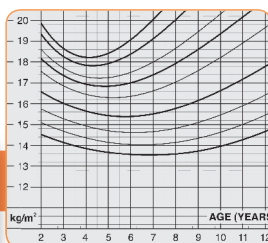


Nutritional Management

Children With Chronic Kidney Disease Stages 2 to 5 and 5D



National Kidney
Foundation®

KDOQI

Based on the KDOQI Clinical Practice
Guideline for Nutrition in Children
With CKD: 2008 Update

Overview

The number of children with CKD continues to increase.

Nutritional status can affect overall health and well-being.

Malnutrition, growth delay, and nutrition-related metabolic abnormalities are common and are associated with a greater risk of morbidity and mortality.

Nutritional care for children with CKD should be centered on the following goals:

- Maintenance of an optimal nutritional status
- Avoidance of uremic toxicity, metabolic abnormalities, and malnutrition
- Reduction of the risk of chronic morbidities and mortality in adulthood

Consider nutrition counseling based on an individualized assessment and plan of care for children and their caregivers (**R 3.1**).

Individualize nutritional intervention, according to (**R 3.2**):

- Results of the nutritional assessment
- Age
- Development
- Food preferences
- Cultural beliefs
- Psychosocial status

Frequent reevaluation and modification of the nutrition plan of care are suggested. More frequent review is indicated for children with (**R 3.3**):

- Advanced stages of CKD
- Relevant comorbidities influencing growth or nutrient intake, and evidence of inadequate intake or malnutrition, or
- Acute illness or adverse events that may negatively impact nutritional status

Nutritional management should be collaborative, involving the child, caregiver, dietitian, and other members of the pediatric nephrology team (**R 3.4**).

Coordinate nutritional management with a dietitian, ideally one who has expertise in children with CKD (**R 3.4**).

Evaluation of Growth and Nutritional Status

Recommendations for Children With CKD Stages 2 to 5 and 5D:

Evaluate nutritional status and growth on a periodic basis (**R 1.1**).

Consider the following parameters of nutritional status and growth in combination for evaluation (**R 1.2**):

- Dietary intake (3-day diet record or three 24-hour dietary recalls)
- Length- or height-for-age percentile or SDS. Use the following:
 - WHO Growth Standards from birth to 2 years
 - CDC growth reference charts after age 2
- Length or height velocity-for-age percentile or SDS
- Estimated dry weight and weight-for-age percentile or SDS
- BMI-for-height-age percentile or SDS
- Head circumference-for-age percentile or SDS (≤ 3 years old only)
- nPCR in adolescents receiving hemodialysis

Base the frequency of monitoring nutritional and growth parameters on the child's age and stage of CKD (**R 1.3**):

- Perform assessments at least twice as frequently as they would be performed in a healthy child of the same age.
- More frequent evaluation may be warranted in infants and children with:
 - Polyuria
 - Evidence of growth delay
 - Decreasing or low BMI
 - Comorbidities influencing growth or nutrient intake
 - Recent acute changes in medical status or dietary intake

Recommended Parameters and Frequency of Nutritional Assessment for Children With CKD Stages 2 to 5 and 5D

Measure	Minimum Interval (mo)									
	Age 0 to <1 y			Age 1-3 y			Age >3 y			
	CKD 2-3	CKD 4-5	CKD 5D	CKD 2-3	CKD 4-5	CKD 5D	CKD 2	CKD 3	CKD 4-5	CKD 5D
Dietary intake	0.5-3	0.5-3	0.5-2	1-3	1-3	1-3	6-12	6	3-4	3-4
Height or length-for-age percentile or SDS	0.5-1.5	0.5-1.5	0.5-1	1-3	1-2	1	3-6	3-6	1-3	1-3
Height or length velocity-for-age percentile or SDS	0.5-2	0.5-2	0.5-1	1-6	1-3	1-2	6	6	6	6
Estimated dry weight and weight-for-age percentile or SDS	0.5-1.5	0.5-1.5	0.25-1	1-3	1-2	0.5-1	3-6	3-6	1-3	1-3
BMI-for-height-age percentile or SDS	0.5-1.5	0.5-1.5	0.5-1	1-3	1-2	1	3-6	3-6	1-3	1-3
Head circumference-for-age percentile or SDS	0.5-1.5	0.5-1.5	0.5-1	1-3	1-2	1-2	N/A	N/A	N/A	N/A
nPCR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1*

Abbreviation: N/A, not applicable.

