Science Summary
Lactose Intolerance

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Overview

Dairy foods such as milk, yogurt and cheese are an integral part of healthy eating patterns in the United States (U.S.), providing important shortfall nutrients like calcium, potassium and vitamin D, as well as other essential nutrients. The Dietary Guidelines for Americans (DGA) recommends 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older in the Healthy U.S.-Style and Vegetarian Dietary Pattern. Lactose intolerance (LI) is a real condition that can include digestive discomfort and social stress. It affects people differently and deserves individualized management. It may also lead some individuals to avoid or limit dairy food consumption, which can result in missing out on many essential nutrients found in dairy foods. Currently, LI is not associated with risk of poor health outcomes, such as osteoporosis or cancer, but more studies are needed to address these research areas. Objective diagnosis by health professionals coupled with personalized management strategies can help many Americans who experience LI symptoms enjoy dairy foods in their eating patterns and meet nutrient needs.

Dairy foods make important nutrient contributions to the eating patterns of Americans

The goal of the DGA is to enable individuals throughout the lifespan to have healthy eating patterns that promote health and reduce the risk of chronic disease.[1] Dairy foods (milk, yogurt and cheese) make up an important and affordable food group within healthy eating patterns, providing a significant portion of essential nutrients to the American diet such as high-quality protein, calcium, potassium and vitamin D.[1,2] The 2020-2025 DGA recommends 3 servings of low-fat or fat-free dairy foods for Americans 9 years and older, 2½ servings for children 4-8 years and 2 servings for children 2-3 years as part of the Healthy U.S.-Style and Vegetarian Dietary Pattern Eating Pattern.[1] Additionally, the DGA recommends 1⅔ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12-23 months and small amounts of yogurt and cheese for infants as early as 6 months (depending on developmental readiness).[1]

Understanding the difference between lactase non-persistence and lactose intolerance

Given the importance of dairy foods for meeting the nutrient needs of Americans, it is important to consider potential barriers to dairy food consumption, such as *lactose intolerance (LI)*. LI is characterized by a group of

symptoms, such as abdominal pain, bloating, gas and/or diarrhea, that occur after the consumption of dairy foods. If a person develops these symptoms due to the inability to break down milk sugar, *lactose* (Table 1), that person is said to have LI.[3,4]

Table 1. Definitions of Lactose and Lactase[4]

Lactose	A disaccharide (sugar) of glucose and galactose, and the main carbohydrate in milk (5%). Found in mammalian milk and dairy foods including yogurt and cheese.
Lactase	An enzyme that is released in the small intestine. Breaks down lactose into its component monosaccharides, glucose and galactose, for absorption.

Lactase, an enzyme active in the small intestine of the digestive tract, is necessary for the proper breakdown of lactose when consumed. Infants are born with high lactase activity,[5,6] and sometime after age two, individuals will typically experience a natural decline in intestinal lactase activity (also known as *lactase non-persistence*).[3,4,7,8] No standard age or time course is associated with the gradual loss of lactase activity, and research suggests a regional and ethnic variability in the onset of lactase non-persistence.[8]

Lactase malabsorption is the inability of an individual to absorb lactose in the small intestine due to an underlying cause, with the most common reason being lactase non-persistence.[9–11] LI is a highly individualized condition; the types and severity of symptoms, and the amount of lactose that triggers symptoms, varies among and within individuals.[3]

U.S. and global estimates of lactase non-persistence

Lactase non-persistence is reported in nearly 70% of the global adult population,[12] signifying lactose malabsorption is not a disease but a common characteristic of human genetics (Table 2).[4,12] Lactase non-persistence is least common in northern Europe, with less than 10% of adults being lactase non-persistent in Sweden and Denmark.[12] The frequency of lactase non-persistence increases in southern Europe, with 50% of adults being lactase non-persistent in Spain and Italy.[12] Lactase non-persistence is extremely high in Asian countries; greater than 99 percent of adults in China are lactase non-persistent.[12] On a global basis, there is limited recent research on the prevalence of lactose non-persistence in children under age five. Data is based on research from the 1960s-70s of varying evidence quality, with studies reporting a range between 0-17.9% prevalence of LI in this age group.[13]

