



LACTOSE INTOLERANCE REVISITED

SUMMARY

Misunderstandings related to lactose intolerance and how to effectively manage this condition can lead to the unnecessary avoidance of dairy foods, which can compromise nutrient intake, especially calcium, and health. Part of this misunderstanding may be related to failure to appreciate the differences between lactose maldigestion and lactose intolerance. Primary lactose maldigestion is a normal, genetically-controlled decline in the intestinal activity of lactase, the enzyme necessary to digest lactose (milk sugar). This decline occurs at variable periods after weaning, depending on an individual's genetic background. Lactose intolerance refers to the gastrointestinal symptoms associated with the incomplete digestion of lactose. Individuals with lactose maldigestion may or may not develop symptoms (i.e., lactose intolerance).

Common symptoms of lactose intolerance include abdominal pain, bloating, flatulence, and diarrhea. The severity of symptoms varies with the amount of lactose consumed in relation to the amount of lactase.

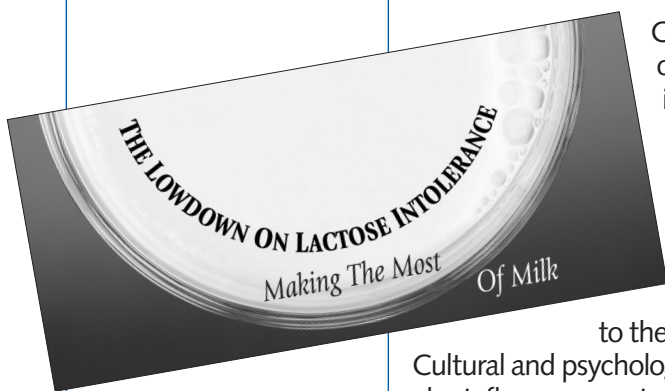
Cultural and psychological attitudes can also influence perceived tolerance to lactose-containing foods. Self-diagnosis of lactose intolerance is not recommended as it can lead to unnecessary dietary restrictions, expense, nutritional shortcomings, and the missed opportunity to diagnose other manageable disorders (e.g., irritable bowel syndrome, celiac disease, cow's milk protein allergy). The breath hydrogen test is the "gold standard" for diagnosing lactose maldigestion and intolerance. A positive diagnosis of lactose maldigestion does not necessarily mean that

an individual will experience symptoms of lactose intolerance.

Approximately 25% of the U.S. adult population and 75% of the world's population are estimated to be lactose maldigesters. However, the percentage of lactose maldigesters who are lactose intolerant remains to be objectively determined. In general, lactose intolerance tends to be grossly overestimated.

The goal for managing lactose intolerance is to remain symptom-free while meeting nutrient needs, especially for calcium, a nutrient often limited in many people's diets. Management strategies should be individualized and periodically reevaluated. Strategies to improve tolerance to lactose include eating yogurt with live, active cultures and aged cheeses such as Cheddar and Swiss, and using lactose-free milk and other milk products and exogenous lactase in tablets or liquid form. Also, repeated exposure to lactose-containing foods (e.g., consuming less than 1/2 cup of milk and gradually increasing the amount) may improve tolerance through colonic adaptation.

Several government and medical organizations including the 2005 Dietary Guidelines for Americans and the American Academy of Pediatrics support intake of dairy foods, with appropriate modifications in the types and amounts, for those who are lactose intolerant. Health professionals can play an important role in educating their lactose intolerant clients about the importance of dairy foods in the diet and providing them with educational materials and tips to help them comfortably consume three servings of dairy foods (e.g., milk, cheese, yogurt) a day, as recommended by the Dietary Guidelines for Americans. **D**



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INTRODUCTION

Lactose intolerance is described as the gastrointestinal symptoms that may be experienced following intake of lactose (milk sugar) in amounts greater than the body's ability to digest and absorb lactose (1). This condition receives considerable attention in both medical and lay publications. A recent survey showed that 79% of consumers are aware of lactose and more than one-third (37%) are trying to consume less lactose, a 7% increase from 2007 (2). Unfortunately, along with this awareness come misunderstandings concerning lactose intolerance.

