

NKD
national kidney diet

Professional Guide

Third Edition

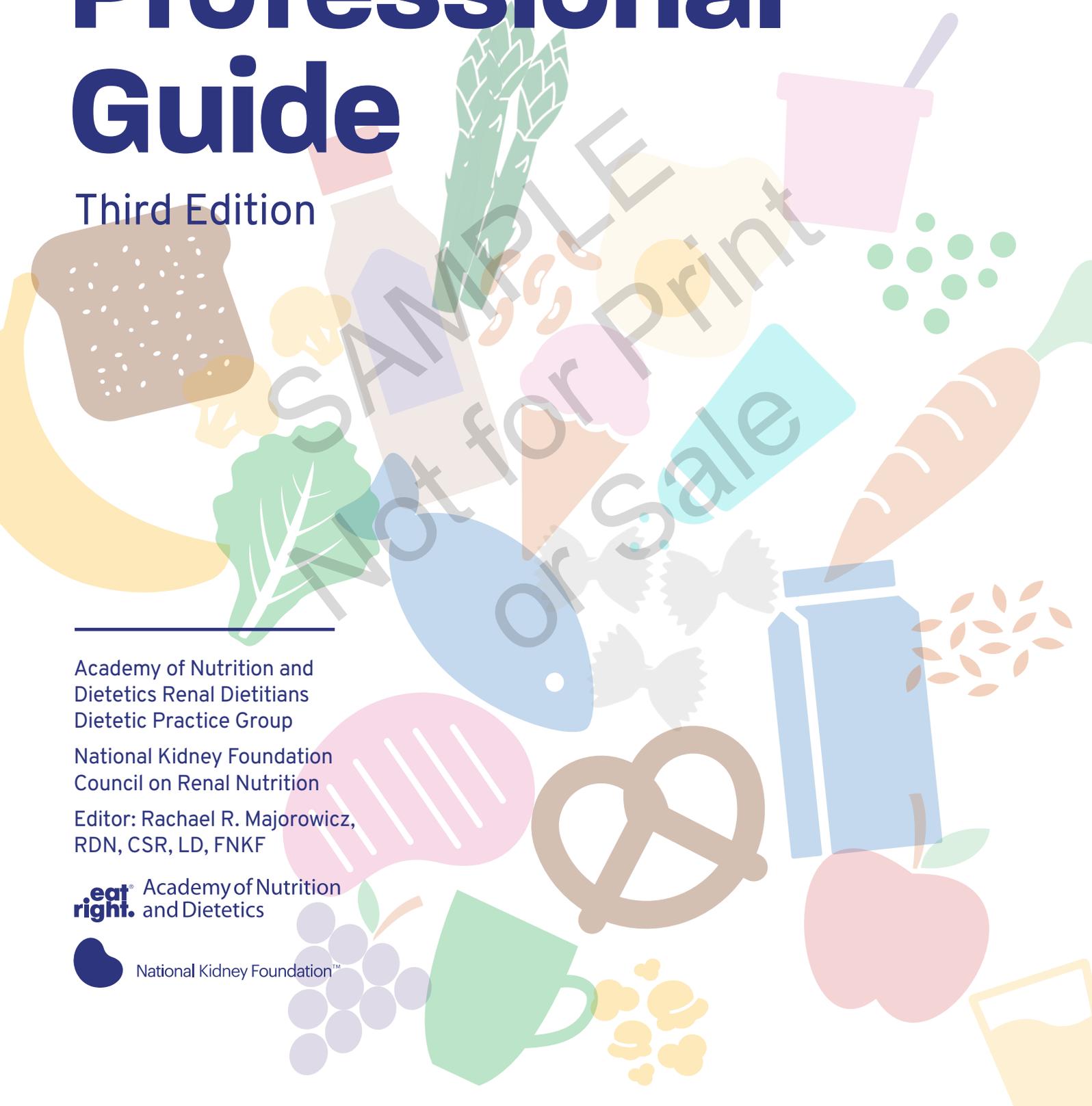
Academy of Nutrition and
Dietetics Renal Dietitians
Dietetic Practice Group

National Kidney Foundation
Council on Renal Nutrition

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 National Kidney Foundation™



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National Kidney Diet Professional Guide, Third Edition

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Preface

The third edition of the *National Kidney Diet Professional Guide* comes 30 years after it was first published in 1993. Renamed from the *National Renal Diet*, this new edition builds upon the solid foundation of the previous editions to address the ongoing need for practical guidance and patient education materials in the evolving world of nephrology nutrition.

This reference is the fruit of countless hours spent by experienced renal dietitians, beginning in 2015, as a joint collaboration of the National Kidney Foundation Council on Renal Nutrition and the Academy of Nutrition and Dietetics Renal Dietitians Dietetic Practice Group. It is designed to assist the registered dietitian nutritionist in assessing, diagnosing, and managing the nutrition care of patients with chronic kidney disease (CKD), both on dialysis and not on dialysis, based on the updated 2020 Kidney Disease Outcomes Quality Initiative (KDOQI) nutrition guidelines, as well as more recent literature. A significant focus of this guide is on patient education and ongoing monitoring. In updating this edition, the authors, editors, and reviewers worked diligently to ensure that the professional guide not only includes the most current research but is also a tool that practitioners can use in a practical and meaningful way.

The previous *National Renal Diet Healthy Food Guide* booklets have been completely revamped and updated as separate patient education handouts covering topics such as nutrition for CKD, dialysis nutrition, potassium, phosphorus, protein, and food label reading, among others. This format allows for more options in customizing patient education. In response to the burgeoning landscape of telehealth, the accompanying patient education material is now available in downloadable form in English and Spanish.

We hope that you find the third edition of the *National Kidney Diet Professional Guide* and the accompanying patient education handouts a welcome addition to your education library.

