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Assessment of Nutritional Status and Growth in Children with End Stage Renal Disease Undergoing Maintenance Hemodialysis: A Multicenter Study

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Abstract

Background Chronic kidney disease is a worldwide health problem, with increasing prevalence and adverse outcomes. Children's nutritional status reflects the degree to which physiologic needs for nutrients are being met. Impairment of growth is associated with all stages of chronic renal failure

Objective To assess the nutritional status and the severity of malnutrition in children undergoing hemodialysis (HD) in all pediatrics dialysis centers in Baghdad.

Methods A total of 86 participants (41 males and 45 females), with end stage renal disease (ESRD) undergoing HD, from all pediatric HD centers in Baghdad City, recruited in this cross-sectional study with analytic components, among six months' period. A structured interview questionnaire was used with the children or their care givers, included: demographic and clinical characteristics of patients, nutritional assessment of studied children using pediatric subjective global nutritional assessment (SGNA) tool and also growth parameters to assess the growth status of the study group.

Results The overall proportion of estimated nutritional status was as follow: Thirty-three children (38.4%) were normal/well nourished, 39 patients (45.3%) were moderately malnourished and 14 patients (16.3%) were severely malnourished. Uremic symptoms were more significantly associated with severe state of nutritional deficiency (p=0.002). The duration of dialysis was significantly higher in children with severe nutritional deficiency in comparison with children with normal or moderate nutritional deficiency, their mean and interquartile range were 41.00 (76.00) months versus 24.00 (27.00) months and 24.00 (38.00) months, respectively (p = 0.001).

Conclusion Nutritional assessments are complex and critical in pediatric patients with ESRD. Using a comprehensive tool such as pediatric SGNA is more reflective of their nutritional status than when compared to other parameters.

Keywords Nutritional status, pediatrics end stage renal disease, pediatrics subjective global nutritional assessment (SGNA)

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List of abbreviations: BMI = Body mass index, CKD = Chronic Kidney Disease, ESRD = End stage renal disease, HD = Hemodialysis, MAC = Mid-arm circumference, SGNA = Pediatric subjective global assessment tool, TSFT = Triceps skin fold thickness

Introduction

Nutrition in pediatrics has always been one of the most important factors for optimal growth. Patient with chronic

kidney disease (CKD) need special consideration for better long-term outcomes, including nutritional status, optimal height, and cognitive function [1]. Malnutrition is an evident problem in children with end stage renal disease (ESRD) on hemodialysis (HD) [2].

Factors implicated in growth failure in children with CKD may include growth hormone insensitivity, electrolyte disturbances, metabolic acidosis and poor nutritional intake [3,4]. Some factors can be managed and are potentially amenable to correction such as mineral bone disorders, acidosis, electrolyte imbalance, hematological and metabolic disorders, hormonal abnormalities and nutritional deficiencies; however, others are difficult to be modified such as parental height, associated syndromes and birth parameters, which have significant impact on achieving normal longitudinal growth [5,6].

Data about growth and development of Iraqi children with ESRD are rarely available in published literature and the effect of dialysis on growth parameters in those children is incompletely understood. The poverty of such information has encouraged us to plan and conduct the current study aiming at assessment the nutritional status and the evidence of malnutrition and its related factors in association with growth parameters of children with ESRD undergoing hemodialysis, using the pediatric subjective global assessment tool (SGNA), anthropometric measurements, growth parameters and biochemical tests.

Methods

This is a descriptive cross-sectional study with analytic elements. The study was conducted in five governmental HD units from 1st of February 2022 to 31st of July 2022.

We included all patients with ESRD who were scheduled to undergo regular HD (at least one session per week) for more than 6 months. Age ranged from 6-18 years old.

Data collection

Data were collected by direct interviews using a structured interview questionnaire was designed and used to interview the children or their care givers. It included the demographic and clinical characteristics of patients, and nutritional assessment.

Nutritional assessment parameters It included six parts:

Part I: Biosocial and medical data:

- Biosocial data
- Family history of CRF
- The duration, frequency of HD among children
- Uremic symptom

Part II: Physical assessment sheet.

Part III: Anthropometric measurements sheet.

