Special Report

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MAYO CLINIC

Celiac disease

Stepping into the spotlight

No doubt you've noticed the recent wave of gluten-free products in health food stores, supermarkets, and even restaurants and bakeries. Best-selling books, popular magazines, websites and TV news programs are all talking about the benefits of avoiding gluten, a protein in wheat, rye and barley.

For people with celiac disease and for those with other types of gluten sensitivity, the newfound interest in avoiding gluten has been a boon. A gluten-free diet is the only effective treatment for celiac disease. Having a whole supermarket aisle of gluten-free products to shop from is a big change from the past. Indeed, going out to eat is now a viable option for many with celiac disease — something that would have been difficult, if not impossible, in years gone by — as restaurant menus are increasingly offering gluten-free items, even pizzas. However, there's a note of caution. While packaged foods labeled gluten-free are reliably gluten-free, foods prepared in a restaurant kitchen aren't held to the same standard, and cross contact with gluten can occur. Thus, these foods can pose a problem for people who must avoid gluten.

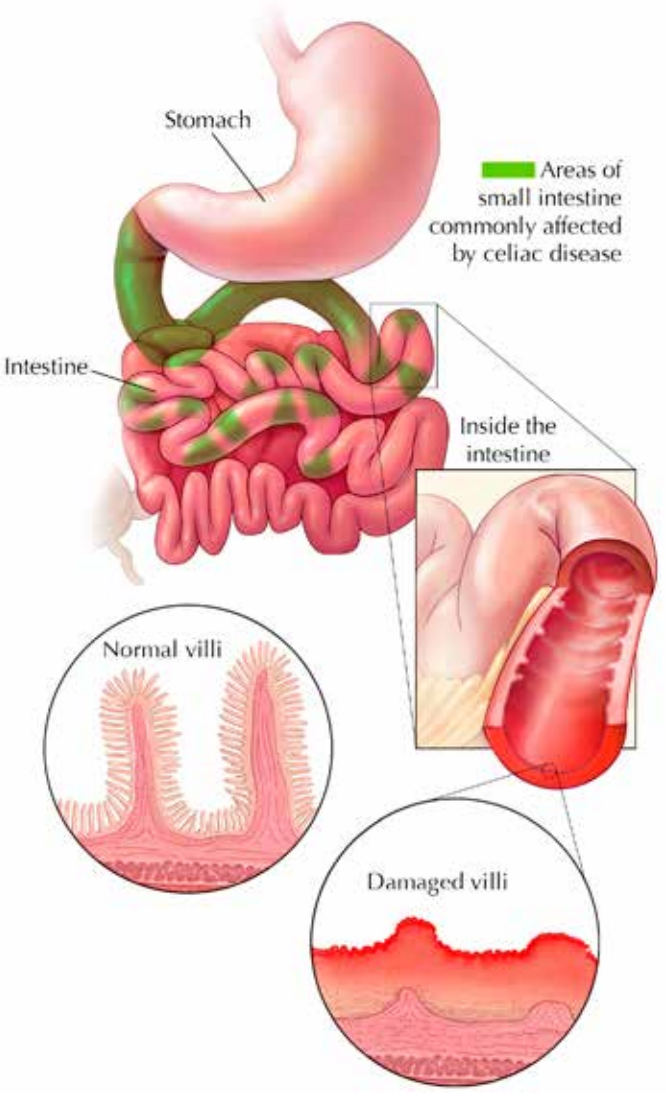
There's another reason awareness of celiac disease is growing. The number of people with the disease is rising, and it's not just because of improved screening and diagnosis. More people are developing the illness. What was once thought to be a rare disorder that happened only in children is now seen as a health problem that can affect people of all ages. In fact, more adults than children are diagnosed these days — the average age at diagnosis is about 45. And what surprises many people is that celiac disease can affect almost every part of the body, not just the digestive system.

A problem with the immune system

Celiac disease is an immune disorder — a condition in which your immune system overreacts to something that's normally harmless. In the case of celiac disease, when you eat foods that contain gluten, your immune system responds to the gluten as it would to a germ or other foreign invader — it tries to attack and destroy it. The trouble is, your small intestine pays the price. The constant attack on gluten irritates and inflames your small intestine, damaging the tiny, hair-like projections (villi) that line the small intestine. Villi absorb vitamins, minerals and other nutrients from the food you eat.

