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# The Effect of Regular Hemodialysis on the Nutritional Status of Children with End-stage Renal Disease

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**Abstract** **Original Research Article**

***Background:*** Children with end-stage renal disease (ESRD) have rates of mortality estimated to be 30-times higher than expected for age compared with those of healthy children. Physical manifestations of under-nutrition, such as body mass index (BMI) have been associated with increased risk of mortality. Traditional measures, such as height, weight and serum albumin concentration, may not be accurate indicators to assess the nutritional status of children receiving maintenance hemodialysis. Meeting the special nutritional needs of these children often requires nutritional supplementation, by either the enteral or the parenteral route. Recently, in children receiving maintenance hemodialysis that is malnourished, intradialytic parenteral nutrition (IDPN) has been utilized as a means to provide additional protein and calories. ***Objectives:*** The present study was carried out to identify the malnutrition in children receiving maintenance hemodialysis, with special focus on outcome. ***Method:*** This was A cross-sectional observational study was conducted in the Department of Pediatrics of a Pediatric hospital of Benghazi from January 2019 to June 2019. 81 children aged from five to eighteen years on regular hemodialysis. Outcome measures: Measurements included questionnaire that elicited information on social demographic characteristics, Patient's medical history, and duration of hemodialysis. Anthropometry, biochemical parameters were measured. Anthropometric measurements were expressed as z - scores. Data were analyzed using descriptive statistics. The Chi-Square test was applied to examine the study data. ***Results:*** Data shows that 49. 4% of children had BMI between 5th percentile up to the 85th percentile were considered normal weight, while, 30. 9% of children had BMI less than the 5th percentile, were categorized as underweight. With regard to biochemical parameters, children had significantly higher serum phosphate, creatinine, and Blood urea nitrogen. However, study population had lower of hemoglobin and serum albumin. In addition, results show that a significant positive correlation between children who were on dialysis for 33-36months with underweight and high serum creatinine and parathyroid hormone. ***Conclusions:*** Nutritional assessment is essential to the management of children with CRF. Anthropometry is a sensitive indicator of the nutritional status.

**Keywords:** Nutritional status, children, nutritional assessment, anthropometric measurement, CRF, hemodialysis, ESRD



## INTRODUCTION

Chronic kidney disease (CKD) refers to a condition related to irreversible kidney damage that can further progress to end stage renal disease (ESRD). CKD is a major public health problem worldwide. Most of the existing data on the epidemiology of CKD during childhood concentrates on the late and more severe stages of renal impairment and are not population based in nature [1]. The incidence of CKD in Europe was consistent, being around 11– 12 per million of the age related population. The incidence rate of severe pre-terminal CKD in Lorraine (France) has been estimated as 7. 5 per year per million of the age-related population in children younger than 16 years [2]. A number of factors influence incidence and prevalence rate of CKD variability of childhood. Factors such as racial and ethnic distribution, type of prevalent renal disease, and

quality of medical care available for preterminal CKD patients have a significant impact on patient outcome [3]. Malnutrition [defined either by body mass index (BMI) or biochemical markers such as albumin] is a well-recognized complication and an independent risk factor for increased mortality in children with ESRD receiving maintenance HD [4]. Malnutrition is recognized to be a serious and common complication of chronic kidney disease (CKD) and is associated with increased morbidity and mortality [4]. Children with ESRD have rates of mortality approximately 30-times higher than expected forage when compared with those of healthy children. Although multiple factors might be responsible, physical manifestations of malnutrition, such as short stature, lower BMI, in the pediatric population have been demonstrated to be associated with increased risk of death [5].

Growth failure is one of the most common and profound clinical manifestation of chronic kidney disease (CKD) in infants, children and adolescents [5]. Affected children exhibit a range of potentially serious medical and psychological complications, as well as increased mortality. The etiology of growth failure in these children is multifactorial, age at onset of the disease, primary renal disease, severity of CRF, hormonal resistance; anemia, metabolic acidosis, malnutrition, renal osteodystrophy, and inadequate dialysis are all implicated [6].

Nutritional status is particularly important in children as it influences growth and sexual and neuro-cognitive development. Thus, its accurate and regular assessment is highly recommended in patients on regular hemodialysis (HD) [7]. Kidney disease wasting (KDW) in chronic dialysis children affects approximately one third of HD patients. Serum levels of inflammatory markers are increased, and numerous causes of chronic inflammation may be present. Hypoalbuminemia is frequently seen in patients with CKD and has been consistently shown to be associated with increased mortality in children [8]. Nutrition assessment for the monitoring of nutritional status of children on maintenance hemodialysis, the Kidney Disease Outcomes Quality Initiative (K-DOQI) recommends the following measures: dietary interview, serum albumin, height or length, estimated dry weight, mid-arm circumference, skin fold thickness, head circumference for children aged 3 years or less [9]. The pediatric renal dietician is valuable to assess and manage malnutrition in children with renal disease, and detailed guidelines exist with regard to frequency of nutrition assessment of children on maintenance hemodialysis [10]. The aim of this study is to evaluate the nutritional status in children with CRF on hemodialysis in Benghazi Pediatric Hospital.