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Rachael R. Majorowicz, RDN, CSR, LD, FNKF
Editor

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Introduction



Chronic kidney disease (CKD) is widespread in the United States; approximately 37 million Americans live with CKD.¹ Kidney disease can arise from a variety of etiologies, such as polycystic kidney disease, nonsteroidal anti-inflammatory drug use, lupus, contrast dye, and glomerular diseases. The leading causes of CKD are diabetes mellitus (DM) and hypertension (HTN).

Experts estimate that only 12% of those with HTN and DM are aware that they have CKD.¹ Health professionals have emphasized disease prevention in recent years, resulting in a 2019 Executive Order on Advancing American Kidney Health aimed to increase CKD awareness and encourage preventive measures to help slow CKD progression to end stage kidney disease. Registered dietitian nutritionists (RDNs) play a key role in providing education on preventative measures to help slow disease progression and should be well informed on nutritional considerations for those noted with a decline in kidney function.

Medical nutrition therapy (MNT) is an essential component in managing CKD. MNT can help prevent CKD progression and assist in preventing complications that can arise, such as mineral and bone disorders, dyskalemia, metabolic acidosis, and malnutrition, within any stage of CKD.² See Table 1 for the stages of CKD based on glomerular filtration rate.³

TABLE 1 Stages of Chronic Kidney Disease³

| Stage | Glomerular filtration rate (mL/min/1.73 m ²) | Description |
|-------|--|---|
| 1 | ≥90 | Kidney damage with normal or increased glomerular filtration rate (GFR) |
| 2 | 60-89 | Mild decrease in GFR |
| 3a | 45-59 | Moderate decrease in GFR |
| 3b | 30-44 | Moderate-to-severe decrease in GFR |
| 4 | 15-29 | Severe decrease in GFR |
| 5 | <15 | Kidney failure |

How to Use the *National Kidney Diet Professional Guide* and Handouts

Chapter 1 provides the foundational patient-education lens through which we recommend remaining chapters to be viewed. Please make time to read and refer to this chapter often. Chapter 2 presents an overview of crucial nutrients to assess for all stages of CKD. Chapters 3 through 5 provide further details on the management of each specific stage of CKD including in-center and home dialysis. The Summary of Changes sections that close out these chapters provide a concise list of updates to previous practice guidelines. Chapters 6 and 7 cover special topics including renal transplant nutrition and diabetes and CKD comanagement. Finally, additional information is provided on renal supportive care, nutrition diagnosis terminology, and insurance coverage and reimbursement related to CKD.

Customers who purchase this title will also receive an email giving them access to several downloadable patient education materials that have been developed to allow individualized education for each patient and are available in both English and Spanish. These handouts align with the updated 2020 Kidney Disease Outcomes Quality Initiative (KDOQI) nutrition guidelines and are tailored with positive messaging that teaches patients about healthy foods that they can enjoy while meeting their nutrition needs for kidney disease. These handouts are previewed on pages 100 to 102 of this book.

Additional National Kidney Diet patient education materials available from the Academy of Nutrition and Dietetics (www.eatrightSTORE.org) include *Dish Up a Kidney-Friendly Meal For Patients with Chronic Kidney Disease (Not on Dialysis)* and *Dish Up a Dialysis-Friendly Meal for Patients with Chronic Kidney Disease on Dialysis*. These two placemat-sized, double-sided tearpads offer patient-friendly meal-planning advice, practical nutrition tips, positive messaging, and extensive lists of foods offering greater variety for patients.

Downloadable patient education handouts included with the professional guide:

- **Nutrition Tips for Chronic Kidney Disease (for People Not on Dialysis)** provides an overview of information on diet for people with CKD and is a great starting point when educating new patients.
- **Nutrition for Dialysis** provides a summary of tips that address the specific nutrition needs of people on dialysis.
- **The Food Label and Chronic Kidney Disease** addresses each section of the Nutrition Facts label as it relates to CKD and includes tips for identifying sodium, potassium, and phosphorus.
- **Grocery Guide for Kidney Disease** includes a list of foods appropriate for patients with CKD.
- **Lower and Higher Potassium Fruits and Vegetables** offers colorful pictorial lists of low- and high-potassium fruits and vegetables.
- **Taking Control of Phosphorus** presents in-depth instructions on reading food labels for phosphorus, lists of high phosphorus foods, and appropriate substitutes.
- **Your New Protein Needs (for People Not on Dialysis)** reviews animal vs plant-based protein sources, approximate protein content of common foods, and label-reading instructions.
- **Resources for Patients With Chronic Kidney Disease** provides information on how to find a kidney-friendly RDN, as well as resources directing the reader to CKD-appropriate recipes, educational websites, and smartphone apps.

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Chapter 2

Assessment of Nutrient Needs in Chronic Kidney Disease



Chapter 2 provides an overview of crucial nutrients and their recommendations in all stages of chronic kidney disease (CKD). Table 2.1 presents a summary of nutrition needs across the stages of CKD.^{1,2} The subsequent chapters provide further details specific to the management and treatment of each stage of CKD.