On a microscopic scale, villi normally resemble the deep pile of a plush carpet. The damage resulting from celiac disease makes the inner surface of the small intestine look similar to a tile floor. As a result, your body is unable to absorb enough nutrients necessary for health and growth.

Celiac disease is thought to result from a combination of genetics and something in the environment. With celiac disease, certain genes make people susceptible to the illness and gluten is the primary environmental trigger. This is how the stage is set:



Why is celiac disease on the rise?

Doctors are trying to determine why the number of people with celiac disease is getting bigger. Part of the increase is due to greater numbers of people being diagnosed who previously would have slipped under the radar. But improved diagnosis doesn't account for all of it.

One theory is that when and how gluten is introduced in early infancy may play a role. However, recent research didn't show a benefit of delaying or reducing gluten dose in infancy. Another theory, commonly called the "hygiene hypothesis," proposes that because our environment is so much cleaner and more sanitary than in the past, the balance between microbes and the human immune system has been thrown off, making people with less exposure to infectious organisms more susceptible to autoimmune diseases, such as celiac disease.

Other theories revolve around changes in the past few decades in how wheat is grown, processed and consumed and whether these changes may put genetically predisposed individuals at greater risk of developing celiac disease.

■ *Genetic factors* — For a person to develop celiac disease, certain genes belonging to the human leukocyte antigen (HLA) gene family must be present. Simply having these genes doesn't mean you'll develop celiac disease, though. In fact, many people have these genes, but only about 1 in 20 to 1 in 50 actually develop the disease. Other additional genes are likely needed for the disease to occur, although they may not be as influential as the HLA genes. Scientists are beginning to identify some of these other genetic factors.

■ *Gluten* — Gluten is a protein found in wheat, barley and rye grains. It's the stuff that makes the combination of flour and liquid a stretchy, spongy mass. When combined with yeast and water, gluten gives texture and structure to breads, cakes and most baked goods. Wheat, a primary source of gluten, is used in pastas and cereals. Malt, a form of barley, is a key ingredient in many beers and vinegars, and is added to some corn and rice cereals as a flavor enhancer. Gluten itself is a stabilizer or thickener in foods such as soups, sauces, salad dressings and soy sauce. Nonfood sources include vitamins, medications, lipsticks and communion wafers.

■ *Triggering event* — For some people, another element beyond gluten and the necessary genes is required for celiac disease to develop. This is often called a triggering event. Sometimes, for reasons that aren't clear, celiac disease may emerge after some form of trauma, such as an infection, physical injury, the stress of pregnancy, severe stress or surgery. How or why these conditions trigger the onset of celiac disease is unclear.

Signs and symptoms

What has surprised doctors and scientists in recent years is the range of symptoms that celiac disease can produce. Signs traditionally thought to be caused by celiac disease include diarrhea, weight loss and malnutrition. While these certainly are part of the disease profile, they're not present in everyone with celiac disease. In reality, one person might feel chronically bloated and gassy, while another might experience headaches and fatigue. Some people have difficulty trying to keep weight on, while others are overweight.

Here are some of the ways in which celiac disease can appear:

■ *Gastrointestinal symptoms* — It's not uncommon for people with celiac disease to have regular bouts of diarrhea, often with mushy or bulky stools that float due to large amounts of unabsorbed fat and other nutrients. In addition, the bowel movements can be very odorous, which comes from the inability of the intestines to absorb fat. The fat stays in the gut (intestine) and becomes part of your stool, a condition known as steatorrhea. Unabsorbed fat also makes you need to empty your bowels more often, sometimes as often as 10 or more times a day. On the other hand, some people are bothered by constipation rather than diarrhea. Malabsorption of nutrients, inflammation in the gut, and altered nervous system and hormone regulation may all contribute to making your bowels more sluggish than normal.

General belly pain, bloating and excessive gas (flatulence) also are common symptoms of celiac disease. When unabsorbed nutrients such as carbohydrates arrive in your colon, bacteria in your colon will break down these nutrients. This fermentation process creates large amounts of gas, which can make you feel bloated and uncomfortable, and result in excessive flatulence.

