Lactose Intolerance

Article #2
What is lactose intolerance?

Lactose intolerance is an inability to digest and absorb lactose (the sugar in milk) that results in gastrointestinal symptoms when milk or products containing milk are drunk or eaten.

What causes lactose intolerance?

Lactose is a larger sugar that is made up of two smaller sugars, glucose and galactose. In order for lactose to be absorbed from the intestine and into the body, it must first be split into glucose and galactose. The glucose and galactose then are absorbed by the cells lining the small intestine. The enzyme that splits lactose into glucose and galactose is called lactase, and it is located on the surface of the cells that line the small intestine.

Lactose intolerance is caused by reduced or absent activity of lactase that prevents the splitting of lactose (lactase deficiency). Lactase deficiency may occur for one of three reasons, congenital, secondary or developmental.

Congenital causes of lactose intolerance

Lactase deficiency may occur because of a congenital absence (absence from birth) of lactase due to a mutation in the gene that is responsible for producing lactase. This is a very rare cause of lactase deficiency, and the symptoms of this type of lactase deficiency begin shortly after birth.

Secondary causes of lactose intolerance

Another cause of lactase deficiency is secondary lactase deficiency. This type of deficiency is due to diseases that destroy the lining of the small intestine along with the lactase. An example of such a disease is celiac sprue.

Developmental causes of lactose intolerance

The most common cause of lactase deficiency is a decrease in the amount of lactase that occurs after childhood and persists into adulthood, referred to as adult-type hypolactasia. This decrease is genetically programmed, and the prevalence of this type of lactase deficiency among different ethnic groups is highly variable. Thus, among Asian populations it is almost 100%, among American Indians it is 80%, and among blacks it is 70%; however, among American Caucasians the prevalence of lactase deficiency is only 20%. In addition to variability in the prevalence of lactase deficiency, there also is variability in the age at which symptoms of lactose intolerance appear. Thus, among Asian populations, the symptoms of deficiency (intolerance) occurs around the age of 5, among Blacks and Mexican-Americans by the age of 10, and among the Finnish by age 20.

It is important to emphasize that lactase deficiency is not the same as lactose intolerance. Persons with milder deficiencies of lactase often have no symptoms after the ingestion of milk. For unclear reasons, even persons with moderate deficiencies of lactase may not have symptoms. A diagnosis of lactase deficiency is made when the amount of lactase in the intestine is reduced, but a diagnosis of lactose intolerance is made only when the reduced amount of lactase causes symptoms.

What are the symptoms of lactose intolerance?

The common symptoms of lactose intolerance are gastrointestinal, primarily, abdominal pain, diarrhea, flatulence (passing gas), and, less commonly, abdominal bloating, abdominal distention, and nausea. Unfortunately, these symptoms can be caused by other gastrointestinal conditions or
diseases, so the presence of these symptoms are not very good at predicting whether a person has lactase deficiency or lactose intolerance.

Symptoms occur because the unabsorbed lactose passes through the small intestine and into the colon. In the colon, one type of normal bacterium contains lactase and is able to split the lactose and use the resulting glucose and galactose for its own purposes. Unfortunately, when they split the lactose into glucose and galactose, these bacteria also release hydrogen gas. Some of the gas is absorbed from the colon and into the body and is then excreted by the lungs in the breath. Most of the hydrogen, however, is used up in the colon by other types of bacteria. A small proportion of the hydrogen gas is expelled and is responsible for the increased flatus (passing gas). Some people have an additional type of bacterium in their colons that changes the hydrogen gas into methane gas, and these people will excrete only methane or both hydrogen and methane gas in their breath and flatus.

Not all of the lactose that reaches the colon is split and used by colonic bacteria. The unsplit lactose in the colon draws water into the colon (by osmosis). This leads to loose, diarrheal stools.

The severity of the symptoms of lactose intolerance vary greatly from person to person. One reason for this variability is that people have different amounts of lactose in their diet; the more lactose in the diet, the more likely and severe the symptoms. Another reason for the variability is that people have differing severities of lactase deficiency, that is, they may have mildly, moderately, or severely reduced amounts of lactase in their intestines. Thus, small amounts of lactase will cause major symptoms in severely lactase deficient people but only mild or no symptoms in mildly lactase deficient people. Finally, people may have different responses to the same amount of lactose reaching the colon. Whereas some may have mild or no symptoms, others may have moderate symptoms. The reason for this is not clear but may relate to differences in their intestinal bacteria.