Part IV: Biochemical tests.

Part V: Dietary intake survey.

Part VI: Pediatrics SGNA tool [7], which was based on the history and physical examination of the participants.

Anthropometric data

- Height measurement; based on recently documented measures from the patient's record.
- Weight measurement, based on the documented last post dialysis weight (dry weight) measurements.
- Body mass index (BMI) was calculated by dividing the dry weight over the squared height in meters, and was classified according to the World Health Organization categorization for patients on HD [8].

Growth parameters

Patients over 2 years of age can be evaluated by monitoring their weight, height, BMI, and growth velocity using the Centers for Disease Control and Prevention (CDC) (2–20-years) growth charts [9], classified as:

- Underweight: Less than the 5th percentile.
- Healthy Weight: 5th percentile to less than the 85th percentile.

- Overweight: 85th to less than the 95th percentile.
- Obesity: Equal to or greater than the 95th percentile.
- Wasting (low weigh for-height) <3rd percentile (or <-2 SD), long-term undernutrition.
- Stunting (low height-for-age) <3rd percentile (or <-2 SD), short stature.

Biochemical variables

The following reference ranges were used for patients on HD during the data analysis: normal serum calcium range: 8.4-10.2 mg/dl, serum creatinine 0.6-1.2 mg/dl, serum phosphorus 3-4.5 mg/dl, parathyroid hormone (PTH) 230-630 pg/ml, total serum protein 6-7.8 mg/dl, and serum albumin 3.5-5.5 mg/dl [8].

Dialysis adequacy

Dialysis adequacy was estimated by calculating the Kt/V, according to Daugirdas formula [9]

Ethical consideration

Arab Board Committee approval will be obtained and the confidentiality of the data were explained to the participants. Written informed consents, were taken from each participant before the start of the study.

Data management and statistical analysis

Statistical analysis was performed using statistical package for social sciences (SPSS, version 26; Chicago, IBM, USA). Quantitative variables were expressed as mean, standard deviation, median, interquartile range and range. Qualitative variables were expressed as number and percentage. Chi-square test was utilized to evaluate association between qualitative variables. One-way ANOVA was used to study mean difference among classes of SGNA. P value was regarded significant at levels of 0.05 or less.

Results

The classification of enrolled children with ESRD according to pediatric SGNA is shown in figure 1. Thirty-three children (38.4%) were normal, 39 patients (45.3%) had moderate nutritional deficiency and 14 patients (16.3%) had severe nutritional deficiency.

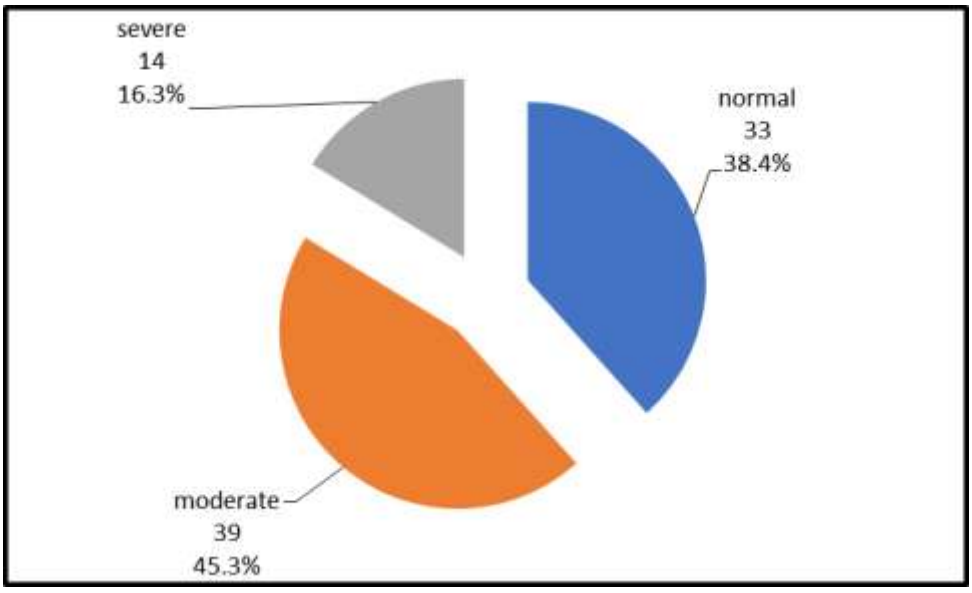

Figure 1. Pie chart showing the frequency distribution of children enrolled in the current study based on the Pediatric Subjective Global Nutrition Assessment (SGNA)