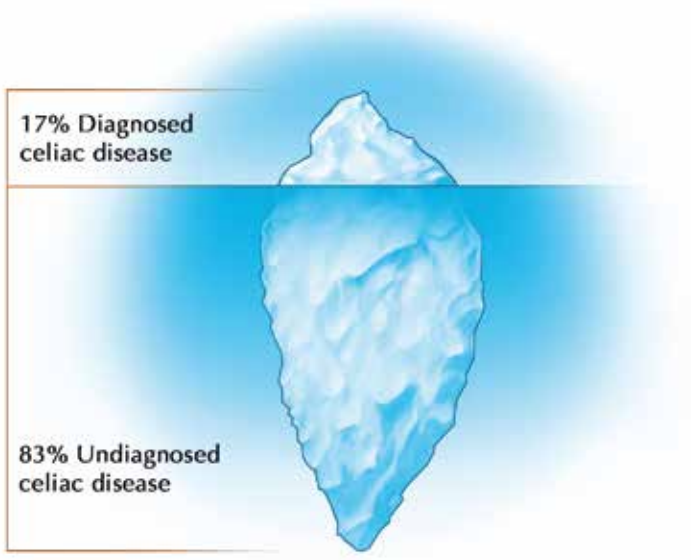
Damage to the small intestine also can make it more difficult to digest dairy products. That's why a number of people with celiac disease are also lactose intolerant. Lactose intolerance can in turn contribute to diarrhea, pain and bloating.

The celiac iceberg

Celiac disease is often described in terms of an iceberg, a floating mass of ice with only its tip visible above water. Based on blood test screenings, it's estimated that around 1 percent of the American population has celiac disease. However, diagnosed cases — which represent the visible tip of the iceberg — are far fewer.

The ice mass underneath the surface represents those who have celiac disease but don't know it. These might include people who have bothersome symptoms but who don't seek help or who have received a wrong diagnosis.

It also includes people who aren't necessarily experiencing symptoms, but who, if tested, would have a positive result. This group is sometimes referred to as having silent (asymptomatic) celiac disease. An example would be family members of someone with celiac disease who were encouraged to get tested even though they felt fine. By some estimates, asymptomatic celiac disease is approximately seven times more common than is symptomatic celiac disease.



Finally, there are those individuals who have potential celiac disease — their genetic and blood tests are positive for celiac disease but a biopsy doesn't show any intestinal damage.

People with celiac disease are more likely to experience heartburn than are those who don't have the disease. Why this occurs isn't clear, but the heartburn usually goes away after starting a gluten-free diet. It may be due to inflammatory changes and unabsorbed nutrients in the upper intestine. However, people who have heartburn aren't more likely to have celiac disease.

- *Skin rash* — Sometimes celiac disease reveals itself by way of a skin disorder. Dermatitis herpetiformis is an itchy, blistering skin rash that's found mainly on your elbows, forearms, back, knees, scalp or buttocks. The rash may come and go, but rarely resolves for good. Although the rash is pretty common in people with celiac disease, those who have the rash usually don't have any gastrointestinal symptoms. Even so, they eventually experience changes to the lining of the small intestine that are identical to those of celiac disease. Most commonly, the rash first develops around ages 40 to 50, but it can occur at any age. To treat the rash, the oral antibiotic dapsone is often prescribed. A topical steroid may improve the rash, but it won't do anything for intestinal damage. A gluten-free diet is necessary to remove the root cause of the rash and keep it from coming back.
- *Brain and nervous system disorders* — It's not unusual for people who've just been diagnosed with celiac disease to describe having migraine-like headaches. The headaches may occur every now and then, or they can be severely debilitating. Once celiac disease is treated, the headaches typically go away.

Numbness and tingling in your legs or hands (peripheral neuropathy) is a common nerve-related symptom of celiac disease. It usually comes on gradually. The symptoms tend to happen every now and again and can't be easily explained by another condition. Many conditions can cause similar nervous system symptoms, so it's not an easy jump from having numbness and tingling

Lactose intolerance

Lactose intolerance may occur as a result of, or along with, celiac disease. When your small intestine can't tolerate the natural sugar (lactose) in milk and other dairy products, you have lactose intolerance.

Because lactose intolerance is common in people with celiac disease, your doctor or dietitian may recommend that you avoid dairy products when first starting a gluten-free diet. Once your small intestine has had time to heal and normal absorptive functions have returned, you can experiment with eating dairy products again.

