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Brief classification and latest therapy for lactose intolerance

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Abstract. Lactose intolerance is a digestive problem with a high incidence worldwide. The disease occurs mainly due to a lack or deficiency of lactase in the body, which prevents effective digestion of lactose. Congenital lactose intolerance is caused by a genetic defect that prevents the body from producing enough lactase, and its incidence is relatively low. Secondary lactose intolerance is caused by other gastrointestinal disorders, such as celiac disease, and is relatively common. Functional lactose intolerance is the most common form of lactose intolerance, in which lactase activity is reduced or lactose absorption is impaired, but there is no apparent organic disease. This article lists several possible solutions for different types of lactose intolerance based on the latest research. In studies of lactose intolerance, scientists have found that the rate of lactose intolerance varies widely across populations, with significant differences in prevalence by race and region. In addition, several studies have shown a link between lactose intolerance and the composition of the gut microbiome. Therefore, the study of lactose intolerance has important implications for understanding how the human digestive system works and the relationship between the gut microbiome and health.

Keywords: lactose intolerance, symptoms, solutions, classification.

1. Introduction

1.1. Background

A carbohydrate called lactose is present in milk and other dairy products. Lactose is broken down into glucose and galactose in the intestines by the enzyme lactase. These sugar molecules are then absorbed into the bloodstream and used for energy or storage [1]. Lactose intolerance is the body's inability to digest lactose, a sugar found in milk and dairy products. When the body lacks lactase, which is the enzyme used to digest lactose, it can't be broken down, leading to bloating, diarrhea and other symptoms. In contemporary society, the incidence of lactose intolerance is increasing year by year due to the changes in people's diet and living habits [2]. With the continuous improvement of people's awareness of nutrition and health, more and more people begin to pay attention to the impact of lactose intolerance on health, especially in Europe and the United States and other regions, more and more people choose to avoid or reduce the intake of dairy products [3]. At the same time, some businesses are starting to introduce products specifically for the lactose intolerant to meet consumer demand. Nowadays, lactose intolerance is a common condition, with an estimated 75% of the global population having some degree of lactose intolerance [4]. In the context of technological development, lactose intolerance detection methods have been improved and popularized, including hydrogen breath

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test and lactose tolerance test [5]. Hydrogen breath test: once you consume a solution with a high lactose content, the doctor will periodically measure the amount of hydrogen in your breath. If you are exhaling too much hydrogen, you may not be adequately digesting and absorbing lactose [6]. A lactose intolerance test involves obtaining blood samples to measure your blood glucose levels two hours after ingesting a high-lactose beverage. Through genetic testing and other means, people can get a more accurate picture of their lactose metabolism and make a more scientific diet plan. Therefore, lactose intolerance has become a hot topic in contemporary society, involving nutrition and health, food culture, commercial market and many other fields.

1.2. Research progress

Recent research suggests that symptoms of lactose intolerance may be linked to changes in the gut microbiome. Some studies have shown that the gut microbiome of lactose intolerant people differs from that of the normal population, lacking some beneficial flora and containing more harmful ones. These changes in microbial communities may lead to a decrease in the breakdown and absorption of lactose in the gut, causing symptoms of lactose intolerance. In addition, some studies have found that symptoms of lactose intolerance may be related to the dose and frequency of lactose intake. Smaller lactose intakes may not cause symptoms of lactose intolerance, while larger intakes may cause noticeable symptoms. In addition, some studies have found that the symptoms of lactose intolerance may be related to mutations in human genes, especially in the lactase gene. Currently, researchers are further studying the relationship between factors such as the gut microbiome, lactose intake and genetic variation and lactose intolerance in order to better understand the causes and treatments of lactose intolerance. In addition, some studies are exploring the use of probiotics and prebiotics to improve the gut microbiome to alleviate the symptoms of lactose intolerance.

1.3. Framework of the paper

The paper aims at concluding the research about lactose intolerance under modern technology. The topic is separated into the following sequence: the structure of lactose, principles and symptom for lactose intolerance, impact of lacking in lactose, classification of lactose intolerance, factors contributing to the lactose intolerance and possible solutions. To be specific, the distinctive types of lactose intolerance include primary lactose intolerance, secondary lactose intolerance and congenital lactose intolerance, which are introduced specifically in part 2.4. The possible reasons of the presence of lactose intolerance are mainly contributed to ages, ethnicity, premature birth and therapy operations towards special diseases.