Sociodemographic characteristics of children enrolled in the current study classified based on SGNA are shown in table 1. There was no significant difference in mean age, the frequency of males and females, the place of enrollment, the frequency of residence, the level of education and the care giver status, education and occupation.

Table 1. Sociodemographic characteristics of children enrolled in the current study classified based on Pediatric Subjective Global Nutrition Assessment (SGNA)

Characteristic		SGNA of ESRD children			P value
		Normal *n* = 33	Moderate *n* = 39	Severe *n* = 14	
Age (years)	Mean ±SD	13.06 ±4.82	12.97 ±2.78	14.43 ±2.79	0.426 O
	Range	3-22	7-20	10-20	NS
Gender	Male	18 (54.5 %)	15 (38.5 %)	8 (57.1 %)	0.293 C
	Female	15 (45.5%)	24 (61.5%)	6 (42.9%)	NS
Place	Medical city	3 (9.1%)	5 (12.8%)	3 (21.4%)	0.751 C NS †
	Ibn albaladi	7 (21.2%)	13 (33.3%)	4 (28.6%)	
	Karama	5 (15.2%)	6 (15.4%)	1 (7.1%)	
	Iscan	16 (48.5%)	11 (28.2%)	5 (35.7%)	
	Kadhmia	2 (6.1%)	4 (10.3%)	1 (7.1%)	
Residence	Urban	22 (66.7%)	23 (59.0%)	12 (85.7%)	0.192 C
	Rural	11 (33.3%)	16 (41.0%)	2 (14.3%)	NS
Education	Illiterate	8 (24.2%)	9 (23.1%)	5 (35.7%)	0.344 C NS †
	Read and write	10 (30.3%)	11 (28.2%)	6 (42.9%)	
	Primary	11 (33.3%)	18 (46.2%)	2 (14.3%)	
	Intermediate	4 (12.1%)	1 (2.6%)	1 (7.1%)	
Care giver	Father alive	3 (9.1%)	2 (5.1%)	2 (14.3%)	0.223 C NS †
	Mother alive	1 (3.0%)	1 (2.6%)	2 (14.3%)	
	Other	0 (0.0%)	0 (0.0%)	1 (7.1%)	
	Father/Mother alive	27 (81.8%)	30 (76.9%)	7 (50.0%)	
	Father/other	1 (3.0%)	1 (2.6%)	1 (7.1%)	
	Mother/other	1 (3.0%)	1 (2.6%)	0 (0.0%)	
	Father/Mother/Other	0 (0.0%)	4 (10.3%)	1 (7.1%)	
Education of caregiver	Illiterate	0 (0.0%)	1 (2.6%)	0 (0.0%)	0.944 C NS †
	Read and write	3 (9.1%)	5 (12.8%)	2 (14.3%)	
	Primary	15 (45.5%)	14 (35.9%)	4 (28.6%)	
	Intermediate	7 (21.2%)	8 (20.5%)	3 (21.4%)	
	Secondary	8 (24.2%)	11 (28.2%)	5 (35.7%)	
Occupation	Paid employee	15 (45.5%)	15 (38.5%)	7 (50.0%)	0.670 C NS †
	Private job	12 (36.4%)	18 (46.2%)	5 (35.7%)	
	Unemployed	1 (3.0%)	3 (7.7%)	1 (7.1%)	
	Retired	4 (12.1%)	3 (7.7%)	0 (0.0%)	
	Housewife	1 (3.0%)	0 (0.0%)	1 (7.1%)	

n: number of cases; SD: standard deviation; C: chi-square test; O: One-way ANOVA test; NS: not significant; †: more than 20% of cells have expected count of <5

Medical history and clinical characteristics of children enrolled in the current study classified based on SGNA are shown in table 2. Medical history and family history showed no significant association to SGNA (p>0.05). Uremic symptoms were more significantly associated with severe state of nutritional deficiency (p=0.002). There was no significant difference in mean systolic or diastolic blood pressure among various stages of SGNA (p >0.05).