In the U.S., about 36% of the adult population overall is lactase non-persistent,[14] with lactase non-persistence in 20-30% of white persons of European or Scandinavian decent, 70% of Mexicans and 80% of African Americans.[12] Lactase non-persistence is detected in 70% of Ashkenazi Jews (generally those of East European descent) in America, 100% of Native Americans and 100% of Native Alaskans.[12]

Whereas the prevalence of lactase non-persistence can be determined by genetic analysis, and lactose malabsorption determined by a number of clinical tests, the true global prevalence of LI is unknown, as not everyone with lactose malabsorption will experience LI following consumption of lactose. Symptoms of LI caused

Table 2. Global Estimates for Lactose Malabsorption in Adults*

	Estimated Prevalence of Lactose Malabsorption, %	Confidence Interval, 95%
Asia and Oceana		
Australia	44%	(35, 53)
Cambodia	68%	(66, 71)
China	85%	(83, 86)
India	61%	(58, 64)
Japan	73%	(59, 86)
New Zealand	10%	(8, 11)
South Korea	100%	(100, 100)
Thailand	84%	(79, 90)
Vietnam	100%	(100, 100)
Eastern Europe, former Soviet Republics		
Czech Republic	81%	(75, 87)
Estonia	28%	(25, 31)
Hungary	39%	(36, 41)
Poland	43%	(39, 47)
Russia	61%	(59, 64)
Ukraine	61%	(51, 71)
Americas		
Brazil	60%	(58, 62)
Canada	59%	(44, 74)
Colombia	80%	(73, 87)
Mexico	48%	(44, 52)
United States	36%	(33, 39)
Middle East/Northern Africa		
Cyprus	16%	(15, 18)
Egypt	68%	(66, 71)
Israel	89%	(88, 91)
Saudi Arabia	28%	(25, 31)
Turkey	69%	(66, 71)
Western Sahara	53%	(41, 65)
Southern, Eastern, Western Africa		
Botswana	88%	(78, 98)
Ethiopia	77%	(75, 79)
Kenya	39%	(34, 43)
Namibia	93%	(89, 96)
Niger	13%	(7, 19)
Tanzania	45%	(41, 49)
Western, Northern, Southern Europe		
Belgium	15%	(13, 17)
Denmark	4%	(0, 9)
France	36%	(32, 39)
Germany	16%	(15, 18)
Ireland	4%	(-1, 9)
Italy	72%	(71, 74)
Spain	29%	(27, 31)
United Kingdom	8%	(7, 9)

*Data in table are summarized from the Supplementary Appendix to Storhaug et al.[14]

by lactose malabsorption are dependent on a variety of factors, such as amount of lactose eaten, whether the lactose-containing food is eaten alone or with other foods as well as the gut microbiome of an individual.[4,12] In the U.S., several surveys demonstrate that self-reported LI (4-12%) is lower than the estimated prevalence of lactase non-persistence (36%).[15–19]

Lactose intolerance: The importance of proper diagnosis for patient care

Obtaining a proper diagnosis is an important step when it comes to managing LI. LI is a complex condition, and many LI symptoms can mimic those of other conditions (*e.g.*, irritable bowel syndrome),[3,4] so it is important to determine the underlying cause in order to best help the patient. For example, some individuals believe they have LI, though objective testing indicates they can digest lactose.[20] Health professionals recommend objective testing (*e.g.*, the breath hydrogen test) to help ensure proper diagnosis,[20] which may help those with LI find personalized dietary strategies that they deserve with the guidance of health care professionals. Self-diagnosis and/or improper diagnosis may cause individuals to forfeit the consumption of dairy foods, and by extension the essential nutrients needed for health that dairy foods provide, without a resolution of symptoms.