**Elimination diet**

Probably the most common way that people self-diagnose lactose intolerance is by an elimination diet, a diet that eliminates obvious milk and milk products. There are several problems with this type of "testing."

1. Milk products are so common in prepared foods from the supermarket or restaurant that it is likely that an elimination diet that is not rigorous (i.e., does not eliminate all milk) will still include substantial amounts of milk. Thus, persons with severe lactase deficiency attempting an elimination diet may be ingesting enough lactose to have symptoms and erroneously conclude that lactose intolerance is not responsible for the symptoms.

2. People often make the assumption that they are lactose intolerant based on a short trial of elimination. A short trial may be adequate if symptoms are severe and occurring daily, but not if the symptoms are subtle and/or variable. In the latter case, an elimination diet may need to be continued for weeks.

3. Because symptoms of lactose intolerance are subjective and variable, there always is the possibility of a "placebo effect" in which people think they feel better eliminating milk when, in fact, they are no better. With subjective symptoms such as those of lactose intolerance, a placebo effect can be expected to occur 20-40% of the time.

If an elimination diet is to be used for diagnosing lactose intolerance, it should be a rigorous diet. *A rigorous diet requires counseling by a dietician or reading a guide to a lactose-elimination diet.* The diet also needs to be continued long enough to clearly evaluate whether or not symptoms are better. If there is doubt about improvement on the diet, particularly if symptoms normally fluctuate
in intensity over weeks or months, repeated periods of lactose elimination should be tried until a firm conclusion can be drawn. Elimination of all milk products should eliminate symptoms completely if lactose intolerance alone is the cause of the symptoms.

**Milk challenge**

A milk challenge is a simpler way of diagnosing lactose intolerance than an elimination diet. A person fasts overnight and then drinks a glass of milk in the morning. Nothing further is eaten or drunk for 3-5 hours. If a person is lactose intolerant, the milk should produce symptoms within several hours of ingestion. If there are no symptoms, it is unlikely that lactose intolerance is the cause of the symptoms. It is important for the milk that is used to be non-fat milk to eliminate the possibility that fat in the milk is the cause of symptoms. It is not possible to eliminate the possibility that symptoms are due to milk **allergy**, a very different condition than lactose intolerance; however, this is not usually confusing since allergy to milk is rare and usually occurs in infants and young children. (If milk allergy is a consideration, pure lactose can be used instead of milk.)

An important issue in the milk challenge is the amount of milk to use.

- If a person drinks glasses of milk or ingests larger amounts of milk-containing products in their normal diet, then a larger amount of milk should be used in the challenge, 8-16 ounces in an adult, equivalent to one or two large glasses of milk.

- If the person being tested usually does not drink glasses of milk or ingest larger quantities of milk-containing products, there may be a problem with using 8-16 ounces of milk for testing. These larger quantities of milk used for testing may cause symptoms, but the smaller amounts of milk or milk products that these persons ingest in their normal diet may not be enough to cause symptoms. Technically, they may be lactose intolerant when they are tested with larger amounts of milk, but lactose in their normal diet cannot be responsible for their usual symptoms.

Recognition of this issue is important in interpreting the results of a milk challenge.