Dialysis characteristics of children enrolled in the current study classified based on SGNA is shown in table 3. The duration of dialysis was higher in a significant manner in children with severe nutritional deficiency in comparison with children with normal or moderate nutritional deficiency, their mean and interquartile range were 41.00 (76.00) months versus 24.00 (27.00) months and 24.00 (38.00) months, respectively (p=0.001). There was no significant difference in mean frequency of dialysis and mean duration of dialysis session among various stages of SGNA (p>0.05). Access type in form of catheter was more frequently associated with severe nutritional deficiency state in comparison with normal or moderate state, 78.6 % versus 39.4 % and 43.6 %, respectively (p=0.038). Kt/V mean was comparable among various stages of SGNA (p= 0.143).

Table 2. Medical history and clinical characteristics of children enrolled in the current study classified based on Pediatric Subjective Global Nutrition Assessment (SGNA)

Characteristic		SGNA of ESRD children			P value
		Normal *n* = 33	Moderate *n* = 39	Severe *n* = 14	
Medical history	Cystic disease	1 (3.0%)	1 (2.6%)	2 (14.3%)	0.411 C NS †
	Other	29 (87.9%)	34 (87.2%)	10 (71.4%)	
	More than one condition	3 (9.1%)	4 (10.3%)	2 (14.3%)	
Family history of CKD	Positive	4 (12.1%)	7 (17.9%)	4 (28.6%)	0.395 C NS
	Negative	29 (87.9%)	32 (82.1%)	10 (71.4%)	
Uremic symptom	No symptoms	20 (60.6%)	18 (46.2%)	0 (0.0%)	0.002 C * †
	Nausea	7 (21.2%)	6 (15.4%)	2 (14.3%)	
	Poor appetite	0 (0.0%)	1 (2.6%)	1 (7.1%)	
	More than one symptom	6 (18.2%)	14 (35.9%)	11 (78.6%)	
Systolic BP (mmHg)	Mean ±SD	120.85 ±21.00	125.21 ±27.61	131.79 ±30.10	0.407 O NS
	Range	87-160	80-200	90-180	
Diastolic BP (mmHg)	Mean ±SD	80.09 ±17.82	79.79 ±22.31	83.57 ±15.97	0.818 O NS
	Range	55-130	45-150	60-110	

n: number of cases; SD: standard deviation; C: chi-square test; O: One way ANOVA test; NS: not significant; *: significant at p ≤0.05; †: more than 20 % of cells have expected count of <5

Table 3. Dialysis characteristics of children enrolled in the current study classified based on Pediatric Subjective Global Nutrition Assessment (SGNA)

Characteristic		SGNA of ESRD children			P value
		Normal *n* = 33	Moderate *n* = 39	Severe *n* = 14	
Duration of dialysis (months)	Median (IQR)	24.00 (27.00)	24.00 (38.00)	41.00 (76.00)	0.001 K ***
	Range	3-72	3-84	3-192	NS
Frequency HD	Mean ±SD	2.58 ±1.09	2.46 ±0.68	3.00 ±1.36	0.216 O
	Range	1 -7	1 -4	2 -7	NS
Duration per session (hours)	Mean ±SD	3.27 ±0.45	3.15 ±0.37	3.14 ±0.54	0.444 O
	Range	3-4	3-4	2-4	NS
Access type	Fistula	20 (60.6%)	22 (56.4%)	3 (21.4%)	0.038 C *
	Catheter	13 (39.4%)	17 (43.6%)	11 (78.6%)	
Kt/V	Mean ±SD	1.19 ±0.32	1.23 ±0.47	1.48 ±0.70	0.143 O
	Range	0.52 -2.01	0.44 -2.82	0.67 -3.02	NS

n: number of cases; SD: standard deviation; IQR: inter-quartile range; C: chi-square test; O: One way ANOVA test; K: Kruskal Wallis test; NS: not significant; *: significant at p≤0.05; ***: significant at p≤0.001

Biochemical characteristics of children enrolled in the current study classified based on SGNA are shown in table 4. There was no significant difference in mean serum creatinine, calcium, phosphorus, albumin and total protein among various stages of SGNA (p>0.05). Mean serum PTH (parathyroid hormone) was significantly highest in severe state (p=0.05) and mean hemoglobin level was significantly lowest in severe state (p=0.003).