## OBJECTIVES

To assess the growth and the nutritional status in ESRD children on regular HD

To correlate their duration of dialysis with BMI and laboratory parameters

To identify how effects the duration of dialysis on BMI of HD children

## MATERIALS AND METHODS

This cross-sectional observational study was conducted in the Department of Pediatrics of a Pediatric hospitalof Benghazi during the period January 2019 to june 2019. The subjects of the study were childrens guests aged from five to eighteen years, who were on dialysis. The study was approved by the local Institute's Ethical Committee of Benghazi University and Pediatric hospitalof Benghazi were gave written informed consent

## DATA COLLECTION

Clinical and laboratory assessment. Patient's medical history, demographics, and duration of hemodialysis were obtained from the hospital registry. None of the patients were on tube feeding or parenteral nutrition. On the day of evaluation, predialysis blood samples were collected to estimate fasting blood sugar(FBS) ,hemoglobin ,iron level, calcium ,phosphate (PO4),parathyroid hormone (PTH) ,serum creatinine, serum albumin ,blood urea nitogen ,sodium and potassium.

Anthropometric measurements were carried out 10–20 minutes after completion of hemodialysis. Full examination was carried out , including: Post-dialysis body weight (in kg), which coincided with the dry weight, standing height (in cm) and height or length Height and body weight were measured with light clothing. Body mass index (BMI) was calculated as the ratio of end dialysis body weight in kilogram and the square of the height in meters (kg/m2). the patients' nutritional status was classified as follows, according to the BMI: underweight for less than the 5th percentile, healthy weight from 5th percentile up to the 85th percentile, overweight for 85th to less than the 95th percentile, patient has obesity, if the body mass index equals to or greater than the 95th percentile.

## STATISTICAL ANALYSIS

Descriptive statistics an analysis were carried out with the statistical software package SPSS21. 0). Chi –square test was processed to ascertain statistical significance between the duration of dialysis with months and Body mass index(BMI), Serum Creatinine and Parathyroid hormone. Frequency and percentage were presented for qualitative variables.

# RESULTS

**Table-1: Demography, body mass index (BMI) and duration of dialysis with months of study pobpulation**

| **Charactaristcs N=(81)** | | **Frequency** | **Percent** |
|---|---|---|---|
| sex | Male | 52 | 64. 2% |
| | Female | 29 | 35. 8% |
| Age group with years | 3-7 | 43 | 53. 1% |
| | 8-12 | 22 | 27. 2% |
| | 13-17 | 16 | 19. 8% |
| Nationality | libyan | 80 | 98. 8% |
| | Other | 1 | 1. 2% |
| Residency of benghazi | Residence | 50 | 61. 7% |
| | None residence | 31 | 38. 3% |
| Body mass index(BMI) | underweight, less than the 5th percentile | 25 | 30. 9% |
| | healthy weight, 5th percentile up to the 85th percentile | 40 | 49. 4% |
| | overweight, 85th to less than the 95th percentile | 8 | 9. 9% |
| | has obesity, equal to or greater than the 95th percentile | 8 | 9. 9% |
| duration of dialysis with months | 1-4 | 20 | 24. 7% |
| | 5-8 | 25 | 30. 9% |
| | 9-12 | 23 | 28. 4% |
| | 13-16 | 3 | 3. 7% |
| | 17-20 | 1 | 1. 2% |
| | 21-24 | 6 | 7. 4% |
| | 33-36 | 1 | 1. 2% |
| | 37-40 | 1 | 1. 2% |
| | 41-44 | 1 | 1. 2% |

The final study sample included 81 patients, 64. 2% boys and 35. 8% girls, with 53. 1% aged of three to seven years. Approximatly 62% of patients are residence in the city of benghazi. The duration of hemodialysis ranged from one month to fourty four months (3 years and six months) with the high percentage of 30. 9% for children aged from 5 to 8 years. Regarding to Body mass index (BMI), 49. 4% of patients had BMI between 5th percentiles up to the 85th percentileund, which considered patients had healthy weight, furthermore 30. 9% of patients had BMI less than the 5th percentile, which considered the patients had underweight.