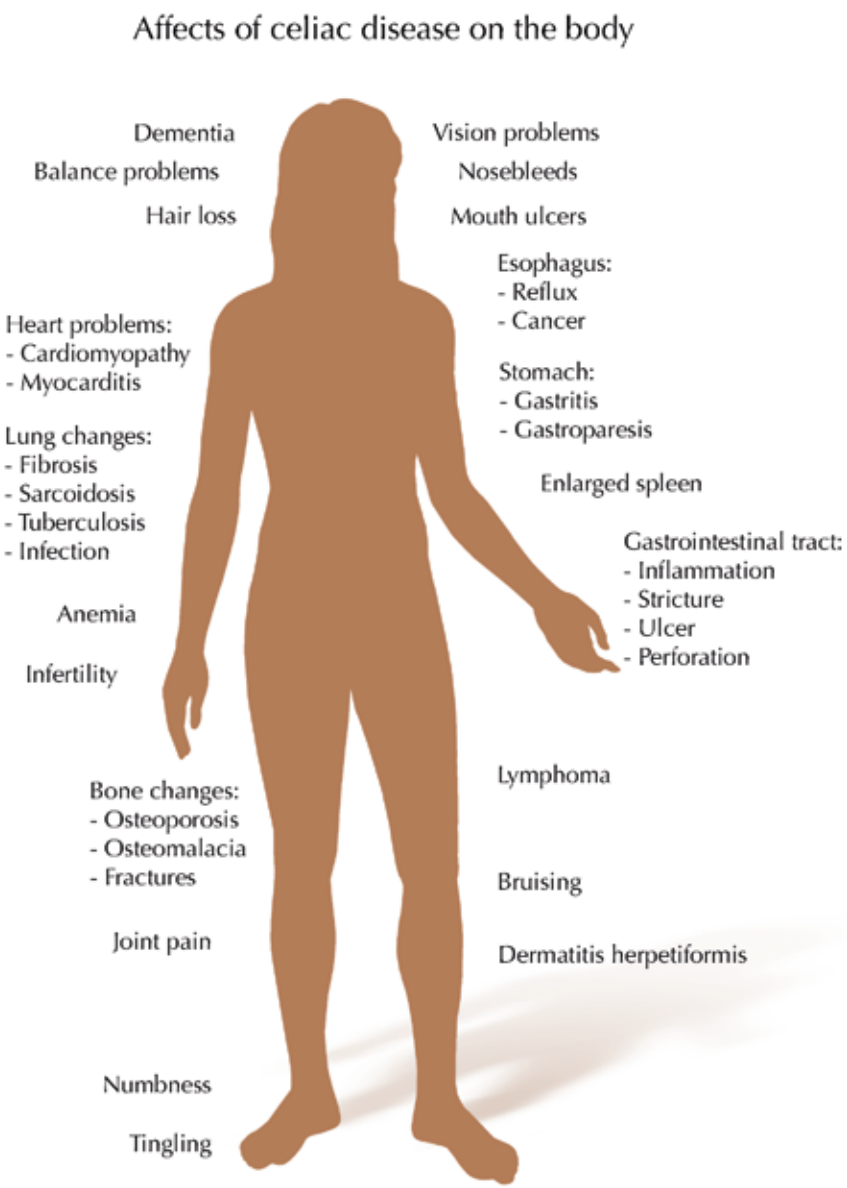
If your symptoms return when you resume eating foods containing lactose, talk to your doctor or a dietitian. You may need to avoid lactose for a longer period or limit it indefinitely.

in your legs to suspecting you have celiac disease. Because of this, diagnosis is often delayed by many years.

Celiac disease is also associated with other neurological problems. Deficiencies in certain vitamins that can occur with celiac disease — in particular vitamin B-12, vitamin B-6, vitamin E and copper — may affect various nervous system functions. In addition to numbness and tingling in the feet and hands, the deficiencies can produce signs and symptoms such as a decline in hand coordination and difficulties with balance and walking, as well as generalized loss of strength (gluten ataxia). Some vitamin deficiencies can affect mental (cognitive) function and contribute to fatigue.

It's not clear exactly how celiac disease impairs brain and nervous system functions. In addition to causing nutrient deficiencies, it may be that celiac disease leads your immune system to attack not only the small intestine but other parts of the body as well. The longer the disease continues untreated, the harder it becomes to reverse the damage. A person with gluten ataxia may not recover completely.

Almost all parts of the body may be affected by celiac disease. The disease presents itself in many different ways. This is why celiac disease is often difficult to recognize.



■ *Fatigue and depression* — People diagnosed with celiac disease often describe feeling tired all the time, despite getting enough sleep. In addition, a majority of adults with celiac disease have low iron levels (iron deficiency anemia). A celiac disease-damaged gut may not be able to absorb enough iron. Without adequate iron, your body can't produce enough of a substance in red blood cells that enables the cells to transport oxygen throughout your body (hemoglobin). As a result, iron deficiency anemia can leave you feeling tired and short of breath.