Table 4. Biochemical characteristics of children enrolled in the current study classified based on Pediatric Subjective Global Nutrition Assessment (SGNA)

Characteristic		SGNA of ESRD children			P value
		Normal *n* = 33	Moderate *n* = 39	Severe *n* = 14	
Creatinine (mg/dl)	Mean ±SD	8.5±3.29	7.87±3.05	9.08±4.44	0.482 O
	Range	1.6-15.2	1.98-16.4	5.32-23.55	NS
Calcium (mg/dl)	Mean ±SD	7.92±1.60	7.78±1.77	7.32±1.68	0.539 O
	Range	5.2-11.24	4.5-12.8	3.96-11	NS
Phosphorus (mg/dl)	Mean ±SD	6.89±1.98	6.78±2.76	6.31±2.36	0.754 O
	Range	4.27-13.1	1.58-15.1	3.78-12.15	NS
PTH (pg/ml)	Median (IQR)	498.0 (691.2)	366.2 (580.6)	1405.0 (1301.2)	0.050 K *
	Range	9.3-2200	7.1-2200	136.2-3000	
Albumin (g/dl)	Mean ±SD	4.01±0.49	3.95±0.67	3.83±0.8	0.659 O
	Range	2.5-4.8	2.26-5.3	2.1-4.7	NS
TSP (g/dl)	Mean ±SD	6.35±1.42	6.02±1.05	6.51±1.62	0.387 O
	Range	3.3-9.65	3.3-9.01	4.53-9.65	NS
Hb (g/dl)	Mean ±SD	9.08±1.3	8.65±1.72	7.33±1.61	0.003 O **
	Range	6.6-11.6	5.8-12.4	4.9-11	

n: number of cases; SD: standard deviation; IQR: inter-quartile range; One-way ANOVA test; K: Kruskal Wallis test; NS: not significant; *: significant at p≤0.05; **: significant at p≤0.01, PTH: Parathyroid hormone, TSP: Total serum protein, Hb: Hemoglobin

Nutritional status measurements and growth parameters of children enrolled in the current study classified based on SGNA are shown in table 5. Mean height, mean TSFT (triceps skin fold thickness), mean MAC (mid-arm circumference), mean dry weight and mean BMI showed significant variation with respect to states of SGNA (p<0.05); but there was no significant variation in mean knee height (p= 0.292).

Less than 5th percentile with respect to height for age, weight for age and BMI for age was more significantly associated with severe state of SGNA in comparison with normal state and moderate state (p<0.001). There was no significant difference in mean daily carbohydrate (CHO), protein and fat (p>0.05), but mean total Daily total calories was significantly lowest in severe state of SGNA in comparison to normal and moderate states (p<0.001). The amount of daily protein intake was between 0.4 to 4.6, 0.5 to 3 and 0.6 to 2.6 gram in normal, moderate and severe SGNA states respectively.

Table 5. Nutritional status and growth parameters measurements of children enrolled in the current study classified based on Pediatric Subjective Global Nutrition Assessment (SGNA)