TABLE 2.1 Nutrient Recommendations for Chronic Kidney Disease^{1,2}

| Nutrient | CKD stages 1-5 | In-center dialysis | Home dialysis |
|----------|--|--------------------|--|
| Energy | 25-35 kcal/kg LPD and VLPD may need at least 30 kcal/kg | 25-35 kcal/kg | PD: 25-35 kcal/kg minus kcal from the dialysate SDHD and NHD: 25-35 kcal/kg |
| Protein | CKD 1-2 (GFR >60): 0.8 g/kg CKD 3-5 with DM: 0.6-0.8 g/kg CKD 3-5 without DM: <ul style="list-style-type: none">• LPD 0.55-0.6 g/kg (GFR <60) or• VLPD 0.28-0.43g/kg + KA (GFR <20) | 1.0-1.2 g/kg | |
| Sodium | <2,300 mg/d or <100 mmol/d | | |

| Nutrient | CKD stages 1-5 | In-center dialysis | Home dialysis |
|------------|--|--|---|
| Potassium | Individualized to maintain serum levels within goal range. Assess and correct nondietary causes while determining the need to adjust dietary potassium intake. | | |
| Phosphorus | Individualized to maintain serum levels within goal range. Consider the bioavailability of phosphorus sources. | <p>PD and SDHD: Same as earlier CKD stages.</p> <p>NHD: Usually not restricted; may need to be supplemented.</p> | |
| Calcium | 800-1,000 mg/d or 20-25 mmol/d, if not taking active vitamin D analogs. | Adjust calcium intake (dietary calcium, calcium supplements, or calcium-based binders) with consideration of concurrent use of vitamin D analogs and calcimimetics to avoid hypercalcemia or calcium overload. | |
| Vitamin D | <p>Consider vitamin D2 or D3 supplement to correct 25(OH)D insufficiency or deficiency.</p> <p>For nephrotic range proteinuria, it is reasonable to consider supplementation of vitamin D.</p> | Consider vitamin D2 or D3 supplement to correct insufficient or deficient levels. | |
| Fluid | Individualized based on fluid status. | 500-1,000 mL/d plus urine output (1,000 mL/d minimum). | <p>PD: Maintain fluid balance and minimize dextrose as needed.</p> <p>SDHD and NHD: Monitor blood pressure and weight and adjust as needed.</p> |

Abbreviations: 25(OH)D = 25-hydroxyvitamin D | CKD = chronic kidney disease | DM = diabetes mellitus | GFR = glomerular filtration rate | KA = ketoacid analog | LPD = low-protein diet | NHD = nocturnal hemodialysis | PD = peritoneal dialysis | SDHD = short daily hemodialysis | VLPD = very low-protein diet

Energy

Energy sustains body functions including metabolism, protein synthesis, physical activity, circulation, and immune function. Energy is supplied by dietary protein, carbohydrates, and fats. Consider energy intake and expenditure when determining energy balance. Factors affecting energy management include age, sex, body composition, physical activity, and health requirements for wellness or healing. Understanding the patient's daily energy needs is an important first step in adopting a realistic nutrition and activity plan.

Accurately assessing energy needs in individuals with CKD is essential to keep the patient well-nourished and provide the best outcomes. Clinicians should assess weight status, physical activity, body composition, CKD staging, overall nutritional status, age, other comorbidities, and whether a low-protein diet (LPD) or very low-protein diet (VLPD) should be considered when estimating energy needs.

TIP Refer to Table 2.1 and the appropriate chapter to determine the energy needs for each stage of CKD.

Malnutrition is a common condition affecting those with progressive CKD. However, the clinical presentation in some individuals with CKD goes beyond what is typically seen from a mere deprivation of energy or protein. Individuals with CKD experience not only weight loss but often a profound loss (ie, wasting) of the body's protein mass and fuel stores in the setting of chronic inflammation accompanied by consequences of uremia. This condition has been labeled protein-energy wasting (PEW).³

The International Society of Renal Nutrition and Metabolism has established criteria for the diagnosis of PEW. On at least three occasions, spaced 2 to 4 weeks apart, a patient must exhibit findings in three of the four criteria listed in Box 2.1.⁴ At least one of the findings in each category must be present to receive a diagnosis of kidney disease-related PEW.

Protein

In CKD stages 1 and 2, protein needs are the same as in the general population, around 0.8 g/kg, and should be individualized based on nutritional status and

BOX 2.1 Diagnostic Criteria for Protein-Energy Wasting⁴

| Criteria | Category findings |
|-----------------------|---|
| BMI | BMI <23 Total body fat percentage <10% Unintentional weight loss over time (>5% over 3 months or >10% over 6 months) |
| Serum levels | Albumin <3.8 g/dL (bromocresol green)—not valid if low due to urinary or gastrointestinal protein loss, liver disease, or use of cholesterol-lowering medication Transthyretin (prealbumin) <30 mg/dL for patients on dialysis Cholesterol <100 mg/dL |
| Muscle mass | 5% decrease in muscle mass over 3 months or 10% decrease over 6 months Midarm muscle circumference area >10% below the 50th percentile for reference population Creatinine appearance |
| Dietary intake | Unintentional low protein intake: <0.8 g/kg (dialysis) or <0.6 g/kg (chronic kidney disease stages 2 through 5) for ≥2 months Unintentional low energy intake: <25 kcal/kg for ≥2 months |

lifestyle factors. The kidneys are still able to adequately filter most nutrients and end products of protein metabolism.

As kidney function declines to stage 3, excessive protein intake should be discouraged and a low-protein diet considered when appropriate to help delay kidney disease progression and improve outcomes. In CKD stages 4 and 5, a very low-protein diet with ketoacid analogs can also be considered in stable and well-nourished individuals to delay progression to dialysis.

Protein needs in end stage kidney disease (ESKD) on dialysis are considerably higher than earlier stages of kidney disease due to protein losses during the dialysis process and greater protein catabolism.

TIP

Refer to Table 2.1 and the appropriate chapter to determine the protein needs for each stage of CKD.

Sodium

Sodium, along with chloride, is a principal ion in the extracellular compartment, including blood plasma, interstitial fluid, and transcellular fluid (cerebrospinal fluid and joint fluid).⁵ Together, sodium and chloride are responsible for maintaining the balance of water in and around cells, proper nerve and muscle function, and maintenance of stable blood pressure. The body obtains sodium through ingesting food and beverages and loses sodium through sweat and urine. In healthy adults, the kidneys maintain sodium homeostasis by adjusting the amount excreted in urine. When sodium balance is disturbed, either through dietary intake or decline in kidney function, the total amount of sodium in the body is affected.