*Only applies to adolescents receiving HD.

GROWTH FAILURE

Recommendations to Manage Growth Failure in Children With CKD Stages 2 to 5 and 5D:

Identify and treat existing nutritional deficiencies and metabolic abnormalities in children with CKD, short stature*, and potential for linear growth (**R 2.1**). Factors contributing to poor growth include:

- Inadequate protein and calorie intake
- Polyuric and salt-wasting conditions
- Metabolic acidosis
- Renal osteodystrophy
- Resistance to hormones mediating growth

Correct serum bicarbonate level to at least the lower limit of normal (22 mmol/L) (**R 2.2**).

Consider rhGH therapy in children with (**R 2.3**):

- Short stature*, and
- Potential for linear growth if growth failure[†] persists beyond 3 months despite treatment of nutritional deficiencies and metabolic abnormalities

*Short stature: Height SDS < -1.88 or height-for-age < 3 rd percentile

[†]Growth failure: Height velocity-for-age SDS < -1.88 or height velocity-for-age < 3 rd percentile

Energy Requirements

Poor energy intake is common in children with CKD due to reduced appetite and vomiting.

Children with excessive energy intake are at risk for short- and long-term complications associated with being overweight or obese.

National registry data for pediatric dialysis or transplant patients showed a significantly higher mortality rate at the upper and lower extremes of BMI-for-age.

Recommendations for Children With CKD Stages 2 to 5 and 5D:

Consider energy requirements for children with CKD to be 100% of the EER for chronological age, individually adjusted for PAL and body size (ie, BMI) (R 4.1).

- Further adjustment to energy intake is suggested based upon the response in rate of weight gain or loss (R 4.1).

Consider supplemental nutritional support when (R 4.2):

- The usual intake of a child fails to meet his or her energy requirements, and
- The child is not achieving expected rates of weight gain and/or growth for age.

Consider oral intake of an energy-dense diet and commercial nutritional supplements as the preferred route for supplemental nutritional support (R 4.3).

- Consider tube feeding when energy requirements cannot be met with oral supplementation.
- Energy-dense foods may be needed in children with CKD stage 5 with oligoanuria.

Possible factors affecting poor appetite include:

- Thirst for water rather than food in those with polyuric CKD
 - Administration of multiple unpleasant medications
- Preference for salty rather than energy-dense sweetened foods
- Accumulation of appetite-regulating cytokines and hormones
 - Gastroesophageal reflux
 - Disordered gastric motility
 - Delayed gastric emptying

CVD is the leading cause of morbidity and mortality in the pediatric CKD population, accounting for ~25% of total deaths (a rate 1000 times higher than the national pediatric CVD death rate).

Consider a trial of IDPN to augment inadequate nutritional intake for malnourished children (BMI-for-height-age <5th percentile) receiving maintenance HD who are unable to meet their nutritional requirements through oral and tube feeding (R 4.4).

- IDPN should not be promoted as a sole nutrition source; it should be used to augment other sources.

Balance calories from carbohydrate and unsaturated fats within the physiological ranges recommended as the AMDR of the DRI when prescribing oral, enteral, or parenteral energy supplementation (R 4.5).

- Uneven distribution of calories from each macronutrient may be associated with increased risk of CHD, obesity, and diabetes.
- Atherogenic dyslipidemia occurs in CKD stage 3 and increases in prevalence as kidney function deteriorates.

Encourage dietary and lifestyle changes to achieve weight control in overweight or obese children with CKD (R 4.6).

Acceptable Macronutrient Distribution Ranges

Macronutrient	Children 1–4 y	Children 4–18 y
Carbohydrate	45%–65%	45%–65%
Fat	30%–40%	25%–35%
Protein	5%–20%	10%–30%

Vitamins and Trace Elements

Patients with CKD and those on dialysis therapy are at risk of vitamin and mineral deficiencies as a result of abnormal renal metabolism, inadequate intake/poor gastrointestinal absorption, and dialysis-related losses.

