

Diet for Kidney Stone Prevention

National Kidney and Urologic Diseases Information Clearinghouse



National Institute of
Diabetes and Digestive
and Kidney Diseases

How does diet affect the risk of developing kidney stones?

Kidney stones can form when substances in the urine—such as calcium, oxalate, and phosphorus—become highly concentrated. The body uses food for energy and tissue repair. After the body uses what it needs, waste products in the bloodstream are carried to the kidneys and excreted as urine. Diet is one of several factors that can promote or inhibit kidney stone formation. Certain foods may promote stone formation in people who are susceptible, but scientists do not believe that eating any specific food causes stones to form in people who are not susceptible. Other factors that affect kidney stone formation include genes, environment, body weight, and fluid intake.

More information about kidney stones can be found in the National Kidney and Urologic Diseases Information Clearinghouse fact sheets *Kidney Stones in Adults* and *Kidney Stones in Children* at www.kidney.niddk.nih.gov.

What are the types of kidney stones?

Four major types of kidney stones can form:

- **Calcium stones** are the most common type of kidney stone and occur in two major forms: calcium oxalate and calcium phosphate. Calcium oxalate

stones are more common. Calcium oxalate stone formation may be caused by high calcium and high oxalate excretion. Calcium phosphate stones are caused by the combination of high urine calcium and alkaline urine, meaning the urine has a high pH.

- **Uric acid stones** form when the urine is persistently acidic. A diet rich in purines—substances found in animal protein such as meats, fish, and shellfish—may increase uric acid in urine. If uric acid becomes concentrated in the urine, it can settle and form a stone by itself or along with calcium.
- **Struvite stones** result from kidney infections. Eliminating infected stones from the urinary tract and staying infection-free can prevent more struvite stones.
- **Cystine stones** result from a genetic disorder that causes cystine to leak through the kidneys and into the urine, forming crystals that tend to accumulate into stones.

Why is knowing which type of kidney stone a person has important?

The first step in preventing kidney stones is to understand what is causing the stones to form. This information helps the health care provider suggest diet changes to prevent future kidney stones. For example, limiting oxalate in the diet may help prevent calcium oxalate stones but will do nothing to prevent uric acid stones. Some dietary recommendations may apply to more than one type of stone. Most notably, drinking enough fluids helps prevent all kinds of kidney stones by keeping urine diluted and flushing away materials that might form stones.

How does a health care provider determine the type of kidney stone?

If a person can catch a kidney stone as it passes, it can be sent to a lab for analysis. Stones that are causing symptoms can be retrieved surgically or with a scope inserted through the urethra into the bladder or ureter, then sent to a lab for analysis.

Blood and urine can also be tested for unusual levels of chemicals such as calcium, oxalate, and sodium to help determine what type of kidney stone a person may have had.

Dietary Changes to Help Prevent Kidney Stones

People can help prevent kidney stones by making changes in fluid intake and, depending on the type of kidney stone, changes in consumption of sodium, animal protein, calcium, and oxalate.

Drinking enough fluids each day is the best way to help prevent most types of kidney stones. Health care providers recommend that a person drink 2 to 3 liters of fluid a day. People with cystine stones may need to drink even more. Though water is best, other fluids may also help prevent kidney stones, such as citrus drinks.

Recommendations based on the specific type of kidney stone include the following:

Calcium Oxalate Stones

- reducing sodium
- reducing animal protein, such as meat, eggs, and fish
- getting enough calcium from food or taking calcium supplements with food
- avoiding foods high in oxalate, such as spinach, rhubarb, nuts, and wheat bran

Calcium Phosphate Stones

- reducing sodium
- reducing animal protein
- getting enough calcium from food or taking calcium supplements with food

Uric Acid Stones

- limiting animal protein

How much fluid should a person drink to prevent kidney stone formation?

People who have had a kidney stone should drink enough water and other fluids to produce at least 2 liters of urine a day. People who have had cystine stones may need to drink even more. The amount of fluid each person needs to drink depends on the weather and the person's activity level—people who work or exercise in hot weather need more fluid to replace the fluid they lose through sweat. A 24-hour urine collection may be used to determine the volume of urine produced during a day. If the volume of urine produced is too low, the person can be advised to increase fluid intake. Drinking enough fluid is the most important thing a person can do to prevent kidney stones.