**Breath test**

The **hydrogen breath test** is the most convenient and reliable test for lactase deficiency and lactose intolerance. For the breath test, pure lactose, usually 25 grams (the equivalent of 16 oz of milk), is ingested with water after an overnight fast. In persons who are lactose intolerant, the lactose that is not digested and absorbed in the small intestine reaches the colon where the bacteria split the lactose into glucose and galactose and produce hydrogen (and/or methane) gas. Small amounts of the hydrogen and methane are absorbed from the colon into the blood and then travel to the lungs where they are excreted in the breath. Samples of breath are collected every 10 or 15 minutes for 3-5 hours after ingestion of the lactose, and the samples then are analyzed for hydrogen and/or methane. If hydrogen and/or methane is found in the breath, it means that the small intestine of the person having the test was unable to digest and absorb all of the lactose. He or she is lactase deficient. The amount of hydrogen or methane excreted in the breath is roughly proportional to the degree of lactase deficiency, that is, the larger the amount of hydrogen and/or methane produced, the greater the deficiency. The amount of hydrogen and/or methane in the breath, however, is not proportional to the severity of the symptoms. In other words, a person who produces little hydrogen and/or methane may have more severe symptoms than a person who produces a large amount hydrogen and/or methane.
The breath test is the best test for determining lactase deficiency and lactose intolerance, but it has several weaknesses. The first is that it is a long, boring test. The second is that it suffers from the same issue as the milk challenge test with respect to the quantity of lactose that should be used. (See previous discussion.) Lastly, the breath test can be falsely abnormal when there is spread of bacteria from the colon into the small intestine, a condition called bacterial overgrowth of the small bowel. When overgrowth occurs, the bacteria that have moved up into the small intestine get to the lactose in the intestine before it has time to be digested and absorbed normally, and these bacteria produce hydrogen and/or methane. This may lead erroneously to a diagnosis of lactose intolerance. Other conditions also interfere with the breath test. Thus, diseases that markedly speed up transit of lactose through the small intestine prevent lactose from being fully digested and absorbed, leading to a misdiagnosis of lactose intolerance. Recent treatment with antibiotics can suppress colonic bacteria and their production of hydrogen or methane and lead to a misdiagnosis of lactose tolerance. Fortunately, these latter conditions are uncommon and usually can be anticipated on the basis of a person’s history or symptoms.

**Blood glucose test**

The blood glucose test is an older test for lactase deficiency and lactose intolerance. For the blood glucose test, lactose is ingested (usually 0.75 to 1.5 gm of lactose per kg of body weight) after an overnight fast, and serial blood samples are drawn and analyzed for glucose. If the level of blood glucose rises more than 25 mg/100ml, it means that the lactose has been split in the intestine and the resulting glucose has been absorbed into the blood. This implies that lactase levels are normal. Unfortunately, the blood glucose test, though simple in principle, requires the collection of multiple samples of blood. Moreover, the test has many real and potential problems, the most common of which is false positive tests, that is, an abnormal test in people who have normal lactase levels and no lactose intolerance. For these reasons, the blood glucose test is not often used.

**Stool acidity test**

The stool acidity test is a test for lactase deficiency in infants and young children. For the stool acidity test, the infant or child is given a small amount of lactose orally. Several consecutive stool samples then are tested for acidity. With a deficiency of lactase, unabsorbed lactose enters the colon and is split into glucose and galactose. Some of the glucose and galactose is broken down by the bacteria into acids, for example, lactic acid. Lactic acid turns the stool acidic. Therefore, a lactase deficient infant or child will develop an acidic stool following the test dose of lactose.

Despite the availability of the stool acidity test, the superiority of breath testing has led to modifications in equipment for collecting breath samples that makes it easier to do breath testing in young children and even infants. As a result, the stool acidity test is not done frequently.

**Intestinal biopsy**

The most direct test for lactase deficiency is biopsy of the intestinal lining with measurement of lactase levels in the lining. The biopsy can be obtained by endoscopy or by special capsules that are passed through the mouth or nose and into the small intestine. The analysis of lactase levels in the biopsy requires specialized procedures that are not often available, and, as a result, lactase levels are not often measured except for research purposes.

**What are the sources of lactose in the diet?**

Although milk and foods made from milk are the only natural sources of lactose, lactose often is "hidden" in prepared foods to which it has been added. People with very low tolerance for lactose should know about the many food products that may contain lactose, even in small amounts. Food products that may contain lactose include:
• Bread and other baked goods
• Processed breakfast cereals
• Instant potatoes, soups, and breakfast drinks
• Margarine
• Lunch meats (except those that are kosher)
• Salad dressings
• Candies and other snacks
• Mixes for pancakes, biscuits, and cookies

Some products labeled nondairy, such as powdered coffee creamer and whipped toppings, also may include ingredients that are derived from milk and, therefore, contain lactose.

Smart shoppers learn to read food labels with care, looking not only for milk and lactose among the contents but also for such words as whey, curds, milk by-products, dry milk solids, and nonfat dry milk powder. If any of these are listed on a label, the item contains lactose.

In addition to food sources, lactose can be "hidden" in medicines. Lactose is used as the base for more than 20% of prescription drugs and about 6% of over-the-counter drugs. Many types of birth control pills, for example, contain lactose, as do some tablets for stomach acid and gas. However, these products typically affect only people with severe lactose intolerance.