Recommendations for Children With CKD Stages 2 to 5 and 5D

Consider the provision of a dietary intake consisting of at least 100% of the DRI for thiamin (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), biotin (B8), cobalamin (B12), ascorbic acid (C), retinol (A), α -tocopherol (E), vitamin K, folic acid, copper, and zinc (R 6.1).

It is suggested to provide supplementation of vitamins and trace elements to children with CKD stages 2 to 5 if dietary intake alone does not meet 100% of the DRI or if clinical evidence of a deficiency, possibly confirmed by low blood levels of the vitamin or trace element, is present (R 6.2).

It is suggested that children with CKD stage 5D receive a water-soluble vitamin supplement, with the exception of children with healthy appetites for a variety of nutritious foods and children receiving most or all of their energy requirements from adult renal formulas (R 6.3).

Dietary Reference Intake: Recommended Dietary Allowance and Adequate Intake

	Infants 0-6 mo	Infants 7-12 mo	Children 1-3 y	Children 4-8 y	Males 9-13 y	Males 14-18 y	Females 9-13 y	Females 14-18 y
Vitamin A (μ g/d)	400	500	300	400	600	900	600	700
Vitamin C (mg/d)	40	50	15	25	45	75	45	65
Vitamin E (mg/d)	4	5	6	7	11	15	11	15
Vitamin K (μ g/d)	2.0	2.5	30	55	60	75	60	75
Thiamin (mg/d)	0.2	0.3	0.5	0.6	0.9	1.2	0.9	1.0
Riboflavin (mg/d)	0.3	0.4	0.5	0.6	0.9	1.3	0.9	1.0
Niacin (mg/d; NE)	2*	4	6	8	12	16	12	14
Vitamin B ₆ (mg/d)	0.1	0.3	0.5	0.6	1.0	1.3	1.0	1.2
Folate (μ g/d)	65	80	150	200	300	400	300	400
Vitamin B ₁₂ (μ g/d)	0.4	0.5	0.9	1.2	1.8	2.4	1.8	2.4
Pantothenic Acid (mg/d)	1.7	1.8	2	3	4	5	4	5
Biotin (μ g/d)	5	6	8	12	20	25	20	25
Copper (μ g/d)	200	220	340	440	700	890	700	890
Selenium (μ g/d)	15	20	20	30	40	55	40	55
Zinc (mg/d)	2	3	3	5	8	11	8	9

Note: RDAs are in bold type; AIs are in ordinary type. *As preformed niacin, not niacin equivalents (NE) for this age group.

Protein Requirements

Suggested Dietary Protein Intake for Children With CKD Stages 3 to 5 and 5D (R 5.1):

- CKD stage 3: 100%–140% of the DRI for ideal body weight
- CKD stages 4 to 5: 100%–120% of the DRI for ideal body weight
- CKD stage 5D: 100% of the DRI for ideal body weight, plus an allowance for dialytic protein and amino acid losses (R 5.2).

These requirements refer to a stable child and assume that energy intake meets 100% of estimated requirements.

Modified protein requirements may be needed in children with proteinuria, those who are obese or stunted, on dialysis, during and after peritonitis episodes, and during recovery from intercurrent illness.

Recommended Dietary Protein Intake in Children with CKD Stages 3 to 5 and 5D

DRI

Age	DRI				
	DRI (g/kg/d)	Recommended for CKD Stage 3 (g/kg/d) (100%-140% DRI)	Recommended for CKD Stages 4-5 (g/kg/d) (100%-120% DRI)	Recommended for HD (g/kg/d)*	Recommended for PD (g/kg/d)†
0-6 mo	1.5	1.5-2.1	1.5-1.8	1.6	1.8
7-12 mo	1.2	1.2-1.7	1.2-1.5	1.3	1.5
1-3 y	1.05	1.05-1.5	1.05-1.25	1.15	1.3
4-13 y	0.95	0.95-1.35	0.95-1.15	1.05	1.1
14-18 y	0.85	0.85-1.2	0.85-1.05	0.95	1.0

*DRI + 0.1 g/kg/d to compensate for dialytic losses.