2. Influence and therapy for lactose intolerance

2.1. Structure of lactose

Lactose, which is a nutrient substance in most dairy products, is a disaccharide in the classification of carbohydrates, consisting of glucose and galactose. The chemical formula of lactose is C_12 H_22 O_11, which indicates the lactose contains twelve carbon atoms, 22 hydrogen atoms and eleven oxygen atoms. The abbreviated Lewis structure of lactose is shown in Figure 1.

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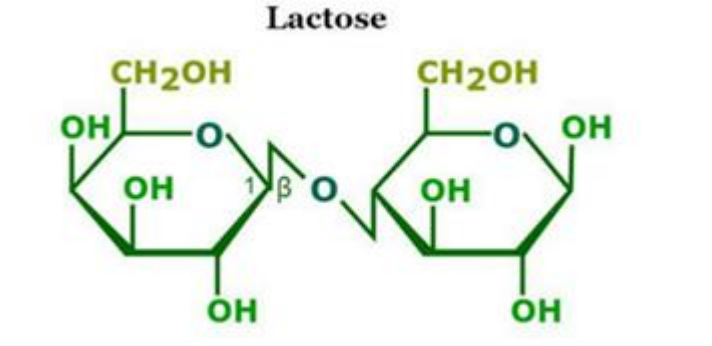

Figure 1. Lewis structure of lactose [7].

2.2. Principle and symptom for lactose intolerance

When people absorb food containing lactose, the digestion system of human body will start to decompose the lactose. An enzyme, which is called lactase, contributes to breaking down the lactose into smaller pieces. The monomer of lactose is the monosaccharide called galactose and glucose [7]. The simple sugars can be absorbed by the small intestinal wall and transformed into the form of energy that can be used for human body. Most people can secrete lactase in small intestine and digest the lactose successfully. Some patients with lactose intolerance are unable to generate enough amount of lactase in their intestines, which leads to the piling up of lactose. The undecomposed lactose will be attributed to the bacteria in the intestine, which will lead to a series of symptoms of lactose intolerance. Notably, lactose intolerance mostly appear among the adults while disease is not so common among infants and teens [8]. The possible reason is that all the nutrients absorbed by the infants come from the breast milk or milk powder. After absorbing food with lactose molecules, people who have lactose intolerance will experience the classical symptoms in about thirty minutes to two hours The symptoms of lactose intolerance include diarrhea, flatulence (fart), abdominal pain, dyspepsia, abdominal swelling, abdominal distension pain and nausea [9]. The syndromes of lactose intolerance, which are especially high risks for the older adult, also exist. People with the symptoms of lactose intolerance will have lower absorption of calcium and bone mineral density [10]. The condition will contribute to osteoporosis in long term. Tables are centered. The caption goes above the table. The caption text should indent 5 spaces from left margin and justify. Table examples are on page 1 and 2 and below.

2.3. Impact of lacking in intake of lactose

In general, lactose can help people maintain strong muscles, tough bones and teeth. Lactose contributes to holding blood pressure at a stable level as well. For young children, dairy products containing lactose can be a substitute for compensate the desire of sweetmeat, which can decrease the possibility of decayed teeth. Preventing harmful bacteria from invading the intestine and improving the environment of intestinal flora are considerable functions of lactose [11]. To some degree, lacking of lactose will decrease the amount of trace elements in the human body, including magnesium, zinc and calcium, unsteady the body health index and affect intestine conditions.

2.4. Types of lactose intolerance

Though the phenotype of different types of lactose intolerance has similar symptoms, the factors led to the lactase efficiency vary beneath each type. The situations are mainly divided into three cases: primary lactose intolerance, secondary lactose intolerance and congenital lactose intolerance.