Some studies suggest citrus drinks like lemonade and orange juice protect against kidney stones because they contain citrate, which stops crystals from growing into stones.

How does sodium in the diet affect kidney stone formation?

Sodium, often from salt, causes the kidneys to excrete more calcium into the urine. High concentrations of calcium in the urine combine with oxalate and phosphorus to form stones. Reducing sodium intake is preferred to reducing calcium intake.

The U.S. recommended dietary allowance (RDA) of sodium is 2,300 milligrams (mg), but Americans' intake averages 3,400 mg, according to the U.S. Department of Agriculture.¹ The risk of kidney stones increases with increased daily sodium consumption. People who form calcium oxalate or calcium phosphate stones should limit their intake to the U.S. RDA level, even if they take medications to prevent kidney stones.

How can a person limit sodium intake?

Learning the sodium content of foods can help people control their sodium intake. Food labels provide information about sodium and other nutrients. Keeping a sodium diary can help a person limit sodium intake to 2,300 mg. When eating out, people should ask about the sodium content of the foods they order.

Some foods have such large amounts of sodium that a single serving provides a major portion of the RDA. Foods that contain high levels of sodium include

- hot dogs
- canned soups and vegetables
- processed frozen foods
- luncheon meats
- fast food

¹U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2010*. 7th ed. Washington, D.C.: U.S. Government Printing Office; December 2010.

People who are trying to limit their sodium intake should check labels for ingredients and hidden sodium, such as

- monosodium glutamate, or MSG
- sodium bicarbonate, the chemical name for baking soda
- baking powder, which contains sodium bicarbonate and other chemicals
- disodium phosphate
- sodium alginate
- sodium nitrate or nitrite

How does animal protein in the diet affect kidney stone formation?

Meats and other animal protein—such as eggs and fish—contain purines, which break down into uric acid in the urine. Foods especially rich in purines include organ meats, such as liver. People who form uric acid stones should limit their meat consumption to 6 ounces each day.

Animal protein may also raise the risk of calcium stones by increasing the excretion of calcium and reducing the excretion of citrate into the urine. Citrate prevents kidney stones, but the acid in animal protein reduces the citrate in urine.

How does calcium in the diet affect kidney stone formation?

Calcium from food does not increase the risk of calcium oxalate stones. Calcium in the digestive tract binds to oxalate from food and keeps it from entering the blood, and then the urinary tract, where it can form stones. People who form calcium oxalate stones should include 800 mg of calcium in their diet every day, not only for kidney stone prevention but also to maintain bone density. A cup of low-fat milk contains 300 mg of calcium. Other dairy products such as yogurt are also high in calcium. For people who have lactose intolerance and must avoid dairy products, orange juice fortified with calcium or dairy with reduced lactose content may be alternatives. Calcium supplements may increase the risk of calcium oxalate stones if they are not taken with food.

How does oxalate in the diet affect kidney stone formation?

Some of the oxalate in urine is made by the body. However, eating certain foods with high levels of oxalate can increase the amount of oxalate in the urine, where it combines with calcium to form calcium oxalate stones. Foods that have been shown to increase the amount of oxalate in urine include

- spinach
- rhubarb
- nuts
- wheat bran

Avoiding these foods may help reduce the amount of oxalate in the urine.

What diet plan should a person follow to prevent future kidney stones?

A dietitian can help a person plan meals that lower the risk of forming stones based on the type of stone the person formed in the past. A person with a history of kidney stones may want to talk to a dietitian who specializes in kidney stone prevention or nutrition for people with kidney problems.

A dietitian can also help overweight people plan meals to help them lose weight. Studies have shown that being overweight increases the risk of kidney stones, particularly uric acid stones. Diets that are low in carbohydrates have been shown to further increase the risk of uric acid stones and should be avoided.

Studies have shown the Dietary Approaches to Stop Hypertension (DASH) diet can reduce the risk of kidney stones. The DASH diet is high in fruits and vegetables, moderate in low-fat dairy products, and low in animal protein. More information about the DASH diet can be found on the National Heart, Lung, and Blood Institute's website at www.nhlbi.nih.gov/health/health-topics/topics/dash.