Misconceptions regarding lactose intolerance can lead to the unnecessary avoidance of milk and other dairy foods, which in turn can jeopardize nutritional status and health (1,3-6). A recent study in young adolescent girls found that self-imposed restriction of dairy foods because of perceived milk intolerance was associated with lower spinal bone mineral content. This lower bone mass may contribute to later risk for osteoporosis (5). The researchers concluded "it is important to address misconceptions surrounding lactose intolerance at an early age, to prevent perceived lactose intolerance from reducing calcium intake, with consequent negative effects on bone health" (5).

Milk and other dairy foods (e.g., yogurt, cheese) are nutrient-rich foods providing nine essential nutrients including calcium, potassium, phosphorus, protein, and vitamins A, D (if fortified), B₁₂, riboflavin, and niacin (or niacin equivalents) (7-9). The 2005 Dietary Guidelines for Americans recommends three cups per day of low-fat or fat-free milk or equivalent milk products for those aged 9 years and older (10). For children 2 to 8 years, two cups per day of low-fat or fat-free milk or equivalent milk products are recommended (10).

Consuming recommended intakes of dairy foods as part of a healthful diet improves overall diet quality and helps reduce the risk of several major diet-related chronic diseases such as osteoporosis, hypertension, kidney stones, and colon cancer, and helps maintain a healthy body weight (1,10). Considering dairy foods' beneficial role in health, it is important to address



Misunderstandings related to lactose intolerance (i.e., the development of gastrointestinal symptoms following intake of lactose or milk sugar) can lead to the unnecessary elimination of dairy foods from the diet.

misconceptions about lactose intolerance and help lactose intolerant individuals comfortably include dairy foods in their diets.

This *Digest* reviews current evidence about lactose intolerance, including how it differs from lactose maldigestion, as well as symptoms of lactose intolerance, diagnosis, and prevalence. Effective management of lactose intolerance, including advice from government and national medical organizations, is also presented.

SETTING THE STORY STRAIGHT

Lactose Maldigestion vs. Lactose Intolerance. Part of the misconception surrounding lactose intolerance relates to lack of understanding of the differences between lactose maldigestion and lactose intolerance. Lactose maldigestion (also called primary lactase deficiency or lactase nonpersistence) results from a normal physiologic, genetically determined decline in the activity of lactase (β -galactosidase), an enzyme that hydrolyzes lactose into simple sugars, glucose and galactose, sometime after weaning (usually between the ages of 3 and 5 years) (1,11-15). In contrast, lactose intolerance refers to the gastrointestinal symptoms associated with incomplete digestion of lactose. For example, an individual with lactose maldigestion may consume 12 g lactose (i.e., the amount in 1 cup of milk) without symptoms, but be intolerant to 24 g (i.e., amount in 2 cups of milk) (1). Lactose maldigestion does not necessarily lead to lactose intolerance (1,3) or mean that dairy foods need to be avoided (16).

Lactase deficiency exists in three forms: congenital, secondary, and primary (1,13,17,18). Congenital lactase deficiency is an extremely rare condition in which intestinal lactase is very low or absent at birth. The only management strategy is a lifelong lactose-free diet. Secondary or acquired lactase deficiency is the temporary loss of lactase activity resulting from injury to the small intestine (e.g., due to cancer radiation or chemotherapy, or some medications) or certain digestive diseases (e.g., celiac disease, inflammatory bowel disease, Crohn's disease) (1,17). Once the underlying problem is resolved, lactase

activity is usually restored. Primary lactase deficiency, as described above, is the most common form of lactose maldigestion and the type discussed in this Digest.

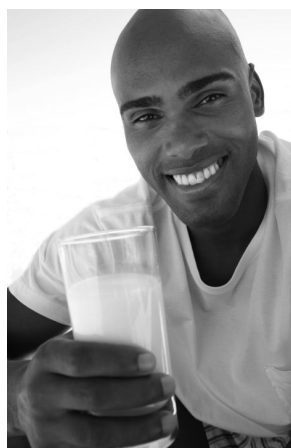
Symptoms of Lactose Intolerance.