Mean of Fasting blood sugar (FBS), iron, calcium, Parathyroid hormone (PTH), sodium and potassium levels were within normal range. Patients had significantly higher means of Phosphate (PO45. 155) mg/dL with Standard deviation 2. 398, Serum creatinine 1. 302 mg/dl with Standard deviation1. 188,as well as, higher mean of Blood urea nitogen 37. 186 mg/dL with Standard deviation25. 710. On the other hand, study population had lower means of Hemoglobin and Serum albumin.

**Table-2: Laboratory parameters of study population**

| **Laboratory parameters** | **Mean** | **Standard deviation** | **Normal range for reference** |
|---|---|---|---|
| Fasting blood sugar(FBS) mg/dL | 105.481 | 37.061 | 7-110 |
| Hemoglobin gm/dL | 10.231 | 1.964 | 12-14 |
| Iron level gm/dL | 62.969 | 20.800 | 50-150 |
| Calcium mg/dL | 8.257 | 1.671 | 8.4-10.2 |
| Phosphate (PO4) mg/dL | 5.155 | 2.398 | 2.4-4.1 |
| Parathyroid hormone (PTH) pg/mL | 51.850 | 25.270 | 14-65 |
| Serum creatinine mg/dl | 1.302 | 1.188 | 1.06-0.12 |
| Serum albumin g/dL | 2.695 | 1.249 | 3.5-4.5 |
| Blood urea nitogen mg/dL | 37.186 | 25.710 | 5-20 |
| Sodium(Na) mmol/l | 136.644 | 6.827 | 136-145 |
| Potassium (K) mmol/l | 5.103 | 4.215 | 3.5-5.5 |

Statistically significant value was reflected by the chi-square test between the duration of disease with months and the readings of Body mass index (BMI) with p value 0. 005, where 12( 48%) of patients were underweight and they were on dialysis for 33-36 months. at the same side, significant p values of serum creatinine and parathyroid hormone were 0. 006 and 0. 00 respectivelly and the duration of disease , where 32. 4% and 40. 9% of patients who were on dialysis for 33-36months .

**Table-3: Association between Duration of dialysis with months Body mass index (BMI), Serum Creatinine, Parathyroid hormone (PTH)**

| | | Duration of dialysis with months Frequency, percentage %, chisqure and pvalue | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-4 | 5-8 | 9-12 | 13-16 | 17-20 | 21-24 | 33-36 | 37-40 | 41-44 | chisqure$\chi^2$ | P value |
| Body mass index(BMI) | underweight, less than the 5th percentile | 0 0% | 2 8% | 1 4% | 3 12% | 1 4% | 4 16% | 12 48% | 1 4% | 1 4% | 4 .45 | .0 005 |
| | healthy weight,5th percentile up to the 85th percentile | 11 27. 5% | 19 47. 5% | 9 22. 5% | 0 0% | 0 0% | 1 2. 5% | 0 0% | 0 0% | | 0 0% | |
| | overweight, 85th to less than the 95th percentile | 4 50% | 3 37. 5% | 1 12. 5% | 0 0% | 0 0% | 0 0% | 0 0% | 0 0% | | 0 0% | |
| | has obesity, equal to or greater than the 95th percentile | 4 57. 1% | 1 14. 3% | 1 14. 3% | 0 0% | 0 0% | 1 14. 3% | 0 0% | 0 0% | | 0 0% | |
| Serum Creatinine | Normal value 0. 12-1. 06 mg/dl | 17 39. 5% | 13 30. 2% | 11 25. 6% | 0 0% | 0 0% | 1 2. 3 | 1 2. 3% | 0 0% | 0 0% | 21. 26 | 0. 006 |
| | more than 1. 06mg/dl | 2 5. 4% | 0 0% | 12 32. 4% | 3 8. 4% | 1 2. 7% | 5 13. 5% | 12 32. 4% | 1 2. 7% | | 1 2. 7% | |
| Parathyroid hormone(PTH) | Less than 14 mg/dL | 0 0% | 0 0% | 1 50% | 0 0% | 0 0% | 0 0% | 1 50% | 0 0% | 0 0% | 45. 95 | 0. 00 |
| | 14-65 mg/dL | 13 23. 2% | 20 35. 7% | 13 23. 2% | 3 5. 4% | 1 1. 8% | 4 7. 1% | 0 0% | 1 1. 8% | | 1 1. 8% | |
| | More than 65 mg/dL | 6 27. 3% | 5 20. 7% | 0 0% | 0 0% | 0 0% | 2 | 9 40. 9% | 0 0% | | 0 0% | |

## DISCUSSION

The aim of this study was to evaluate the nutritional status of CRF children on regular hemodialysis in Benghazi Pediatric Hospital. Assessment of the nutritional status for children receiving maintenance dialysis is extremely important. The Kidney Disease Outcome Quality Initiative (K/DOQI) Clinical Practice guidelines for Nutrition in Chronic Renal Failure (NKF-K/ DOQI, 2000) stated that no single measure provides a complete picture of nutritional status and that many different measures are recommended for assessment of the nutritional status [11]. In the present study we used BMI of children, laboratory parameters, and duration of dialysis to evaluate the nutritional status of children.