Fatigue can also result from depression, anxiety and lack of sleep, all of which have been associated with celiac disease. It's difficult to determine whether these symptoms are connected to the disease itself or whether they're due to the stress of coping with a lifelong illness. Muscle-related or severe fatigue may be related to other disorders that can accompany celiac disease, such as an adrenal or other endocrine disorder.

■ *Bones and teeth* — Celiac disease can prevent you from absorbing calcium and vitamin D — essential elements for strong bones. Immune system and inflammatory changes also may contribute to bone loss. Evidence indicates that among adults with celiac disease, about a third have bone mineral density that's lower than normal (osteopenia) and another third have progressed to serious bone loss (osteoporosis).

An increase in fractures often accompanies low bone density. This increased risk may persist after the diagnosis and treatment of celiac disease, especially among adults who had celiac disease for a long time before they were diag-

nosed with it and aren't able to fully recover a loss of bone mass. This can also be an issue for people who've had celiac disease since they were children and didn't achieve the peak bone mass they should have.

Other problems that are common in people with untreated celiac disease include painful, aching joints and recurrent mouth sores. As with other signs and symptoms of celiac disease, these may be caused by nutrient deficiencies or immune system irregularities.

Who's at risk?

Celiac disease can affect anyone. However, it tends to be more common among whites and people who have:

- *A family member with celiac disease or dermatitis herpetiformis* — Evidence indicates that first-degree relatives — parents, siblings and children — of people with celiac disease or dermatitis herpetiformis are at a substantially increased risk of the disease. The highest risk is among siblings. If you have celiac disease, your brothers or sisters have up to a 20 percent chance of having the disease as well. The risk is lower for parents and children, and even smaller for second-degree relatives, such as nieces and nephews and grandchildren.
- *Another autoimmune disorder* — Celiac disease is associated with other autoimmune disorders, such as type 1 diabetes; autoimmune thyroid disease; Sjögren's syndrome, a condition that causes dry mouth and eyes; and microscopic colitis, an inflammation of the large intestine that causes chronic diarrhea.
- *Down syndrome or Turner syndrome* — It's not exactly clear how these chromosomal disorders are tied to celiac disease. But those who have Down syndrome or Turner syndrome, a condition affecting girls and women that results from an incomplete or missing chromosome, are at higher risk of developing celiac disease.

Testing and diagnosis

There are a number of tests that can help your doctor determine whether you have celiac disease. Certain blood tests are used to see if you're at high risk of the disease. If so, an endoscopic biopsy — a procedure to obtain tissue samples from your small intestine — can confirm whether the disease is present. In a few cases, genetic tests may be helpful.

However, before initiating specific tests, your doctor will want to know your medical history, including any signs and symptoms you may have been experiencing. Things your doctor may look for include gastrointestinal problems, weight loss or gain, signs of iron deficiency, abnormal liver test results, loss of bone density, or other conditions associated with celiac disease, such as type 1 diabetes or thyroid disease. Because celiac disease tends to run in families, your doctor will want to know whether you have any relatives who have been diagnosed with it. A physical exam can be helpful in evaluating a skin rash or checking for mouth sores. This can help your doctor determine what may be causing your symptoms and whether they may be caused by celiac disease or another problem. Specific tests and procedures to diagnose celiac disease include:

- *Blood tests* — When you have celiac disease, your immune system produces antibodies against gluten. Your body also increases production of antibodies (autoantibodies) that target some of your own normal proteins and cells. Blood tests can check for elevated levels of these different types of antibodies. If levels are above a certain level, it's a pretty good indication of celiac disease.

Although several blood tests are available, some are more accurate and easier to analyze than are others. For many people, the only blood test that may

Who should be tested?

The question of who should be checked for the disease has been a matter of considerable debate among doctors and scientists.

Sometimes, the argument is made that everyone should be screened for celiac disease. This is based on the fact that celiac disease is more common than previously thought, its signs and symptoms are so varied, and safe and effective treatment exists in the form of a gluten-free diet.

However, mass screening poses several problems. Many people identified in a mass screening as having celiac disease may have few if any symptoms. Evidence suggests that people with asymptomatic or very mild celiac disease may not have the same risks as those whose symptoms are more prominent. Also, because available screening tests aren't 100 percent accurate, it's possible that some people may test positive for celiac disease on a blood test but after a subsequent endoscopy and biopsy find out they don't have the disease. This is known as a false-positive, and it could mean a lot of needless invasive testing.