Link of lactose intolerance to nutritional status and disease risk

Nutritional status

LI is a real and complex condition that may cause individuals to limit dairy food consumption. However, evidence supports that avoidance of dairy foods by those with LI may hinder individuals from receiving nutrients critically important for health, predisposing them to diseases related to poor diet quality. The American Academy of Pediatrics encourages children with LI to keep dairy foods in their diet to help meet nutrient needs.[21] In 2010, the National Institutes of Health issued a consensus statement on LI and health and provided guidance on the condition; an important finding was that individuals with LI may avoid dairy foods and, as a result, consume less calcium and vitamin D, which can contribute to low bone mineral density and other adverse health outcomes.[3] A cross-sectional study in 2011 of a national sample of U.S. adults indicated that non-Hispanic white, non-Hispanic black and Hispanic adult men and women who self-reported LI consumed less calcium from dairy foods than adults who did not self-report LI.[22] In alignment with this study, a 2013 joint consensus statement on LI from the National Medical Association and the National Hispanic Medical Association encouraged African Americans and Hispanic Americans to eat 3 servings of low-fat or fat-free dairy foods daily.[20] According to the statement, minority groups consume fewer dairy foods than the general population and are at a higher risk for developing certain disease conditions, such as hypertension and diabetes,[20] which are associated with low calcium intake from dairy foods.[23] A 2016 commentary from the Belgian Bone Club and the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases stated that dairy avoidance was associated with detriment to bone health of those with LI, and unnecessary since yogurt and cheese were well tolerated in these populations.[24] In 2015, Jones et al. found that frequency of predicted lactase persistence in Africa was higher in milk versus non-milk drinkers, although authors observed that this relationship was driven by regional and linguistic differences in the study population.[25] Similarly, results from Chin et al. suggest that lactase persistence, as determined by genetic testing, may influence the intake of certain dairy products in U.S. individuals differently

depending on ethnicity.[26] In 2021, a cross-sectional study in Indonesian older adults observed that LI tended to be higher in non-dairy users, and that intakes of protein, calcium, vitamin D and vitamin B12 were lower among non-dairy than dairy users.[27]

Bone health

Public health organizations in Europe and North America continue to recommend 3 servings of dairy per day to ensure adequate nutrient consumption, particularly for bone health.[1,3,24,28] Currently, the influence of lactase non-persistence and LI on bone health is unclear. The results of an ecological correlation study in East and West Africans suggest that the relationship between dairy consumption and osteoporosis risk is influenced by genetic differences in lactase persistence and non-persistence in distinct ethnic populations.[29] A 2018 meta-analysis of 5 case control studies from Finland, Austria, Italy and Spain indicated primary lactase deficiency was associated with reduced bone mineral density in post-menopausal women.[30] In 2019, Hodges et al. summarized data from human and animal studies and concluded that reduced bone density and fragility fractures are increased not by LI, but by reduced calcium consumption associated with dairy avoidance.[28] In 2020, a cross-sectional study of 496 American hip arthroplasty patients by Hamilton et al. concluded that LI was not associated with bone mineral density.[31] A 2021 prospective cohort study of 183 Turkish immigrants living in Germany indicated there was no significant association between LI, calcium intake and markers of bone metabolism or bone mineral density.[32] More studies are needed to develop a robust body of scientific evidence surrounding this topic.

Limited research assessing the role of LI in bone health has also been conducted with children and young adults. In the Adequate Calcium Today study, a school-based randomized intervention provided instructional and behavioral education on the importance of calcium consumption for bone health to 292 (out of 473) Asian, Hispanic and non-Hispanic White sixth-grade girls; following the intervention, calcium intake and total body bone mineral content did not differ between intervention groups, but there was a greater increase in spinal bone mineral content in lactose digesters versus maldigesters.[33] In a 2021 study with Chinese and Malay children, neither LI nor calcium intake were associated with bone health status.[34] In another 2021 cross-sectional study of 300 Malay, Chinese and Indian young adults, LI was not associated with bone health status.[35] More research is necessary to better understand the relationship between lactase persistence and LI and bone health across different life stages and ethnic populations.