How is lactose intolerance treated?

Dietary changes

The most obvious means of treating lactose intolerance is by reducing the amount of lactose in the diet. Fortunately, most people who are lactose intolerant can tolerate small or even moderate amounts of lactose. It often takes only elimination of the major milk-containing products to obtain sufficient relief from their symptoms. Thus, it may be necessary to eliminate only milk, yogurt, cottage cheese, and ice cream. Though yogurt contains large amounts of lactose, it often is well-tolerated by lactose intolerant people. This may be so because the bacteria used to make yogurt contain lactase, and the lactase is able to split the lactose during storage of the yogurt as well as after the yogurt is eaten (in the stomach and intestine). Yogurt also has been shown to empty more slowly from the stomach than an equivalent amount of milk. This allows more time for intestinal lactase to split the lactose in yogurt, and, at least theoretically, would result in less lactose reaching the colon.

Most supermarkets carry milk that has had the lactose already split by the addition of lactase. Substitutes for milk also are available, including soy and rice milk. Acidophilus-containing milk is not beneficial since it contains as much lactose as regular milk, and acidophilus bacteria do not split lactose.

For individuals who are intolerant to even small amounts of lactose, the dietary restrictions become more severe. Any purchased product containing milk must be avoided. It is especially important to eliminate prepared foods containing milk purchased from the supermarket and dishes from restaurants that have sauces.

Another means to reduce symptoms of lactose intolerance is to ingest any milk-containing foods during meals. Meals (particularly meals containing fat) reduce the rate at which the stomach empties into the small intestine. This reduces the rate at which lactose enters the small intestine and allows more time for the limited amount of lactase to split the lactose without being overwhelmed by the full load of lactose at once. Studies have shown that the absorption of lactose from whole milk, which contains fat, is greater than from non-fat milk, perhaps for this very
reason. Nevertheless, the substitution of whole milk or yogurt for non-fat milk or yogurt does not seem to reduce the symptoms of lactose intolerance.

**Lactase enzyme**

Caplets or tablets of lactase are available to take with milk-containing foods.

**Adaptation**

Some people find that by slowly increasing the amount of milk or milk-containing products in their diets they are able to tolerance larger amounts of lactose without developing symptoms. This adaptation to increasing amounts of milk is not due to increases in lactase in the intestine. Adaptation probably results from alterations to the bacteria in the colon. Increasing amounts of lactose entering the colon change the colonic environment, for example, by increasing the acidity of the colon. These changes alter the way in which the colonic bacteria handle lactose. For example, the bacteria produce less gas. There also may be a reduction in the secretion of water and, therefore, less diarrhea.

**Calcium and vitamin D supplements**

Milk and milk-containing products are the best sources of dietary calcium, so it is no wonder that calcium deficiency is common among lactose intolerant persons. This increases the risk and severity of osteoporosis and the resulting bone fractures. It is important, therefore, for lactose intolerant persons to supplement their diets with calcium. A deficiency of vitamin D also causes disease of the bones and fractures. Milk is fortified with vitamin D and is a major source of vitamin D for many people. Although other sources of vitamin D can substitute for milk, it is a good idea for lactose-intolerant persons to take supplemental vitamin D to prevent vitamin D deficiency.

**What are the long-term consequences of lactose intolerance?**

The important long-term health consequence of lactose intolerance is calcium deficiency that leads to osteoporosis. Less commonly, vitamin D deficiency may occur and compound the bone disease. Both of these health issues can be prevented easily by calcium and vitamin D supplements. The real problem is that many lactose intolerant people who consciously or unconsciously avoid milk do not realize that they need supplements. For more about the subject of calcium and vitamin D deficiencies, please see the Vitamins and Calcium Supplements and Osteoporosis articles.

**What is new in lactose intolerance?**

It is now possible to test the DNA of individuals to make a diagnosis of lactose intolerance. This is likely to be an important research tool for studying lactase deficiency and lactose intolerance. It is still too early to know how helpful this sophisticated testing will be in the clinical evaluation and treatment of patients. It is an expensive test.

In 1998, scientists were able to make lactose intolerant rats tolerant of lactose by transferring the gene for lactase to their intestinal lining cells. It is unlikely that this type of gene therapy will find much of an application in people. Nevertheless, it is a fascinating example of what science can accomplish.