As shown in our result the duration of hemodialysis ranged from one month to forty-four months, about 30. 9% of them were for children aged from 5 to 8 years. In addition the result demonstrated that 49. 4% of HD children their BMI was between 5th percentiles up to the 85th percentile, which considered being normal, however, 30. 9% of HD children their BMI was less than 5th percentile, which appeared to be underweight as well as 9. 9% of them their BMI more than 85$^{th}$ and less than 95$^{th}$ while the other 9. 9% of children their BMI was more than 95$^{th}$. Study in Egypt was done by Lotfy et al. show that the BMI of 16% of the HD children was < 5 percentile while only 4% of the patient was 97th percentile [12].

We also found that laboratory investigation of children appeared to be as following, sodium and potassium levels were within normal range. Patients had significantly higher means of Phosphate (PO45. 155) mg/dL Serum creatinine 1. 302 mg/dl as well as, higher mean of Blood urea nitogen 37. 186 mg/ dl, whereas HD children had lower means of Hemoglobin and Serum albumin. Similarity study done by Lotfy et al. illustrated that 66% of patients had hemoglobin level below 11 g/dL, 70% of the patients had serum phosphorus more than 4. 5 mg/dL and all the patients had blood urea nitrogen above the normal level [12]. A survey of prevalence data from the six-state New England area found that more than one third of the children with ESRD undergoing chronic HD had serum

albumin concentrations <2. 9 g/dl [13]. In addition Wong et al. studied 1,723 pediatric patients and found that each 1 g/dl difference in serum albumin at the start of dialysis was associated with a 54% higher risk of death, even after adjusting for the glomerular causes of the ESRD and other potentially confounding variables [14]. Furthermore study found that other biochemical parameters that can indirectly reflect nutritional status are hemoglobin and serum creatinine that, like total protein and serum albumin, have been found to be significantly lower in children on HD therefore children with Low serum hemoglobin and creatinine levels may need for a thorough nutritional assessment [15]. Similar to what has been found, study reported by Furth et al. [16], shows that anemia and hypoalbuminemia were associated with pediatric CKD duration. Regarding to correlation between Duration of dialysis with months Body mass index (BMI), Serum Creatinine, Parathyroid hormone (PTH. In present study, duration of dialysis showed a significant correlation with BMI. Similarly, study done by Badve et al. convinced that mean BMI decreased gradually. The average baseline BMI in the HD group was significantly related with duration of disease [17]. As well as Kotanko and colleagues observed a marked decrease in body weight in 3 months preceding HD patient. The initial decrease in BMI in the first year of starting dialysis could be due to the excess burden of illness that these patients experience at the time of reaching ESKD necessitating dialysis [18]. We also identified that hypocalcemia and hyperphosphatemia were independent risk factors for renal progression in children with CKD. Voormolen et al. [19] have previously found an association between hyperphosphatemia and a more rapid decline in renal function with disease duration (as well as mortality). About HD duration, and PTH and S. creatinine, Study was done by Barbosa et al. which does not coincide with the results. There were no differences observed between those who were below or above 36 months of treatment and PTH, S. creatinine [20]. Some other studies also found no changes of laboratorial factors (urea, creatinine, PTH (ParaThyroid Hormone) over the duration of disease which makes us think of the possibility of other factors occurring besides those investigated [21, 22]. The limitations of the study were the small sample size; the measure of Triceps skin fold (TSF) thickness and Subscapular skin fold thickness were not taken, some of important laboratory tests were not included in the patients' medical records.

## CONCLUSION

Although most ESRD patients their BMI was markedly affected. The longer the HD duration, the more severe was the effect on nutritional status of children, the growth parameters affected was BMI, serum creatinine, serum albumin, and hemoglobin. Evaluating patients frequently and regularly to maintain adequate macro- and micronutrient intake for reduction in morbidity and mortality, as well Nutrients as improvement in quality of life. A multidisciplinary team with a renal dietician may help to manage the nutritional status of CKD children. Further research regarding nutrition must be undertaken tostudy the effects of long hemodialysis duration on health outcomes for Children with End-stage Renal Disease

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