Cancer

Scientific evidence investigating the role of LI on risk of cancer is limited. One narrative review concluded that LI was not associated with risk of colorectal or ovarian cancers.[36] This review also observed that there is currently insufficient evidence to establish a relationship between LI and prostate cancer.[36] Similarly, a 2017 cohort study found no association between LI and colorectal cancer.[37]

A personalized approach: Lactose intolerance doesn't have to be a barrier to consuming dairy foods

Many people with LI may want to enjoy the taste, convenience and variety that dairy foods offer, but may be uncertain about the types or amounts of dairy foods to choose. The 2020-2025 DGA recommends low-lactose and lactose-free dairy products for individuals who are lactose intolerant.[1] A proper diagnosis through a health professional can help people with LI find a personalized management strategy that allows them to enjoy a variety of nutrient-rich dairy foods that can fit in their eating patterns.

Milk

A 2010 systematic review concluded that individuals with presumed LI or lactose malabsorption can tolerate 12 grams of lactose in a single dose, the amount contained in a serving of low-fat milk (Table 3), with minimal or no symptoms when consumed with other foods.[38] Consistent with these results, demand for dairy foods in China (driven by milk and yogurt consumption) has consistently grown in recent years,[39] despite that lactose malabsorption is estimated to occur in ~99% of Chinese adults.[12]

Strategies to enjoy milk for those with LI include drinking small amounts of milk at a time, consuming milk with meals and opting for low-lactose and lactose-free milk. As of 2021, 98% of stores in the U.S. sold lactose-free milk,[40] making it a widely available and increasingly popular option for those with LI.

Table 3. Lactose Content of Selected Dairy Foods in the United States

	Serving Size (1 cup-equivalent)	Lactose Content
Dairy Food		
Milk, low-fat and fat free (FDC* 746772, 746776)	1 cup (246 g)	12 g
Yogurt, Greek, plain, fat-free (FDC 330137)	1 cup (250 g)	6.5 g
Cheese, mozzarella, low moisture, part skim (for pizza; FDC 329370)	1.5 ounces (42 g)	0.3 g
Processed cheese, American (FDC 325198)	2 ounces (57 g)	1.4 g
Cheese, cheddar (FDC 328637)	1.5 ounces (42 g)	<0.1 g
Lactose-free milk	1 cup (246 g)	0 g
Ultra-filtered milk	1 cup (246 g)	0 g**
Fortified soy beverages	1 cup (246 g)	0 g

*Food Data Central database; https://fdc.nal.usda.gov/.
**Some ultra-filtered milk may contain lactose.

Yogurt

Yogurt containing live and active cultures is known to be well tolerated and efficacious for improving lactose digestion in individuals with lactose malabsorption. When yogurt contains live cultures, these bacteria may provide lactase to help the body break down lactose.[38,41–43] Some preliminary studies are finding other options that may show promise to help reduce LI symptoms, such as probiotic[43–45] and prebiotic consumption.[46–48]

Cheese

Natural cheeses such as Cheddar, Colby, mozzarella and Monterey Jack are virtually lactose-free, because 90% of the lactose in milk is removed along with the water and whey during the renneting process. The remaining lactose is fermented into lactic acid.[49]

Conclusion

Dairy foods contribute a significant amount of essential nutrients to the American diet. A barrier to dairy consumption can be LI, which is a real and individual condition that can be managed by tailored dietary guidance, providing the opportunity for people with LI to benefit from dairy's nutrition. The prevalence of LI is unknown and difficult to estimate. Proper diagnosis of LI by a health care professional is paramount for understanding effective, personalized management strategies that can help individuals enjoy diverse dairy foods and healthy eating patterns. Overall, scientific evidence is lacking that addresses gaps in knowledge surrounding the impact of LI on nutritional status, health and disease risk across life stages and ethnic populations.

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