Lactose intolerance is a highly individual condition with a broad range of symptoms which vary from mild to severe and include abdominal pain, bloating, flatulence, and diarrhea (1,11,14,18). These common symptoms are similar to those of other disorders, which contributes in part to misconceptions regarding lactose intolerance. Symptoms of lactose intolerance generally begin about 30 minutes to two hours following intake of lactose-containing foods or beverages (11). Whether and to what extent symptoms develop depend on many factors including the amount of lactose consumed in relation to the level of lactase, gastrointestinal transit time, and an individual's age and genetic background (1,11,13,15,16). In addition to biological factors, cultural and psychological attitudes can influence perceived tolerance to lactose-containing foods (1,19-21).

Diagnosis. Self-diagnosis or subjective evaluations of lactose maldigestion and lactose intolerance can lead to unnecessary dietary restrictions, nutritional shortcomings, and the missed opportunity to diagnose another manageable gastrointestinal disorder (e.g., irritable bowel syndrome, celiac disease) (1,3-6, 16,19-21).

Without objective testing, many people mistakenly attribute their symptoms to cow's milk allergy (17,22,23). Cow's milk allergy is an immunologically mediated reaction to one or more milk proteins, occurs primarily in infancy and early childhood, is rare, and is usually outgrown by 5 years of age (22,23). In contrast, lactose intolerance is a non-immunological reaction to lactose in persons, mostly adults, with low levels of lactase who consume lactose in amounts exceeding the body's ability to digest lactose (22,23). Studies have demonstrated that a number of people who describe themselves as lactose intolerant are not lactose maldigesters and can tolerate usual intakes of lactose (e.g., amount in one cup of milk) as shown by objective testing (3-5,16,19,24-29).

The prevalence of lactose intolerance tends to be grossly overestimated. Unfortunately, an objective validated survey has yet to determine the actual prevalence of lactose intolerance among specific populations.



Both direct (e.g., determination of lactase activity by intestinal biopsy) and indirect (e.g., lactose tolerance test, stool acidity test, breath hydrogen test) methods can be used to diagnose lactase deficiency (1,11,13,18). The breath hydrogen test is the "gold standard" for diagnosing lactose maldigestion (1,4,11,13,19). This test is noninvasive, relatively inexpensive, and suitable for children and adults. Historically, the test involved a large dose of lactose (50 g or the amount in a quart of milk) in aqueous solution (17). Today, the challenge dose of lactose is a maximum of 25 g or the amount of lactose in two 8-ounce glasses of milk. A diagnosis of lactose maldigestion is made if breath hydrogen increases by 10 to 20 ppm above baseline levels. In the future, genetic testing may complement or replace traditional indirect methods to diagnose lactase deficiency (1,13,30-32).

Prevalence. Approximately 25% of the U.S. adult population and 75% of the world population are estimated to be lactose maldigesters (1,4). The prevalence of lactose maldigestion varies among different ethnic and racial population groups and is least common among persons of northern European descent (12,15,17,18). In the U.S., the prevalence of lactose maldigestion is estimated to be lower among non-Hispanic whites than among Mexican Americans, Native Americans, African Americans, and Asian Americans (5,12).

Unfortunately, to date, no scientific studies have used an objective, validated survey to determine actual prevalence rates of lactose intolerance among a large population of adults. In general, lactose maldigestion is an unreliable estimate of lactose intolerance and lactose intolerance prevalence rates tend to be overestimated (1,3,4,16,20,24-29). One reason is that lactose intolerance is dose dependent. In addition, cultural and psychosomatic factors may contribute to an overestimation of lactose intolerance (1,19,20,24,25).