Individuals with CKD typically have higher blood pressure than individuals with normal kidney function. Individuals with CKD may be particularly sensitive to high salt intake, with increased blood pressure that may be explained by the reduction in the ability to excrete the sodium load due to decline in kidney function. Providing education on reducing sodium intake in those with CKD has the potential to lower blood pressure, improve cardiovascular disease, decrease fluid volume overload, reduce endothelial damage, improve proteinuria, reduce inflammation, and delay CKD progression.¹

TIP

Individuals with CKD or with proteinuria should avoid excessive sodium intake, with a daily goal of less than 2,300 mg/d or 100 mmol/d.

Potassium

Potassium is the most abundant intracellular cation in the body and plays a major role in nerve transmission, muscle contraction, blood pressure regulation, and vascular tone. Adequate potassium intake is important for the prevention of kidney stones, bone health, insulin regulation, and blood pressure control.⁶

The kidneys play a crucial role in maintaining serum potassium within nor-

mal range and are very efficient in handling large loads of potassium. Even with reductions in kidney function, serum potassium levels can remain within normal limits. As kidney disease progresses, patients are more likely to see issues arise with hyperkalemia, with the greatest risk typically starting around CKD stage 4.⁷ Experts recommend not to restrict dietary potassium intake unless there is hyperkalemia.

When assessing serum potassium levels, it is helpful to look at trends, if available, and not just the current value. Trends will help the practitioner identify if laboratory values are stable, are improving, or need intervention for potassium management. Other potential causes of hyperkalemia—medications, recent illness or surgery, glycemic control, hydration, bowel issues (eg, constipation or gastrointestinal bleed), changes in dietary intake, metabolic acidosis, catabolic state, dialysate potassium, or difficulty with blood draw—should be considered and corrected when determining dietary intervention.

When treating hyperkalemia, assess and correct nondietary causes while determining the need to adjust dietary potassium intake to maintain serum levels within goal range. Refer to the appropriate chapter to determine the potassium needs for each individual. See the patient education materials on the Lower and Higher Potassium Fruit and Vegetables, The Food Label and Chronic Kidney Disease, Nutrition for Dialysis, and Grocery Guide for Kidney Disease.

TIP

Protein and Potassium

Registered dietitian nutritionists (RDNs) can educate patients on specific protein goals and explain the importance of avoiding excessive protein intake to keep dietary potassium levels within a normal range. The benefits of including plant-based proteins for those with CKD include increased antioxidant intake, increased dietary fiber intake (which may also increase stool excretion of dietary potassium), reduction of renal acid load, and promotion of a healthy gut microbiome. Note that both animal proteins and plant-based proteins can be rich sources of potassium. Educating individuals on their specific protein goals and why it is important to avoid excessive protein intake can help keep dietary potassium levels within goal.

Whole Grains and Potassium

Most intact or whole grains provide less than 200 mg of dietary potassium per serving.⁸ Whole grains offer additional health benefits, such as increased dietary fiber and antioxidants, and can help to regulate blood glucose levels. Adequate dietary fiber intake may help with potassium removal via the stool. Elimination of intact and whole grains is discouraged due to loss of vitamins, minerals, and fiber.

Potassium Additives

RDNs can educate patients on ways to identify potassium additives in food and supplements, which can reduce overall potassium intake. Potassium additives can be found in many packaged and processed foods (such as enhanced meat, poultry, and fish products) and can contribute significant amounts of potassium to the diet. Potassium (in the form of potassium chloride or potassium salts) may be used to replace sodium in lower-sodium packaged products. Salt substitutes are an example of a product that replaces sodium with potassium chloride. Educating patients on potassium additive identification will go hand in hand with reducing processed foods that may also be high in sodium or phosphate additives.

Supplemental Potassium

Supplemental potassium may be used to prevent kidney stones or given to patients with hypokalemia. Practitioners should use clinical judgment and assessment of individual needs to determine appropriateness.

Practitioners should evaluate individuals with hyperkalemia for use of over-the-counter dietary supplements and herbal blends. Supplements may contain potassium or potassium-containing ingredients. These products do not have to state potassium content on the label. Individuals with hyperkalemia should be advised how to identify these products and educated on potential risks.

Food Label Education

RDNs should help individuals with hyperkalemia who need to monitor dietary potassium by providing helpful tips on how to identify high and low potassium levels on a food label. For example, RDNs can suggest that a main meal contain 600 mg or less of potassium. A side dish, snack, or condiment should contain

approximately 200 mg or less of potassium per serving. These goals may need to be individualized but can act as a general guideline for those needing to monitor potassium intake.

The US Food and Drug Administration requires that potassium content be listed on all food labels. RDNs should advise people with hyperkalemia that there is a rounding rule for potassium on food labels. If the food item has less than 2% of the Daily Value (4,700 mg), then it can be declared as 0%.⁹ This rule can lead to issues if the individual views these foods as “potassium free.” For example, a 2 Tbsp serving of salsa that provides approximately 95 mg potassium can potentially be labeled as 0 mg of potassium per serving. Many people do not adhere to the typical serving size, and someone who needs to monitor potassium intake may consume multiple portions of the seemingly “potassium free” food item.

Cooking Methods to Reduce Potassium in Foods

Several studies have shown that boiling foods results in a considerable reduction in potassium content. The potassium content of potatoes can be reduced by 50% to 75% if they are peeled, cubed, or shredded and then boiled (or double boiled) in a large volume of water.¹⁰ **Soaking potatoes alone resulted in only a minor reduction in potassium content and is generally no longer recommended.** In addition, studies on legumes have found that soaked then boiled or canned legumes are significantly lower in potassium (less than 200 mg per serving). This may provide a significant benefit for individuals following a vegetarian or plant-based eating pattern who have ongoing issues with hyperkalemia.¹¹

Medications and Potassium

The majority of patients with CKD are prescribed blood pressure medications, diuretics, or both. These medications can affect how the kidneys handle potassium and place the patient at risk for either hypokalemia or hyperkalemia. An increased risk of mortality has been shown to occur with both hypokalemia and hyperkalemia. Therefore, it is important to monitor for both conditions in those with CKD. Box 2.2 on page 18 lists commonly prescribed medications that can affect serum potassium.