†DRI + 0.15-0.3 g/kg/d depending on patient age to compensate for peritoneal losses.

Consider using protein supplements to augment inadequate oral and/or enteral protein intake when children with CKD stages 2 to 5 and 5D are unable to meet their protein requirements through food and fluids alone (R 5.3).

Possible Signs of Inadequate Protein Intake:

- Abnormally low serum urea nitrogen levels
- Undesirable downward trend in nPCR for adolescents on HD therapy, and/or
- Documentation of low protein intake using food records, food questionnaires, or diet recall

Strategies to Supplement Protein Intake:

- Add powdered protein modules to expressed breast milk, infant formula, beverages, pureed foods, or other moist foods.
- Add minced or chopped meat, chicken, fish, egg, tofu, or skim milk powder to soups, pasta, or casseroles.
- Oral or enteral liquid protein-rich renal supplements

Average Ratio of Phosphorus to Protein Content in Various Protein-Rich Foods

Food Category	Ratio of mg Phosphorus to g Protein	Ratio Adjusted for Digestion/Absorption
Egg white	1.4	1
Meat	9	6
Tofu	12	7
Egg	14	10
Legumes	17	10
Lentils	20	12
Nuts	25	15
Milk	29	21
Seeds	50	29

Note: Mathematical estimations based on protein digestibility-corrected amino acid scores (PDCAA) and data on estimated phosphorus bioavailability.

Although there is no evidence for a nephroprotective effect of dietary protein restriction, the growing evidence for a major impact of phosphorus overload on cardiovascular morbidity in children and adults with CKD provides a rationale to avoid excessive protein intake in this population.

At a given level of quantitative protein intake, the phosphorus content and bioavailability of the protein sources, the quality of protein, and the metabolic environment are important additional factors to consider in the dietary protein prescription.

Bone Health

Calcium

Insufficient calcium supply may cause deficient mineralization of the skeleton. Calcium overload may be associated with severe vascular morbidity and soft-tissue calcifications.

Recommendations for Children With CKD Stages 2 to 5 and 5D:

It is suggested the total oral and/or enteral calcium intake from nutritional sources and phosphate binders be in the range of 100%–200% of the DRI for calcium for age (**R 7.1.1**).

To avoid the critical accumulation of calcium, oligoanuric children on dialysis therapy may require a further reduction in total oral and enteral calcium intake from nutritional sources and phosphate binders.

Recommended Calcium Intake for Children With CKD Stages 2 to 5 and 5D

Age	DRI	Upper Limit (for healthy children)	Upper Limit for CKD Stages 2-5, 5D (Dietary + Phosphate Binders*)
0-6 mo	210	ND	≤420
7-12 mo	270	ND	≤540
1-3 y	500	2,500	≤1,000
4-8 y	800	2,500	≤1,600
9-18 y	1,300	2,500	≤2,500

Abbreviation: ND, not determined.

*Determined as 200% of the DRI, to a maximum of 2,500 mg elemental calcium.

Methods to improve low oral and/or enteral calcium intake and absorption include:

- Increased consumption of calcium-rich and/or calcium-fortified foods or tube feedings
- Supplementation with calcium containing pharmacological agents between meals or bolus tube feedings
- Use of calcium-containing phosphorus binders for managing hyperphosphatemia
- Supplementation with vitamin D

Vitamin D

Recent clinical evidence suggests a high prevalence of vitamin D insufficiency in children with CKD.

Reasons for the high prevalence of low vitamin D levels in patients with CKD include:

- Sedentary lifestyle with reduced exposure to sunlight
- Limited ingestion of foods rich in vitamin D
- Reduced endogenous synthesis of vitamin D₃ in the skin of patients with uremia
- Urinary losses of 25(OH)D and vitamin D-binding protein in nephrotic patients

Measure serum 25-hydroxyvitamin D levels once per year in children with CKD (**R 7.2.1**).

Supplementation with vitamin D₂ (ergocalciferol) or vitamin D₃ (cholecalciferol) is suggested if the serum level of 25-hydroxyvitamin D is less than 30 ng/mL (75 nmol/L) (**R 7.2.2**).

