , Selenium , Copper , Manganese , Magnesium :

In this study, we observed a significant decrease in the level of selenium, a non-significant decrease in the levels of (zinc, manganese, and magnesium), and a non-significant increase in the level of copper, in children on PD compared to the control. The reason for this is attributed to the fact that patients on PD are at risk of developing nutrients deficiency due to removal of nutrients through the catheter, insufficient dietary intake, and decreased absorption of nutrients in the digestive system (11). Other causes include loss of urinary protein, low albumin and hemoglobin, decreased dietary protein intake, increased weakness, inflammation, and malnutrition (12).

It can be concluded from this study that some nutrient levels can also accumulate in the blood of children with reduced kidney function due to insufficient removal of impurities in peritoneal dialysis.

In this study, a significant decrease in the levels of selenium, manganese, and magnesium, a non-significant decrease in the levels of zinc, and a significant increase in the level of copper were observed in children undergoing HD compared to the control. The reason for this is attributed to , Deficiency is associated with anorexia, poor nutritional efficiency, delayed growth, and weak nervous and immune systems (13) . Also, the decrease due to secondary hyperparathyroidism and disorders of nutrients metabolism are common complications in patients on HD (14). Its deficiency also leads to a defect in plasma membrane proteins and increases oxidative stress in cells, especially red blood cells, which reduces their lifespan, and this deficiency may be associated with anemia (15). Low selenium levels may contribute to immune dysfunction and may increase the risk of death from infectious diseases in dialysis patients (16).

In this study, we also noticed a significant decrease in levels of (zinc, copper, manganese, magnesium) and a non-significant decrease in selenium levels after HD compared to before HD. Because nutrients play key roles in multiple biological systems including immune defense against oxidative stress and infection, it has been hypothesized that the increased morbidity and mortality seen in HD patients may be due in part to nutrients imbalance (17) . The reason for this decrease is that children who on HD are susceptible to changes in nutrients balance through loss of appetite, dietary restrictions, as well as infections and malnutrition. In children who suffer from CKD, this condition may affect the stability of trace element levels in the blood before and after. HD is because the HD process removes harmful substances and fluids from the body. These substances may include heavy metals such as zinc, selenium, copper, manganese, and magnesium (17).

In this study, we also noticed a significant increase in levels of (zinc, selenium, manganese, magnesium) and a significant decrease in copper levels after PD compared to before PD. The reason for the increase in nutrients is that PD solutions may contain high levels of them to compensate for any deficiency that may occur due to the PD process itself. In some cases, there is a response to PD treatment, or there may be a decrease in the ability of the kidneys to remove nutrients or a lack of The ability to regulate its levels naturally after PD, which causes its accumulation in the blood (18). Also, the PD process may lead to changes in the metabolism of many minerals in the body, including copper (19).

Vitamin A and vitamin E :

In children with CKD who were on PD, we observed a non-significant decrease in vitamin A and vitamin E levels compared to normal levels in the control group. The reason for this is attributed to low in vitamins due to malnutrition, poor growth, infections, or due to the peritoneal dialysis process, through which waste and fluids from the blood are transferred through the abdominal membrane, through which some vitamins may be removed from the body (20). Also, during the peritoneal dialysis process, some fat-soluble vitamins, such as vitamin E, may be lost through the fluid used in the peritoneal dialysis process (21).

In children with CKD who were on HD, we observed a significant decrease in vitamin A and vitamin E levels compared to normal levels in the control group. The reason for this is attributed to high blood sugar, high free fatty acids and uremic toxins, as well as tissue damage. There are also other causes of the decline, such as malnutrition, infections, as well as a deficiency of many vitamins during the HD process (22). One recent case-control study demonstrated a significant association between low plasma vitamin A concentrations and carotid atherosclerosis in a small group of patients with CKD (23).

In children with CKD who are on HD, we observed in this study a significant increase in the levels of (vitamin A, vitamin E) after HD compared to before HD. This is consistent with the possibility of increased vitamin A levels in HD patients due to increased retinol-binding protein(24). Also, according to

the researcher's opinion, during HD, the blood is purified from harmful fluids, and through it some vitamins are also recovered, such as vitamin A and vitamin E, which leads to an increase in their levels in the blood. Also, some pediatric patients are given some nutritional supplements and medications, and some medications during the HD process. Which affects the levels of vitamins in the body, leading to their increase. Or the body responds to hemodialysis after performing the dialysis process, so the percentage of vitamins increases.

In children with CKD who are on PD, we observed in this study a significant increase in the levels of (vitamin A, vitamin E) after PD compared to before PD. According to the researcher's opinion, during the PD treatment period, sick children are given nutritional supplements containing vitamins A and E as part of their treatment during the dialysis period. Also, some of the solutions used in PD contain substances that help enhance the absorption of vitamins such as vitamins A and E. Also, according to some studies, a high level of these vitamins has a role in reducing oxidative stress in PD patients. Also, according to some studies, a high level of these vitamins has a role in reducing oxidative stress in PD patients. The reason for the low levels of these vitamins before the PD process in CKD is the significant loss of antioxidant properties by the vitamins, as well as malnutrition and a decrease in blood pressure. Food intake due to dietary restrictions, excretion and changes in proteins and fats carrying vitamins due to increased production of reactive oxygen species (24).

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