Points to Remember

- Kidney stones can form when substances in the urine—such as calcium, oxalate, and phosphorus—become highly concentrated. Diet is one of several factors that can promote or inhibit kidney stone formation.
- Four major types of kidney stones can form: calcium stones, uric acid stones, struvite stones, and cystine stones.
- Drinking enough fluid is the most important thing a person can do to prevent kidney stones.
- People who have had a kidney stone should drink enough water and other fluids to make at least 2 liters of urine a day.
- Sodium, often from salt, causes the kidneys to excrete more calcium into the urine. High concentrations of calcium in the urine combine with oxalate and phosphorus to form stones. Reducing sodium intake is preferred to reducing calcium intake.
- Meats and other animal protein—such as eggs and fish—contain purines, which break down into uric acid in the urine.
- Calcium from food does not increase the risk of calcium oxalate stones. Calcium in the digestive tract binds to oxalate from food and keeps it from entering the blood, and then the urinary tract, where it can form stones.
- A dietitian can help a person plan meals that lower the risk of forming stones based on the type of stone the person formed in the past.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) funds research on the causes, treatments, and prevention of kidney stones. The International Registry for Hereditary Kidney Stone Diseases, funded under National Institutes of Health (NIH) clinical trial number NCT00588562, collects medical information from a large number of patients with kidney stones to create a registry that will help researchers compare similarities and differences in patients and their symptoms.

The Study of the Biological and Physical Manifestations of Spontaneous Uric Acid Kidney Stone Disease, funded under NIH clinical trial number NCT00904046, aims to determine how much fat accumulates within cells and how it affects the kidneys by correlating kidney fat content with urine test results. A second aim is to evaluate the effect of the medication thiazolidinedione on excess fatty acid accumulation in kidney tissue and its correlation with uric acid stone formation.

Tamsulosin for Urolithiasis in the Emergency Department, funded under NIH clinical trial number NCT00382265, studies the effectiveness and safety of tamsulosin in treatment of kidney stones. Other areas of focus include reduction in time to pain-free recovery, decrease in narcotic medication for pain, less need for follow-up, decrease in the need for surgery, and cost savings.

Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at www.nih.gov/health/clinicaltrials. For information about current studies, visit www.ClinicalTrials.gov.

For More Information

National Kidney Foundation

30 East 33rd Street
New York, NY 10016
Phone: 1-800-622-9010 or 212-889-2210
Fax: 212-689-9261
Internet: www.kidney.org

Oxalosis and Hyperoxaluria Foundation

201 East 19th Street, Suite 12E
New York, NY 10003
Phone: 1-800-OHF-8699
(1-800-643-8699) or 212-777-0470
Fax: 212-777-0471
Email: kimh@ohf.org
Internet: www.ohf.org

Urology Care Foundation

1000 Corporate Boulevard
Linthicum, MD 21090
Phone: 1-800-828-7866 or 410-689-3700
Fax: 410-689-3998
Email: info@urologycarefoundation.org
Internet: www.UrologyHealth.org

Acknowledgments

Publications produced by the Clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. The original version of this fact sheet was reviewed by Gary Curhan, M.D., Harvard Medical School, and David Goldfarb, M.D., New York University School of Medicine.

You may also find additional information about this topic by visiting MedlinePlus at www.medlineplus.gov.

This publication may contain information about medications. When prepared, this publication included the most current information available. For updates or for questions about any medications, contact the U.S. Food and Drug Administration toll-free at 1-888-INFO-FDA (1-888-463-6332) or visit www.fda.gov. Consult your health care provider for more information.

National Kidney and Urologic Diseases Information Clearinghouse

3 Information Way
Bethesda, MD 20892-3580
Phone: 1-800-891-5390
TTY: 1-866-569-1162
Fax: 703-738-4929
Email: nkudic@info.niddk.nih.gov
Internet: www.kidney.niddk.nih.gov

The National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The NIDDK is part of the National Institutes of Health of the U.S. Department of Health and Human Services. Established in 1987, the Clearinghouse provides information about diseases of the kidneys and urologic system to people with kidney and urologic disorders and to their families, health care professionals, and the public. The NKUDIC answers inquiries, develops and distributes publications, and works closely with professional and patient organizations and Government agencies to coordinate resources about kidney and urologic diseases.

This publication is not copyrighted. The Clearinghouse encourages users of this publication to duplicate and distribute as many copies as desired.

This publication is available at
www.kidney.niddk.nih.gov.



NIH Publication No.13-6425
February 2013