In those with persistent hyperkalemia, the nephrologist may prescribe a diuretic or add a medication that helps to block intestinal absorption of potassium, such as a potassium binder.

BOX 2.2 Common Medications That Can Alter Serum Potassium

| | | |
|---|-------------------------|--|
| Angiotensin-converting enzyme inhibitors (ACEIs) | ↑ risk for hyperkalemia | Benazepril (Lotensin) Captopril (Capoten) Enalapril (Vasotec) Lisinopril (Prinivil, Zestril) Quinapril (Accupril) Ramipril (Altace) |
| Angiotensin receptor blockers (ARBs) | ↑ risk for hyperkalemia | Eprosartan (Teveten) Irbesartan (Avapro) Losartan (Cozaar) Olmesartan (Benicar) Telmisartan (Micardis) Valsartan (Diovan) |
| Aldosterone antagonists | ↑ risk for hyperkalemia | Amiloride (Midamor) Spironolactone (Aldactone) Triamterene (Dyrenium) |
| Loop diuretics | ↑ risk for hypokalemia | Bumetanide (Bumex) Furosemide (Lasix) Torsemide (Demadex) |
| Thiazide diuretics | ↑ risk for hypokalemia | Bendroflumethiazide (Naturetin) Chlorothiazide (Diuril) Atenolol and chlorthalidone (Tenoretic 100) Hydrochlorothiazide (Microzide) Indapamide (Lozol) Metolazone (Zaroxolyn) |

Phosphorus

Phosphorus is a mineral essential for energy production and storage, bone mineralization, and cellular membrane structure. The goal of phosphorus management is to balance dietary intake with kidney output. This helps maintain homeostasis throughout all stages of CKD. Studies have demonstrated

that high intakes of dietary phosphate are associated with cardiovascular disease, progression of vascular calcification, and complications related to mineral and bone disorder (MBD) even when serum phosphorus levels are within the reference range. Therefore, excess dietary phosphorus may be harmful even in the absence of high serum phosphorus values.¹

Phosphorus balance is directly affected by vitamin D and parathyroid hormone (PTH) levels, both of which are influenced by serum calcium. These laboratory trends should be monitored concurrently for low levels (eg, decreasing calcium and vitamin D in early CKD) or elevated levels (eg, rising PTH and phosphorus as CKD progresses). PTH levels begin to rise prior to any abnormalities in phosphorus and can be an early indicator that the patient should modify phosphorus intake.

Phosphorus needs vary considerably in CKD stages 3 through 5 and 5D. Refer to the appropriate chapter to determine the phosphorus needs for each individual. See the patient education materials on Taking Control of Phosphorus, The Food Label and Chronic Kidney Disease, Nutrition for Dialysis, and Grocery Guide for Kidney Disease.

TIP

Types of Dietary Phosphate

Dietary phosphate is abundant in food and can be classified as either organic or inorganic. The bioavailability of phosphate differs between organic and inorganic food groups.

Organic phosphate is found naturally in plant and animal foods such as dairy, plant or animal proteins, intact and whole grains.¹

- **Animal sources:** 40% to 60% of animal-based phosphorus may be absorbed. In animal foods, phosphorus is bound to proteins and phospholipids, which are mostly bioavailable.
- **Plant sources:** 20% to 50% of phosphorus from plant-based foods (vegetables, beans and legumes, nuts and seeds, intact and whole grains) may be absorbed. In plant-based foods, phosphorus is bound to phytates. Humans have very little phytase activity in the gut, making this form of phosphorus less likely to be absorbed. Phosphate is then excreted through the stool vs being absorbed into the bloodstream.

Inorganic phosphate is found in food as an additive or preservative. Up to 100% of inorganic phosphate added to foods may be absorbed. These additives

are used to control bacterial growth, enhance taste, improve texture, increase shelf stability, and emulsify foods such as cheese and soup. Eating patterns rich in processed and fast foods have been shown to contain significant phosphorus loads, with some studies showing intake of up to 1,000 mg or more per day.¹² See Box 2.3 for examples of common foods with inorganic phosphate.¹³

BOX 2.3 Foods That May Contain Added Phosphate¹³

| <i>Foods</i> | <i>Phosphate functions</i> |
|---|---|
| Meat, poultry, seafood, and plant-based meat alternatives | Preservative, loosens structure of protein, retains moisture, improves flavor |
| Soft cheese spreads; processed cheese; or fat-free cheese, cottage cheese, sour cream, and others with “phos” ingredients | Increases meltability and creaminess |
| Nondairy creamers and enriched milk substitutes | Calcium and phosphorus supplementation and anticaking agent |
| Many bottled or canned beverages, energy or sports drinks, fruit punch, colas, and others | Acidifying agent |
| Powdered coffee, powdered drinks, seasoning packets, and food mixes | Prevents agglomeration or clumping |
| Shelf-stable food items (such as cereals and baked goods) | Inhibits growth of yeast, bacteria, fungi |
| Fast food, convenience food, and restaurant food | Browning, antimicrobial agent, reduces cooking time, retains moisture |

Due to the higher bioavailability of phosphate additives and increased prevalence of convenience and processed food intake, RDNs should emphasize limiting foods with phosphate additives as a priority.

Experts **no longer recommend replacing intact or whole grains with refined alternatives**. Whole grains offer additional health benefits, such as increased dietary fiber and antioxidants, and can help to regulate blood glucose levels.