Characteristic		Anthropometrics measurements of children classified based on SGNA			P value
		Normal *n* = 33	Moderate *n* = 39	Severe *n* = 14	
Height (cm)	Mean ±SD	138.21±18.65	130.26±16.12	125.21±14.67	0.034 O *
	Range	93-169	98-158	90-145	
knee height (cm)	Mean ±SD	41.35±7.36	39.58±5.92	38.36±5.61	0.292 O
	Range	24-56	26.5-52	27-48	NS
TSFT (cm)	Mean ±SD	12.42±5.78	10.44±3.97	8.14±4.15	0.018 O *
	Range	3-35	4-27	3-20	
MAC (cm)	Mean ±SD	19.61±5.12	17.14±3.06	16.03±2.04	0.005 O ***
	Range	11-36	12-28	13-20.4	
Dry weight (kg)	Mean ±SD	38.29±15.73	28.41±7.89	23.29±5.52	< 0.001 O ***
	Range	10.8-71	14.8-47	12-32	
BMI (kg/m^2)	Mean ±SD	19.50±4.67	16.79±2.86	14.72±1.76	< 0.001 O ***
	Range	11.25-32.7	12.16-27.8	12.2-18.4	
		Growth parameters of children classified based on SGNA			
Height for age	<5%	14 (42.4%)	35 (89.7%)	14 (100.0%)	< 0.001 C *** †
	5-85%	18 (54.5%)	4 (10.3%)	0 (0.0%)	
	85-95%	1 (3.0%)	0 (0.0%)	0 (0.0%)	
Weight for age	<5%	5 (15.2%)	31 (79.5%)	14 (100.0%)	< 0.001 C *** †
	5-85%	26 (78.8%)	8 (20.5%)	0 (0.0%)	
	85-95%	2 (6.1%)	0 (0.0%)	0 (0.0%)	
BMI for age	<5%	2 (6.1%)	12 (30.8%)	11 (78.6%)	< 0.001 C *** †
	5-85%	26 (78.8%)	25 (64.1%)	3 (21.4%)	
	85-95%	2 (6.1%)	2 (5.1%)	0 (0.0%)	
	>95%	3 (9.1%)	0 (0.0%)	0 (0.0%)	
		Twenty-four hours' dietary intake by children with ESRD classified based on SGNA			
Daily CHO	Mean ±SD	0.57±0.11	0.60±0.12	0.58±0.19	0.556 O
	Range	0.35-0.83	0.245-1	0.2-0.92	NS
Daily protein	Mean ±SD	0.18±0.14	0.14±0.04	0.17±0.05	0.281 O
	Range	0.08-0.919	0.07-0.23	0.07-0.25	NS
Daily fat	Mean ±SD	0.28±0.07	0.32±0.12	0.33±0.16	0.169 O
	Range	0.13-0.45	0.13-0.7	0.06-0.69	NS
Daily total calories	Mean ±SD	1340.0±426.29	1029.74±328.49	850.71±443.7	< 0.001 O ***
	Range	460-2145	300-1805	285-1805	

n: number of cases; SD: standard deviation; O: One way ANOVA test; K: Kruskal Wallis test; C: chi-square test; NS: not significant; ***: significant at p≤0.001; **: significant at p≤0.01; ***: significant at p≤0.001; †: more than 20% of cells have expected count of <5, TSFT: Triceps skin fold thickness, MAC: Mid-arm circumference, BMI: Body mass index, CHO: Carbohydrate

Discussion

In the present study, the use of pediatric SGNA revealed proportions of nutritional status that agree with Iyengar et al. with respect to proportion of moderately malnourished children; however, the proportion of severely malnourished children in current study were less than that reported in Iyengar et al. study. Nevertheless, when all children with malnourishment were taken into consideration, the proportion in this study will be 61.6% and in Iyengar et al. study is 73% indicating that the majority of children with ESRD on dialysis suffer malnutrition [10].

According to the International Pediatric Peritoneal Dialysis Network, among 1001 children receiving chronic peritoneal dialysis worldwide, the prevalence of undernutrition

(based on BMI z scores) was 8.9%, with a larger burden (20%) seen in South Asia [11]. A single reference tool is not yet available, and objective evaluation techniques for the diagnosis of malnutrition in children with CKD may be unreliable in the presence of edema and fluid overload [12,13]. Additionally, BMI as a measurement is unable to distinguish between subcutaneous fat loss and muscle withering. Due to the fact that this is also true for individuals with CKD, a combination of objective and subjective evaluations has been investigated. It is paradoxical that tests like the SGNA have been proven to be more reliable at predicting outcomes for adults receiving dialysis than tests that exclusively use objective measurements [14]. According to reports, children without CKD had a higher malnutrition burden diagnosed by SGNA than by objective anthropometry measures [15,16].