2.4.1. Primary lactose intolerance. The most typical kind of primary lactose intolerance is not present from birth. Instead, they can digest at an early age since lactase is required by infants, who need to obtain all of their nutrients from milk. As children grow up, they have multiple choices of food to get enough nutrients. In this case, children will generate less amount of lactase when they switch from

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milk to other foods. For common people, the quantity of lactase will still stay high enough to meet the basic needs of digesting dairy products in the adult diet. It is difficult to digest milk products due to primary lactose intolerance, which is characterized by a considerable reduction in lactase production by maturity [9]. Primary lactose intolerance is an adaptation in the system of secretion towards the change that took place in diet habits after preliminary development.

2.4.2. Secondary lactose intolerance. After a small intestine-related disease, trauma, or surgery, the small intestine's ability to produce lactases declines, resulting in this type of lactose intolerance. Among the illnesses linked to secondary lactose intolerance include Crohn's disease, intestinal infection, celiac disease, and bacterial overgrowth [12]. Lactase levels may be restored and indications and symptoms may improve with treatment of the underlying illness, albeit this process can take time [11]. Secondary lactose intolerance is related to artificial intervening processes or postnatal accidents.

2.4.3. Congenital lactose intolerance. Rare, but nonetheless possible, are infants who develop lactose intolerance due to a lactase deficit. Autosomal recessive inheritance, which occurs when the same gene mutation is carried down from both parents, is the pattern of genes used to describe how this condition is passed down from generation to generation. The possibility of mutation taken place in both chromosomes from father and mother is much little compared to primary lactose intolerance and secondary lactose intolerance. Due to inadequate lactase levels, premature newborns might potentially develop lactose intolerance [9]. In conclusion, congenital lactose intolerance is considered as gene mutation by accident.

2.5. Factors contribute to lactose intolerance

2.5.1. Ages. Adulthood is when lactose intolerance often manifests. When it comes to infants and young children, the condition is rare [9]. As previously mentioned, ages are factors for primary lactose intolerance.

2.5.2. Ethnicity. The majority of persons with lactose intolerance are of African, Asian, Hispanic, and American Indian origin. The ancestors of these ethnic groups did not live on developed animal husbandry, which is an industry that will bring many dairy goods to the market as byproducts [9]. In this case, the intake of lactose will sharply fall after they are no longer infants. Ethnicity can be factors for both primary lactose intolerance and congenital lactose intolerance as it is related to evolutionary procedure and inheritance.

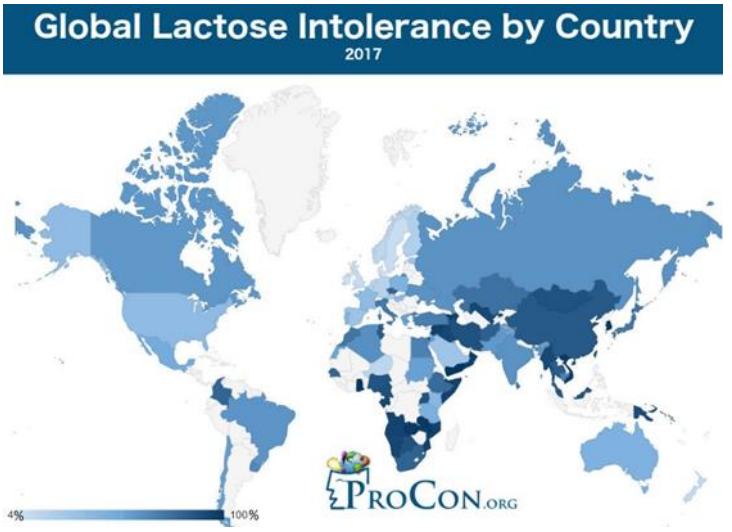

Figure 2. Distribution of lactose intolerance all over the world [13].

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According to the data collected, the country with the largest number of lactose intolerance is Ghana, Malawi, South Korea and Yemen, which have 100% prevalence in the field of lactose intolerance (See Figure 2). The mentioned countries are mainly in Asia and Africa, which are continents concerned about agriculture and handicraft industry in the past. In contrast, Denmark and Ireland only have about 4% prevalence of lactose intolerance throughout the whole country. Most countries that have few cases of lactose intolerance in Europe, which is a continent focusing on animal husbandry and dairy products for several centuries [13].

2.5.3. Premature birth. Preterm newborns may have lower levels of lactase because lactase-producing cells in the small intestine do not begin to mature until late in the third trimester [14]. The deficiency of lactase will bring difficulty for infants to receive nutrients at an early age. Premature birth is considered as the main factor for congenital lactose intolerance.