In the repletion phase, it is suggested that serum levels of corrected total calcium and phosphorus be measured at 1 month following initiation or change in dose of vitamin D and at least every 3 months thereafter (**R 7.2.3**).

When patients are replete with vitamin D, it is suggested to supplement vitamin D continuously and to monitor serum levels of 25-hydroxyvitamin D yearly (**R 7.2.4**).

Phosphorus

Evidence suggests that moderate dietary phosphate restriction is beneficial with respect to the prevention and treatment of hyperparathyroidism and safe with respect to growth, nutrition, and bone mineralization. The dietary prescription should aim at minimizing phosphate intake while ensuring an adequate protein intake.

Multiple pitfalls, including the physical and psychological challenge of the phosphate binder pill burden, inadvertent consumption of food containing phosphate additives, and nonadherence in older children and adolescents, may result in inefficient lowering of serum phosphorus levels.

Conversely, overrestriction may lead to signs of phosphate deficiency, particularly in young infants.

Recommendations for Children With CKD Stages 2 to 5 and 5D:

Consider reducing dietary phosphorus intake to 100% of the DRI for age (**R 7.3.1**):

- When the serum PTH concentration is above the target range for CKD stage, and
- When the serum phosphorus concentration is within the normal reference range for age

Consider reducing dietary phosphorus intake to 80% of the DRI for age (**R 7.3.2**):

- When the serum PTH concentration is above the target range for CKD stage, and
- When the serum phosphorus concentration exceeds the normal reference range for age

After initiation of dietary phosphorus restriction, monitor the serum phosphorus concentration (**R 7.3.3**):

- At least every 3 months in children with CKD stages 3 to 4
- Monthly in children with CKD stages 5 and 5D

In all CKD stages, it is suggested to avoid serum phosphorus concentrations both above and below the normal reference range for age (**R 7.3.3**).

Age-Specific Normal Ranges of Serum Phosphorus

Age	Serum Phosphorus (mg/dL)
0–5 mo	5.2–8.4
6–12 mo	5.0–7.8
1–5 y	4.5–6.5
6–12 y	3.6–5.8
13–20 y	2.3–4.5

Conversion factor for phosphorus:
mg/dL x 0.323 = mmol/L

Recommended Maximum Oral and/or Enteral Phosphorus Intake for Children With CKD

Age	DRI (mg/d)	High PTH and Normal Phosphorus*	High PTH and High Phosphorus†
0-6 mo	100	≤100	≤80
7-12 mo	275	≤275	≤220
1-3 y	460	≤460	≤370
4-8 y	500	≤500	≤400
9-18 y	1,250	≤1,250	≤1,000

* ≤100% of the DRI † ≤80% of the DRI

Target Range of Serum PTH by Stage of CKD

CKD Stage	GFR Range (mL/min/1.73m ²)	Target Serum PTH (pg/mL)
3	30-59	35-70
4	15-29	70-110
5, 5D	<15	200-300

Fluid and Electrolyte Requirements

Fluid and electrolyte requirements of individual children vary according to their primary kidney-disease, degree of residual kidney function, and method of kidney replacement therapy.

Recommendations for Children With CKD Stages 2 to 5 and 5D:

Sodium

Consider supplemental free water and sodium supplements for children with CKD and polyuria to avoid chronic intravascular depletion and to promote optimal growth (R 8.1).

- Infants and children with obstructive uropathy or renal dysplasia have polyuria, polydypsia, difficulty conserving sodium chloride and develop a salt-wasting state, requiring salt supplementation.

Consider sodium supplements for all infants on PD therapy (R 8.2).

- Infants on PD therapy are predisposed to substantial sodium losses, even when anuric, because ultrafiltration removes significant amounts of sodium chloride that cannot be replaced through breast milk or standard commercial infant formulas.

Restrict sodium intake for children with CKD who have hypertension (systolic and/or diastolic blood pressure ≥ 95 th percentile) or prehypertension (systolic and/or diastolic blood pressure ≥ 90 th percentile and < 95 th percentile) (R 8.3).