Medications Containing Phosphate

Prescription medications and over-the-counter medications as well as dietary supplements can be potential sources of inorganic phosphate. When possible, recommend dietary supplements and brands that do not contain added phosphates.

Food Labels and Nutrient Databases

The US Food and Drug Administration does not require companies to list phosphorus on the Nutrition Facts label, so manufacturers often do not include this information. RDNs can teach individuals to look for obvious ingredients known to be rich sources of dietary phosphorus, such as protein sources and phosphate additives.

The numbers for phosphorus presented on the Nutrition Facts label represent both organic and inorganic forms. Because it does not distinguish the breakdown of organic vs inorganic phosphorus, consumers may find it difficult to ascertain bioavailability. It is also important to note that many online databases providing nutrient analysis may only be representing organic phosphate in food items and therefore may underestimate phosphorus content.¹⁴ Clinicians should take this into account when educating patients on reducing phosphorus intake. Teach patients to look for phosphate additives in the ingredient list and choose foods that contain the least number of these or none at all. Instruct individuals who may be limited in their ability to read food labels to look for the words *natural* or *no additives* on the label. This currently indicates there are no additives that contain phosphate. Notably, there is a common misconception that organic foods do not contain added phosphates; this is untrue since phosphates are considered a natural ingredient and therefore are still commonly found in organic products.

RDNs should instruct patients to look for ingredients that include “phos” to identify phosphate additives. Examples include the following:

- **Phosphoric acid**
- **Monosodium phosphate**
- **Monocalcium phosphate**
- **Dicalcium phosphate**
- **Disodium phosphate**
- **Sodium hexametaphosphate**
- **Trisodium phosphate**
- **Sodium tripolyphosphate**
- **Phosphorus oxychloride**

When a food item is made from components containing multiple ingredients, the manufacturer can choose whether or not to list these ingredients if they are generally recognized as safe. For example, a turkey that contains added broth may only report “broth” on the ingredient list and not provide information about the ingredients in the broth. In this instance, the sodium content per serving is the only indicator an additive containing sodium (likely sodium phosphate) was used in the broth.

TIP See the patient education handouts on Taking Control of Phosphorus and The Food Label and Chronic Kidney Disease for more information.

Because phosphate is added to or naturally occurring in many foods, a diet recall will be helpful to both patients and RDNs when they are prioritizing areas on which to focus. Recommend limiting foods that are highest in phosphate additives (fast food, processed meats and cheeses, cereals, and beverages with added phosphates) as these are the most bioavailable, and then discuss alternative options with the patient. Remind the patient to limit consumption of naturally occurring phosphate foods.

Phosphate-Lowering Medications

As kidney function declines and MBD laboratory values become altered, the care team may prescribe medications to help manage serum phosphorus levels, such as phosphate binders or a phosphate absorption inhibitor.

Phosphate Binders

Phosphate binders work by attaching, or binding, to phosphate in the food, resulting in reduced intestinal absorption. Phosphate binders are intended to lessen the amount of absorbed phosphate but will not bind all dietary phosphate. Binders are typically prescribed to be taken with every meal. There are several types of binders on the market, as seen in Box 2.4.

Phosphate Absorption Inhibitors

These novel medications are being developed to reduce paracellular intestinal phosphate absorption via inhibition of sodium-hydrogen ion exchange between cellular tight junctions in the gut.² This passive absorption is nonsaturable; it is how experts believe the majority of phosphate is absorbed in CKD. Studies are underway to determine the safety and efficacy of these medica-

BOX 2.4 Phosphate Binders

| <i>Type</i> | <i>Examples</i> |
|--------------------------|--|
| Calcium-based | Calcium acetate (Calphron, PhosLo, Eliphos, Phoslyra), calcium carbonate (TUMS, Os-Cal, etc) |
| Metal-based | Lanthanum carbonate (Fosrenol) |
| Calcium-free, metal-free | Sevelamer carbonate (Renvela), sevelamer hydrochloride (Renagel) |
| Iron-based | Sucroferric oxyhydroxide (Velphoro), ferric citrate (Auryxia) |

tions. Current reported adverse effects include loose stools or diarrhea due to reduced sodium absorption.

Calcium and Vitamin D

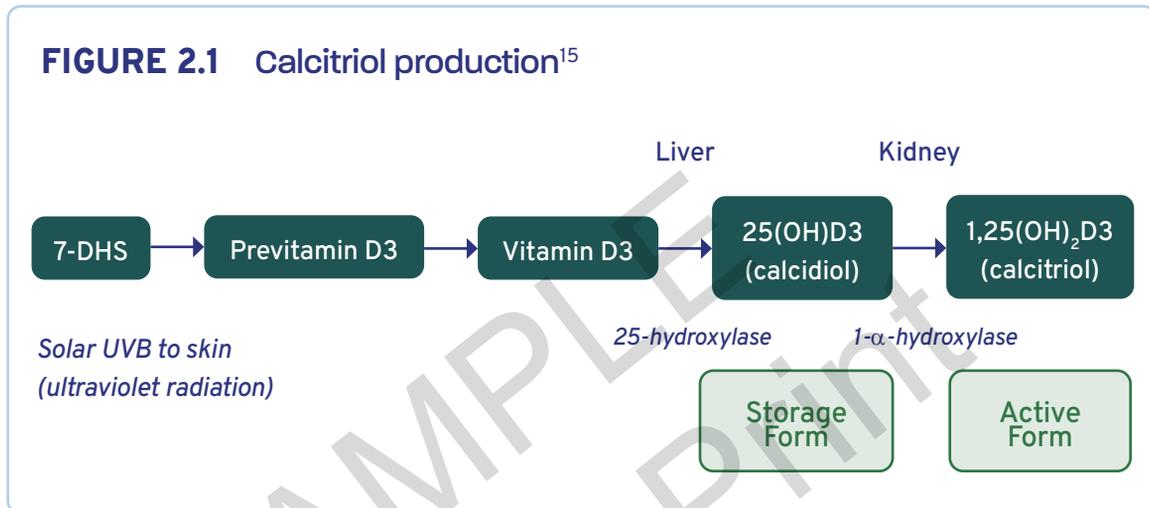
Calcium is the most abundant mineral in the body: 99% of calcium is stored in bones and teeth, and the remaining 1% is found in extracellular fluid, muscle, and tissue. Calcium metabolism is highly regulated in a tight feedback loop by the PTH and vitamin D endocrine system. In the general population, serum calcium levels do not fluctuate based on dietary intake. In patients with CKD, fluctuation may occur because of alterations in homeostasis and concurrent therapies. Serum calcium may remain in the reference range until later stages of CKD.¹