DIETARY MANAGEMENT

A positive diagnosis of lactose maldigestion or even lactose intolerance (symptoms) does not mean that milk and other dairy foods that contain lactose must be eliminated from the diet (1,16,19,20,

24-29,33). Doing so is unnecessary for the majority of patients, nutritionally unwise, and not recommended (4,6,10,13,18,21). Reducing consumption of dairy products due to concerns about lactose intolerance can result in a lower intake of milk's nutrients, especially calcium, a nutrient often limited in the diets of many Americans (10,34,35). A calcium-poor diet is associated with increased risk of osteoporosis and other diet-related chronic diseases (1,3,19,33).

The goal for managing lactose intolerance is to remain symptom-free while meeting nutrient needs, especially for calcium (13,19,33). Management should be individualized and periodically reevaluated as symptoms are related to the amount of lactose consumed at a given time. As indicated below, several strategies are available to enable lactose maldigesters to comfortably include dairy foods as part of a nutritious diet (1,3,11,13,18,29,33,36).

The Amount of Lactose

Consumed. Each individual needs to determine how much lactose can be tolerated at a given time and adjust intake accordingly (1,11,24,26). For example, one can try consuming less than 1/2 cup milk with food and gradually increase the serving size until symptoms just begin to develop (1). Well-controlled, clinical studies have demonstrated that people diagnosed with lactose maldigestion can comfortably consume the amount of lactose in one cup (8 ounces) of milk with a meal or two cups in divided doses over the day with food (16,24,26). Moreover, lactose maldigesters have been shown to tolerate a dairy-rich diet containing 1,300 to 1,500 mg calcium/day (equivalent to at least four servings of dairy foods) (27,28). Consuming milk with meals or solid foods improves tolerance to lactose by delaying gastric emptying, which allows the body more time to digest lactose and reduces the amount of undigested lactose that reaches the colon at any given time (13,37,38).

Types of Dairy Foods. Lactose maldigesters tolerate some types of dairy foods better than others.



Several factors influence lactose maldigesters' tolerance to dairy foods, including the amount of lactose consumed, whether the lactose-containing food is consumed with a meal, the type of dairy food, and colonic adaptation.

Chocolate milk may be better tolerated than white milk (38-40). Whether or not whole milk is better tolerated than fat-free milk and aqueous solutions of lactose is controversial (1,13). Hard, aged cheeses (e.g., Cheddar, Swiss, Parmesan, Colby), due to their negligible amount of lactose and high content of solids, are generally well tolerated by lactose maldigesters (1,13,19,29). Aged cheeses contain minimal lactose because of its removal in the whey during cheese-making and the conversion of any remaining lactose entrapped in the curd to lactic acid and other acids during aging (17).

Yogurts with live, active cultures can be comfortably consumed by some lactose maldigesters (1,13,41-46). The ability to digest the lactose in yogurt is explained by the release of bacterial β -galactosidase or lactase from the yogurt starter cultures (e.g., *Lactobacillus bulgaricus* and *Streptococcus thermophilus*) after consumption. Also, yogurt's semi-solid state delays gastric emptying and intestinal transit time which slows delivery of lactose to the intestine (13,44-46). Tolerance to frozen yogurt and ice cream is similar, although lactose maldigesters generally tolerate these foods less well than nonfrozen yogurts (47). Kefir, a fermented milk, has been demonstrated to be as well tolerated as yogurt by lactose maldigesters (48). Whether unfermented milk with bacterial starter cultures such as sweet acidophilus milk or yogurt milk improves lactose tolerance is controversial (1,49). The addition of probiotic bacteria (i.e., live microorganisms which when consumed in adequate amounts confer a health benefit to the host) such as *L. acidophilus* to dairy products may alleviate symptoms of lactose intolerance, although the effects vary according to the specific probiotic, its strain, and concentration (1,13,50).

Adaptation. Some studies demonstrate that tolerance to lactose can be improved with continuous exposure to lactose-containing foods, especially milk (1,13,28,51,52). Adaptive changes in colonic functions (motility, transit, pH) and gut microflora (e.g.,

increased microbial β -galactosidase activity) are suggested as possible mechanisms for this response (13).

Lactose-free Dairy Products and Lactose Digestive Aids.