- Severe hypertension increases risk of hypertensive encephalopathy, seizures, cerebrovascular events, congestive heart failure, and progression of CKD.
- Modest dietary sodium restriction has been demonstrated to reduce blood pressure in hypertensive children without CKD.
- In dialysis patients, restricting sodium intake is essential to volume and blood pressure control.

Tips to reduce sodium intake include:

- Consuming fresh foods instead of processed and canned foods
- Reading food labels to identify those foods containing no more than 170–280 mg of sodium, or 6%–10% of the sodium DV
- Reducing salt added to foods; in cooking, substituting fresh herbs and spices to flavor foods
- Minimizing intake of fast foods

Fluids

Restrict fluid intake in children with CKD stages 3 to 5 and 5D who are oligoanuric to prevent the complications of fluid overload (R 8.4).

- Concurrent fluid and sodium restriction is needed to overcome thirst.

Daily fluid restriction = insensible fluid losses + urine output + amount to replace additional losses (eg, vomiting, diarrhea, enterostomy output) - amount to be defecited

Age Group	Insensible Fluid Losses	Fluid Loss
Preterm infants		40 mL/kg/d
Neonates		20–30 mL/kg/d
Children and adolescents		20 mL/kg/d or 400 mL/m ²

Potassium

Limit potassium intake for children with CKD who have or are at risk of hyperkalemia (R 8.5).

- The nutrition facts panel on food labels is not required to list potassium, but may provide potassium content as actual amount (mg) and % DV:
- Foods low in potassium: < 100 mg or $< 3\%$ DV
- Foods high in potassium: > 200 to 250 mg or $> 6\%$ DV

Children can lower potassium intake by restricting foods such as bananas, oranges, potatoes, potato chips, tomato products, legumes, lentils, yogurt, and chocolate, and by avoiding potassium-containing salt substitutes.

Children on PD or frequent HD therapy (ie, > 5 sessions/wk) rarely need dietary potassium restriction and may actually develop hypokalemia.

Non-dietary causes of hyperkalemia:

- Hemolysis
- Metabolic acidosis
- Constipation
- Medications (ie, ACEIs, ARBs, NSAIDs and potassium-sparing diuretics)
- Tissue destruction due to catabolism, infection, surgery, or chemotherapy
- Inadequate dialysis

Abbreviations:

ACEI	Angiotensin-converting enzyme inhibitor
AMDR	Acceptable macronutrient distribution ranges
ARB	Angiotensin-receptor blocker
BMI	Body mass index
CDC	Centers for Disease Control and Prevention
CHD	Coronary heart disease
CKD	Chronic kidney disease
D	Dialysis
DRI	Dietary reference intake
DV	Daily value
EER	Estimated energy requirement
HD	Hemodialysis
IDPN	Intradialytic parenteral nutrition
nPCR	Normalized protein catabolic rate
NSAID	Nonsteroidal anti-inflammatory drugs
PAL	Physical activity level
PD	Peritoneal dialysis
PTH	Parathyroid hormone
R	Recommendation
rhGH	Recombinant human growth hormone
SDS	Standard deviation score
UL	Tolerable upper intake level
WHO	World Health Organization

Reference:

National Kidney Foundation. KDOQI clinical practice guideline for nutrition in children with CKD: 2008 update. *Am J Kidney Dis.* 2009;53(suppl 2):S1-S124.

Notice:**SECTION I: USE OF THE CLINICAL PRACTICE GUIDELINE**

This Clinical Practice Guideline document is based upon the best information available at the time of publication. It is designed to provide information and assist decision-making. It is not intended to define a standard of care and should not be construed as one, nor should it be interpreted as prescribing an exclusive course of management. Variations in practice will inevitably and appropriately occur when clinicians take into account the needs of individual patients, available resources, and limitations unique to an institution or a type of practice. Every health care professional making use of these recommendations is responsible for evaluating the appropriateness of applying them in the setting of any particular clinical situation.

SECTION II: DISCLOSURE

The National Kidney Foundation (NKF) makes every effort to avoid any actual or reasonably perceived conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the Work Group. All members of the Work Group are required to complete, sign, and submit a disclosure and attestation form showing all such relationships that might be perceived as actual conflicts of interest.



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