In the present study, we reported that uremic symptoms were more significantly associated with severe state of nutritional deficiency. In addition, we observed no significant difference in mean systolic or diastolic blood pressure among various stages of SGNA. According to Flynn et al. [17], "Thirty-seven percent of children with CKD had either elevated systolic or diastolic blood pressure" indicating that high blood pressure is evenly distributed among those children, thus, in this study it is not surprising to find no significant variation in mean blood pressure among children with ESRD when they were classified based on SGNA because most of those children already has high readings.

In the present study, it was observed that longer duration of dialysis was significantly associated with severe malnutrition state, but, the frequency of sessions and their duration were not associated with nutritional state. However, catheter type of access was associated with severe malnutrition probably because of high rate of infection in association with this kind of access. In a previous study, mean duration of dialysis was longer in children with severe nutritional deficiency state in comparison to children with moderate nutritional deficiency state but the level of significance was (p=0.054) [10] and this is very close to the significant level of (p=0.05). Therefore, we can suggest that longer duration of dialysis will be associated with significantly more deterioration of kidney function and thus worse nutritional status.

In this study, Kt/V mean was comparable among various stages of SGNA. In the study of Cano et al. [18], they found significant correlation between Kt/V and mean protein catabolic rate; however; this correlation is concerned with protein nutritional status and not overall nutritional status so it is difficult to compare our findings to their findings.

There was no significant difference in mean serum creatinine, calcium, phosphorus, albumin and total protein among various stages of SGNA in current study; however, mean serum PTH was significantly highest in severe state and mean hemoglobin level was significantly lowest in severe state. Both, hyperparathyroidism and anemia are well known complications of ESRD in children. Many patients treated with hemodialysis remain anemic despite exogenous erythropoietin therapy, suggesting the anemia experienced by these patients is multifactorial in etiology. Iron deficiency, infection, inflammation, and malnutrition have been implicated in this process. Additionally, secondary hyperparathyroidism has been associated with anemia in adults, but little data exists on this topic in children [19]. Our suggestion is that severe malnourishment contributes to anemia because of lack of essential elements for red blood cells construction and function, thus it is expected to found less hemoglobin level in ESRD children with severe malnutrition state, in addition, a state of hyperthyroidism was linked to anemia and thus higher level of PTH will be associated with anemia and anemia will affect the overall nutrition status of tissue leading to retardation of growth and development.

In this study, mean height, mean TSFT, mean MAC, mean dry weight and mean BMI showed significant variation with respect to states of SGNA and less than 5th percentile with respect to height for age, weight for age and BMI for age was more significantly associated with severe state of SGNA in comparison with

normal state and moderate state. Indeed, these findings were in accordance with the findings of Iyengar et al. [10]. Actually, very few researches have looked at how specific SGNA factors affect how children's nutritional status is classified as a whole. Physical evidence of muscle wasting, gastrointestinal symptoms, and metabolic stress were the three individual SGNA criteria in young children that most significantly predicted SGNA rating in non-CKD children who underwent thoracic or abdominal procedures. The SGNA rating was affected in older children by visible signs of fat wasting, repeated weight loss, gastrointestinal issues, and stunting [20].

In conclusion, malnutrition is an evident problem in pediatric patients on hemodialysis. Several factors contribute to the impairment of nutritional status of these children such as loss of appetite and inadequate intake of calories, severity of their chronic disease status, inflammation and metabolic derangement. Their physical parameters were also greatly affected due to their clinical condition. Using a comprehensive tool such as pediatric SGNAt, was more reflective of their nutritional status than when compared to other parameters such as body mass index or skin fold thickness as these may be affected by fluid retention giving false idea about the patient's condition, and it was significantly correlated with duration of dialysis, type of access, uremic symptoms, total daily caloric intake, anemia and hyperparathyroidism.

The main limitation of this study lies in the lack of new research studies regarding nutritional assessment in CKD patients especially in pediatrics, in Iraq and short duration for data collection period.

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Author contribution

Dr Rashid: Data collection, editing, study design and writing. Both Dr Ali and Dr Azat supervised the study, made the plan and participated in revision of results with interpretation.

Conflict of interest

None.

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