Because of the problems associated with screening everyone, the preferred approach at this point is to screen only individuals considered at high risk of celiac disease, such as those who have signs or symptoms, associated conditions, or a first- or second-degree family member who has celiac disease.

Classifying symptoms

Celiac disease can affect almost any part of the body, causing different symptoms in different people. To help sort through the ins and outs, doctors have classified the disease in several ways. You might hear them use the following terms when talking about celiac disease:

- *Classical celiac disease* — This is the name used when signs of malabsorption are present, such as chronic or intermittent diarrhea; pale, fatty stools; and weight loss. These signs were once referred to as typical, but this has changed because they aren't the most common signs any more.
- *Nonclassical (atypical) celiac disease* — Nonclassical disease doesn't include signs and symptoms of malabsorption. Instead, the individual may have abdominal pain, constipation, fatigue or anemia.
- *Silent (asymptomatic) celiac disease* — This refers to people who don't seem to be experiencing any symptoms. Those with asymptomatic disease often are diagnosed through screening programs for people at high risk, generally because they have close relatives with celiac disease.
- *Potential (latent) celiac disease* — This is used to describe people without symptoms who are considered at high risk of developing the disease later in life. The lining of the small intestine looks normal, but blood tests are positive for celiac disease.
- *Subclinical celiac disease* — This term is sometimes used to describe mild or seemingly unrelated signs and symptoms that aren't normally associated with celiac disease, but may be tied to the condition because of other factors that raise suspicion a person may have celiac disease.

be necessary is the tissue transglutaminase antibody test. However, for a few people, additional blood tests may be appropriate.

- *Biopsy* — If blood tests suggest the presence of celiac disease, the only way to confirm the diagnosis is to check your small intestine for signs of chronic inflammation and damaged tissue. This is done by collecting several tissue samples from your small intestine during an endoscopy procedure. This involves gently inserting a long, flexible tube (endoscope) down your throat and into your esophagus, stomach and intestine while you're under sedation. This tube has a camera on the end of it to view your intestine, and a small tool is used to collect tissue samples for analysis under a microscope. The specialist will examine the samples to determine whether tissue damage is present and consistent with celiac disease.
- *Genetic tests* — Genetic testing isn't a routine part of diagnosing celiac disease, but it can be useful in some cases. For example, it can help clarify a diagnosis when blood tests conflict with biopsy results. Or, for people at high risk — such as those who have Down syndrome or Turner syndrome — genetic testing may help rule out celiac disease so that further testing isn't needed.

It may also be helpful for those who already are eating gluten-free but haven't been adequately tested for celiac disease. It's important to be tested for celiac disease before trying a gluten-free diet. After several weeks of being gluten-free, your antibody levels begin to return to normal and intestinal damage starts to heal, so tests may come back negative even if you have celiac disease. However, if you've already gone gluten-free, genetic testing can help determine whether further testing is needed. You may need to incorporate gluten back into your diet before undergoing further testing. The genetic test can determine if you don't have celiac disease, but it can't tell you if you do have it. This is because many people carry the gene, but only a small percentage will get celiac disease. Having the gene doesn't mean you have celiac disease or will ever get it.

Managing celiac disease

To successfully treat celiac disease, it's crucial that you eliminate gluten. This means avoiding all foods containing wheat, barley or rye — and typically oats, too. This is because oats often are processed in areas where the other grains are processed, and oats can easily become contaminated. A gluten-free diet can help you feel better within a matter of weeks and over time cause healing of your small intestine. The rate of healing varies depending on your age, how long you've had celiac disease, and the severity and extent of damage and how well you follow your diet.

Since gluten is contained in so many foods, the idea of eliminating it from your diet can seem overwhelming. For many people, going gluten-free constitutes a complete lifestyle overhaul, requiring determination and effort. It might help to remember that it's a treatment you can manage yourself — there are no medications to take, no procedures to undergo. By changing what you eat, you can ease your symptoms, heal your body and prevent complications of celiac disease, such as digestive cancer and possibly other autoimmune disorders.

Many foods are naturally gluten-free, including fresh meats, poultry and fish; eggs; fruits and vegetables; rice; potatoes; milk and cheese; and beans, seeds and nuts in their natural form. There are gluten-free flour mixes — typically a combination of rice flour, potato starch flour, tapioca starch flour and cornstarch — that you can purchase or make yourself. Most people find that given time, acceptance and an adventurous spirit, the transition to a gluten-free diet isn't as difficult as they imagined.