Vitamin D is a fat-soluble prohormone required for bone growth and remodeling; inflammation reduction; regulation of cell growth; neuromuscular transmission; immune function support; and regulation of cell division, differentiation, and death. It is created by two inactive vitamin D precursors:

- Ergocalciferol, 25-hydroxyvitamin D₂, is commonly available as a dietary supplement or food additive.
- Cholecalciferol, 25-hydroxyvitamin D₃, is produced when skin is exposed to ultraviolet light, is found in a limited number of foods, and is available in supplement form.

Both of these forms of vitamin D must undergo two hydroxylations to become active hormones (one in the liver and the second in the kidneys) to form the

physiologically active hormone 1,25-dihydroxyvitamin D.² Calcitriol, or 1,25-dihydroxyvitamin D₃, is the most active vitamin D metabolite with endocrine function, whereas total 25-hydroxyvitamin D is the most accurate indicator of bodily vitamin D status and is therefore the routine serum measure. See Figure 2.1 for an overview of calcitriol production.¹⁵



Calcitriol promotes calcium absorption in the intestinal tract and, along with PTH, maintains serum calcium concentration. As kidney function declines, these homeostatic mechanisms become compromised. When kidneys become less able to create calcitriol, intestinal calcium absorption decreases and results in excessive secretion of PTH in response to hypocalcemia. This medical condition is referred to as secondary hyperparathyroidism (SHPT). PTH secretion can also occur with inadequate dietary calcium intake, which can be another contributor to SHPT.

Of particular concern is the contribution of SHPT and nontraditional CKD-related cardiovascular risk factors to heart disease. Cardiovascular calcification increases as GFR declines and is associated with all-cause and cardiovascular mortality in CKD.²

TIP

Calcium and vitamin D needs vary considerably in CKD stages 3 through 5 and 5D. Refer to the appropriate chapter to determine the needs for each individual.

Fluid

Fluid restriction is not typically necessary in the earlier stages of CKD but varies from person to person. Individuals with CKD must maintain adequate fluid intake to eliminate urinary waste and solutes. As kidney function declines, there is a gradual loss of ability to concentrate urine. This limitation can result in fluid overload and hypertension in ESKD.

Fluid needs vary considerably in CKD stages 3 through 5 and 5D. Refer to the appropriate chapter to determine the needs for each individual.

TIP

Summary of Changes

- Experts recommend that adults with CKD limit sodium intake to less than 2,300 mg/d or less than 100 mmol/d.
- In individuals with hyperkalemia, **fruits, vegetables, intact and whole grains, and plant-based proteins should not be discouraged.** Instead, RDNs should educate patients on consuming proper portions of these foods with meals, resolving other causes of hyperkalemia, and choosing foods that may be lower in potassium, if appropriate.
- **There is little benefit to soaking potatoes.** Instead, they should be peeled, cut into small pieces, and boiled (or double boiled) in a large volume of water.
- Due to increased bioavailability of phosphate additives and the prevalence of convenience and processed food intake, RDNs should emphasize limiting these foods. **Experts no longer recommend replacing intact or whole grains with refined alternatives.**

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Taking Control of Phosphorus



Phosphorus is in many foods and drinks. If your kidneys do not work well, you may get too much phosphorus. This can increase your risk of heart disease, bone disease, or death. To reduce the phosphorus in your diet, follow the tips below.

1. Choose lower-phosphorus foods.

Phosphorus is found naturally in some foods. It can also be added to foods as a preservative. Phosphorus added to foods can be more harmful to your health than the natural phosphorus in foods.

Milk, dairy products, proteins, and whole grains contain natural phosphorus. These are healthy foods if used in the amounts recommended by your registered dietitian nutritionist (RDN).

2. Read ingredient lists.

Phosphorus is not always listed in the Nutrition Facts. This does not mean there is no phosphorus in that food or drink item.

To know if phosphorus is added to foods, look in the ingredient list for words with **phos**, such as **phosphoric acid** or **sodium phosphate**. These are types of added phosphorus that may be harmful to your health.

Limit foods with added phosphorus. If the ingredients are hard to see, a magnifier can help.

| Nutrition Facts | |
|---|----------------|
| Serving Size 1/3 cup (40g) | |
| Serving Per Container about 28 | |
| Amount Per Serving | |
| Calories | 160 |
| Calories from Fat | 50 |
| % Daily Value* | |
| Total Fat 5g | 8% |
| Cholesterol 0mg | 0% |
| Sodium 490mg | 20% |
| Potassium 40mg | 1% |
| Total Carbohydrate 26g | 9% |
| Dietary Fiber 1g | 4% |
| Sugars 1g | |
| Protein 3g | |
| Calcium 4% | Iron 6% |
| Thiamin 10% | Riboflavin 6% |
| Niacin 8% | Folic Acid 10% |
| Not a significant source of vitamin A and vitamin C | |
| INGREDIENTS ENRICHED FLOUR BLEACHED WHEAT FLOUR, NIACIN, IRON, THIAMIN MONONITRATE, RIBOFLAVIN, FOLIC ACID, PARTIALLY HYDROGENATED SOYBEAN AND/OR COTTONSEED OIL, LEAVENING (BAKING SODA, SODIUM ALUMINUM PHOSPHATE, MONOCALCIUM PHOSPHATE), DEXTROSE, SALT. | |
| CONTAINS WHEAT INGREDIENTS | |

3. If you are on a phosphorus binding medication, take these with every meal or snack, as directed.

These medications help bind some phosphorus so less is absorbed by your body.