Lactose-free (lactose-hydrolyzed) milk and other milk products are readily available for individuals who have difficulty tolerating lactose (1,11,13,19,53). Intake of exogenous lactase in tablet or liquid form is a practical strategy allowing lactose maldigesters to readily consume lactose-containing dairy foods (1).

EXPERTS' ADVICE

- The 2005 Dietary Guidelines for Americans recommends dairy products as the primary strategy for individuals who are lactose intolerant (10). The Guidelines state "if a person wants to consider milk alternatives because of lactose intolerance, the most reliable and easiest ways to derive the health benefits associated with milk and milk product consumption is to choose alternatives within the milk food group, such as yogurt or lactose-free milk, or to consume the enzyme lactase prior to the consumption of milk products" (10). The Guidelines add that non-dairy calcium-containing alternatives may be selected by individuals who choose to or must avoid all milk products.
- The U.S. Department of Agriculture's Food and Nutrition Service, in its interim final rule revising regulations governing the WIC (Special Supplemental Nutrition Program for Women, Infants and Children) food packages, recommends lactose-reduced or lactose-free dairy products as an important first option before non-dairy choices for WIC mothers and their young children with lactose intolerance. It also allows amounts of cheese that exceed the maximum substitution amounts for those who obtain medical documentation of lactose intolerance (54).
- The U.S. Department of Agriculture's Food and Nutrition Program allows lactose-free milk without requiring documentation for children

Several government and national medical organizations recommend dairy foods (e.g., yogurt with active cultures, aged cheeses, lactose-free milk) as the first option for individuals with lactose intolerance.



with lactose intolerance as part of the reimbursable school meal program (55).

- The U.S. Surgeon General's report on Bone Health and Osteoporosis cautions that bone health may be adversely affected in individuals with lactose intolerance who avoid dairy products and do not replace these foods with other good sources of calcium (56). The report identifies some non-dairy sources of calcium including canned salmon with bones, turnip greens, tofu with calcium, calcium fortified orange juice, and calcium-fortified breakfast cereal (56). These foods generally contain less calcium per serving or in some cases the calcium may be less bioavailable than from milk and milk products (57,58).
- The American Academy of Pediatrics (AAP), in its report on lactose intolerance, encourages children and adolescents with lactose intolerance to still consume dairy foods to obtain enough calcium, vitamin D, protein, and other nutrients essential for bone health and overall health (18). The reports emphasizes that lactose intolerance does not require avoiding dairy foods and points out that many children sensitive to lactose can consume small amounts of milk, especially with other foods; hard cheeses (e.g., Cheddar, Swiss); yogurt with live, active cultures; and lactose-free or lactose-reduced milk (18). Although rice and soy beverages are generally free of lactose, the report indicates that the nutrient content of these beverages is not equivalent to cow's milk (18). Likewise, in its report on optimizing bone health and calcium intakes of infants, children, and adolescents, the AAP recognizes that many children with lactose intolerance can comfortably drink small amounts of milk, especially when accompanied by other foods (59).
- The National Medical Association recommends that everyone, especially African Americans, many of whom are lactose maldigesters, consume three to four servings/day of low-fat

milk, cheese, or yogurt, and/or lactose-free milk to help reduce the risk of nutrient-related chronic diseases (21).

CONCLUSION

Some individuals avoid milk and other dairy products because of lactose intolerance. As a result, they may be depriving themselves of milk's nutrients and increasing their risk of nutrient-related chronic diseases. While individuals vary in their tolerance to lactose, many people with lactose maldigestion who experience symptoms of lactose intolerance can learn new strategies to help them enjoy the taste and health benefits of consuming three daily servings of dairy foods such as milk, cheese, or yogurt, as recommended by the 2005 Dietary Guidelines for Americans (10) and *MyPyramid* (www.mypyramid.gov). Health professionals are encouraged to educate their clients about the health benefits of dairy foods and dairy nutrients, be sensitive to clients' concerns about lactose intolerance, and provide patient education materials and tips to help them include dairy foods and other calcium-rich foods in their diets while remaining symptom-free. D

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