Benefits of treatment

After you begin your new diet, you can expect a number of changes to occur, virtually all of them positive. In general, following a gluten-free diet should:

- *Make you feel better* — Most people with celiac disease — about 70 percent — feel much better within a couple of weeks of eliminating gluten from their diet. In fact, some people begin to feel better within just 48 hours of not eating gluten. Signs and symptoms such as bloating, gas, diarrhea and abdominal pain go away fairly quickly when there's no gluten to irritate your intestine. You also may find you experience fewer headaches and have more energy. Avoiding gluten also heals skin rashes caused by dermatitis herpetiformis.
- *Heal intestinal damage* — Once you stop eating foods that contain gluten, your small intestine begins to repair itself. Evidence suggests that the villi in your intestine start to grow back within a week of not being exposed to gluten, but it can take from a few months to several years for the intestinal lining to regain a normal structure and full function. The more severe the damage, the longer it usually takes to heal. But even in cases of severe, long-standing celiac disease, a gluten-free diet can lead to complete or almost-complete healing. The earlier the disease is diagnosed and the better you are at eliminating all gluten from your diet, the better your chances are for complete healing.
- *Correct vitamin and mineral deficiencies* — Recovery of the lower intestine allows for increased absorption of nutrients even while the duodenum is still healing. Greater absorption of nutrients brings your body's vitamin and mineral levels back to normal, which helps you feel less tired and more energetic.

Professional help

One of the most important first steps you can take toward making a successful transition to a gluten-free lifestyle is to see a registered dietitian. A registered dietitian is an expert in food and nutrition who has met specific educational and professional requirements. A dietitian's job is to translate the medical jargon of nutrition into practical solutions for your life. A qualified dietitian experienced in working with celiac disease can give you the help and support you need as you learn how to eat gluten-free.

Ideally, your doctor will refer you to a dietitian. If not, you can ask your doctor for a referral, or you can search online through the Academy of Nutrition and Dietetics' website (*www.eatright.org/programs/rdnfinder/)* for a registered dietitian near you who specializes in celiac disease or gluten disorders.

Medical insurance will often cover a certain number of visits with a dietitian, but some insurance providers may require a referral from your doctor. Make sure to check with your insurance company to see what's required.

Gluten isn't found only in foods. It's hidden in all sorts of unlikely places, including medications and multivitamins. If you take medications, ask your pharmacist to review them to make sure they don't contain gluten. Also, it's important to read the labels of any supplements and nonprescription medications you purchase. Check the inactive ingredients list for words such as *wheat, modified* or *pregelatinized starch, maltodextrin, dextri-maltose, caramel coloring* or *dextrin*. If you're not sure, check with your pharmacist.

Enriching your diet

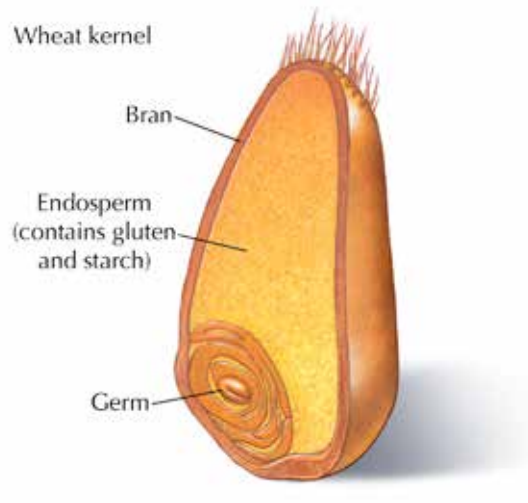
Enrichment and fortification practices aren't commonplace in most specially prepared gluten-free products. So if you eat a lot of gluten-free substitutes, you may be losing a major source of vitamins and minerals. Concern about

Wheat allergy

Wheat allergy is sometimes confused with celiac disease, but the two conditions are very different. Signs and symptoms of wheat allergy are similar to other allergic responses. They generally include hives and skin rash, swelling of the lips and tongue, sneezing, watery eyes, difficulty breathing and — less often — gastrointestinal symptoms.

Wheat allergy occurs when any part of the wheat kernel is consumed and symptoms often develop within seconds to minutes. Celiac disease is specific to one component of wheat — gluten — that's also found in barley and rye. With celiac disease, it often takes hours or days after gluten is consumed for a response.