They can bind only some of the phosphorus in foods and drinks. It is still important to make good food choices.

4. If you are on dialysis, be sure to do all your dialysis sessions.

Dialysis helps remove some of the phosphorus in your blood.

Do not miss any dialysis sessions and stay for the full time.

Foods Highest in Added Phosphorus

- Fast food, convenience store or gas station food, and vending machine food
- Restaurant food
- Beverages such as colas, pepper-type sodas, many flavored waters and bottled teas, and many powdered drink mixes
- Processed cheeses (eg, Velveeta, Cheez Whiz, Kraft American, boxed macaroni and cheese, and cheese spreads)
- Processed meats (eg, hot dogs, salami, bacon, ham, sausage, and others)
- Enhanced proteins (eg, chicken, fish, seafood, pork, and turkey with **“phos”** ingredients)
- Packaged foods with **phos** ingredients

What Can I Eat?

There is a huge variety of foods you can enjoy. Fresh foods such as fruits, vegetables, whole grains, fresh meats, and plant proteins are good choices.

This chart lists higher phosphorus options on the left and better choices that are lower in phosphorus on the right.

| | Higher Phosphorus | Lower Phosphorus |
|--------|---|---|
| Drinks | Drinks with “phos” words in the ingredient list, such as colas or pepper-type drinks, energy or sports drinks, most bottled or canned teas or coffees, flavored waters, and fruit punch Beer and wine | Drinks without “phos” words in the ingredient list, such as most root beer, orange, or clear sodas, fresh lemonade, and water flavorings Coffee (made from coffee beans or powder) Tea (made from tea bags) or bottled teas without “phos” ingredients Water |

Continued on next page

| | Higher Phosphorus | Lower Phosphorus |
|---|--|---|
| Animal or plant proteins | <p>Packaged foods with “phos” ingredients:</p> <ul style="list-style-type: none"> • Processed meats like bacon, bologna, ham, hot dogs, salami, and sausage • Fresh-looking proteins with added “phos” solutions—often in chicken, fish, pork, seafood, and turkey • Chicken or fish sticks, nuggets, patties, or strips • Vegetarian or organic processed foods or meals • Egg substitutes | <p>Recommended amounts of:</p> <ul style="list-style-type: none"> • Beans or lentils • Eggs or egg whites • Fresh lean beef, goat, lamb, mutton, veal, or wild game • “Natural” items without “phos” ingredients, such as: <ul style="list-style-type: none"> ◦ Chicken, fish, pork, seafood, and turkey ◦ Deli meats ◦ Packaged egg whites or egg substitutes ◦ Vegetarian or organic foods • Tempeh • Tofu |
| Dairy | <p>Any with added “phos” ingredients:</p> <ul style="list-style-type: none"> • Nondairy creamers • Enriched almond or rice milk or other milk substitutes • Processed cheeses, such as Kraft American, Velveeta, Cheez Whiz, and cheese spreads • Fat-free cream cheese or sour cream <p>Large portions or frequent use of cheese, dairy milk, creamers, yogurt, or ice cream</p> | <p>Butter (unsalted) or tub margarine</p> <p>Cream cheese (regular or low-fat)</p> <p>Sour cream (regular or low-fat)</p> <p>Whipped cream</p> <p>Any without “phos” ingredients:</p> <ul style="list-style-type: none"> • Unenriched almond, cashew, hemp, oat, rice, or soy milks • Nondairy creamers (original or plant-based) • Half and half <p>Small amounts of:</p> <ul style="list-style-type: none"> • Cheese: cheddar, Colby, mozzarella, Swiss, or other natural cheeses • Cream • Milk • Yogurt (without “phos” ingredients) |
| Fast food, convenience store food, or vending machine foods | <p>Grilled or fried chicken nuggets, sandwiches, strips, or wings</p> <p>Bratwursts, hot dogs, or sausages</p> <p>Pizza</p> <p>Sandwiches with ham, American cheese, or bacon</p> <p>Tacos</p> <p>French fries or other fried potatoes, biscuits, or macaroni and cheese</p> | <p>Hard-boiled eggs</p> <p>Fish filet sandwich (no cheese)</p> <p>Hamburger (no cheese or bacon)</p> <p>Tuna or egg salad sandwich (no cheese)</p> <p>Lettuce or mixed-greens salad (no chicken)</p> <p>Coleslaw, fruit, vegetables, popcorn, or tortilla chips</p> |
| Frozen foods or dinners | <p>Any frozen foods or meals with added “phos” ingredients, including organic foods</p> | <p>Any frozen foods or meals without “phos” ingredients, including organic foods</p> |

Ask your dietitian if you have questions about foods you enjoy or what to eat.

Review

Can you find the added phosphorus? Circle or underline the ingredients with added phosphorus.

INGREDIENTS Whole grain corn, sugar, whole grain oats, brown sugar syrup, corn syrup, canola and/or rice bran oil, salt, dried corn syrup, banana puree, corn bran, corn starch, trisodium phosphate, color added, sodium citrate, natural flavor, natural almond flavor.

What are 2 to 3 foods or drinks with added phosphorus that I eat often?

What are some lower phosphorus foods and drinks I can enjoy instead?

Notes