Celiac disease and wheat allergy represent two ends of a spectrum. In the middle are some emerging conditions — commonly referred to as sensitivities — that are gathering increasing attention. These conditions make up a middle ground. They represent individuals who don't have celiac disease or who aren't allergic to wheat, but who are bothered after eating foods containing gluten or made from wheat. There's a lot about these disorders that researchers are working to understand.



Gluten-free foods

A gluten-free diet doesn't have to be boring. Fruits, vegetables, rice, meat, poultry and fish are all naturally gluten-free. If you focus on what you can have rather than on what's forbidden, you'll be able to really enjoy your diet. For inspiration, check out the following dishes — they're either naturally gluten-free or can be made without gluten:

- Grilled rib-eye steak
- Spicy black bean chili
- Sliced watermelon
- Baked ham
- Flourless chocolate cake
- Broiled salmon
- Wild rice casserole
- Steamed asparagus
- Mango sorbet
- Guacamole with corn tortilla chips
- Scrambled eggs
- Garlic mashed potatoes
- Trail mix
- Chef's salad

Further reading

The book *Mayo Clinic Going Gluten-Free* is a guide to living gluten-free for those with celiac disease or other related conditions.

Learn more by visiting *www.store.MayoClinic.com,* or by calling 877-647-6397 (toll-free) between 8 a.m. and 5 p.m. Central time, Monday through Friday, to order a copy.

reduced vitamins and minerals could change as the demand for gluten-free products increases and more large-volume food manufacturers get into the gluten-free game. Some enriched and fortified gluten-free products are already available, and before long, there may be a wider selection of healthy options. For now, though, it's important to pay attention to certain vitamins and minerals that are difficult to include in a gluten-free diet. These include:

- *B vitamins* — The B vitamins, which include vitamins B-6 and B-12, thiamin, riboflavin, niacin and folate, can be found in many vegetables, fruits, meat, fish, dairy products and legumes. B vitamins help maintain nerve cells and red blood cells. Low levels of some of these vitamins may be linked to memory loss and depression. Ask your doctor or dietitian if a supplement or multivitamin may be appropriate.
- *Calcium* — Your body needs an adequate supply of calcium to build and maintain strong bones. Your heart, muscles and nerves also need calcium to function properly. A gluten-free diet isn't inherently low in calcium, but if the amount of calcium you consume is limited, perhaps because of lactose intolerance, you need to be sure to get adequate calcium elsewhere. In addition to dairy products, sources of calcium include some legumes, sesame seeds, nuts, oranges and dark green leafy vegetables, such as kale and turnip greens.

In some cases, your dietitian may recommend taking a gluten-free calcium supplement that also contains vitamin D. Most adults need 1,000 to 1,200 milligrams (mg) of calcium a day.

- *Vitamin D* — This vitamin is essential for helping your body absorb calcium and maintain optimal bone health. Vitamin D is produced in the skin in response to sunlight, but if you live in a northern climate or stay out of the sun to protect your skin, your dominant source of the vitamin is from food. Similar to calcium, a gluten-free diet isn't inherently low in vitamin D, but you still need adequate amounts of the vitamin to reduce your risk of osteoporosis. Most adults need 600 to 800 international units a day.

If you don't drink milk and you don't take a multivitamin, you're likely not getting enough vitamin D. Ask your doctor if you should take a vitamin D supplement and, if so, how much of the supplement. Drinking fortified almond, coconut, rice or soy milk also may help to meet your calcium and vitamin D needs.

If you need to take higher doses of calcium or vitamin D due to osteoporosis or vitamin D deficiency, it's important that your doctor monitor your blood and, sometimes, urine levels to make sure you're not getting too much.

- *Iron* — Your body needs iron to produce hemoglobin. This mineral enables red blood cells to carry oxygenated blood throughout your body. If you're short on iron, you may feel tired and out of breath because oxygen isn't distributed normally. When you give up gluten, you eliminate grain products that are iron fortified. Thankfully, many naturally gluten-free foods, such as lean red meat, beans and lentils, dark green vegetables, and dried fruits and nuts, are sources of iron. Just make sure that you're eating enough of them. If your iron is low, your doctor may recommend an iron supplement.

Vitamin and mineral deficiencies can cause serious health complications if not identified and treated. To maintain your health, actively seek out strategies for replacing vitamins and minerals that may be missing after your switch to a gluten-free diet. Your doctor will help you determine if supplements are needed, and your dietitian can help you improve your food choices. ❐

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