2.5.4. Diseases and therapy operations. When the specific injury or intestinal disease, including celiac disease, Crohn's disease and bacterial overgrowth, takes place, the environment of intestine flora will be changed. The situation will lead to a higher risk of stopping producing lactase in the intestine [14]. Notably, the radiation therapy for cancer in stomach and intestinal side effects from chemotherapy may also contribute to the decreased amount of lactase.

2.6. Solutions towards lactose intolerance

Even if lactose intolerance is present, there is typically no need for special care for kids with modest symptoms and healthy growth and development. Exogenous lactase supplementation, probiotic and prebiotic administration, as well as calcium and vitamin D supplements, are all used in the treatment of children who exhibit evident symptoms. Dietary treatments are essential for managing lactose intolerance, and the precise techniques employed to cut out or lower lactose intake vary on the kind of sensitivity. Breast milk or formula containing lactose might impair growth in kids who have congenital lactose intolerance and should be replaced with lactose-free formula as soon as possible. These kids also need to follow a lifelong lactose-free diet. For patients with lactose intolerance, they should adapt the best individualized diet while ensuring adequate nutrient intake to avoid nutrient deficiencies [15].

2.6.1. Fractional multiple methods. As some people have the symptom of lactose intolerance due to limited amount of lactase secreted in the intestine, a large amount of lactose intake in a short period of time should be avoided. Fewer dairy products once and increasing the frequency may improve the situation by decreasing the accumulation of undecomposed lactose in the intestine [16].

2.6.2. Low-lactose and lactose-free dairy products. One of the primary providers of calcium, top-notch protein, and a range of vitamins and minerals is milk. Comparatively, to completely avoiding dairy products, there is no benefit to growth and development from doing so. Dairy products with and without lactose have the benefit of not reducing consumption of these nutrients [16].

2.6.3. Yogurt and fermented product. Yogurt, fermented foods, and other yogurts are very low in lactose but include almost all the nutrients found in milk, including protein, calcium, vitamin D, riboflavin, and vitamins B6 and B12. Probiotics and prebiotics contained in yogurt have an impact on the gut microbiota because they are created by fermenting the lactose in milk into lactic acid. Hence, yogurt is more tolerable for those who are lactose intolerant [16]. In the experiment about the change of content of lactose in the fermentation process of yogurt, the scientists take 100 grams of milk in the container. After adding the sugar and lactic acid bacteria, the content of lactose will be measured in every 1.5 hours. The data is collected in the following chart (See Table 1). As the fermentation time increases, the amount of lactic acid bacteria enhances by step while the content of lactose is on a

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decline curve. In 4.5 hours, the content of lactose in yogurt will decrease to 79% of the origin milk [17].

Table 1. Lactose content and the amount of lactic acid bacteria versus time interval [17].

Time interval/hours	Lactose content/grams	Lactic acid bacteria/molecule
0	4.23	
1.5	3.89	4,000,000
3	3.66	13,000,000
4.5	3.58	30,000,000

2.6.4. Lactase addition. Foods that already contain lactose can be reduced in lactose content by adding lactase. While ingesting lactose-containing meals, lactose intolerant persons need to take a lactase supplement. Every time they consume something, whether you're nursing, taking standard formula, or drinking regular milk, they need to take lactase supplements. If a newborn under the age of six months still wants to nurse, they can opt to treat their lactose intolerance by taking lactase orally [16]. There are two varieties of lactase available today, acid lactase and neutral lactase. Industrial manufacture of dairy products devoid of lactose mostly utilizes lactase neutral. To break down lactose in the stomach, acid lactase tablets are frequently utilized in clinical settings, along with breast milk or normal dairy products. It is necessary to take lactase, an enzyme dietary supplement, 5 to 30 minutes before a meal that contains lactose. However, while lactase may be present in cases of partial lactose digestion, it does not completely alleviate symptoms. Lactose intolerance shouldn't solely be treated with enzyme supplements, but they can be used in conjunction with a limited diet [15].

2.6.5. Supplement of probiotics. After entering the body, probiotics release β-galactosidase, which helps the body digest and absorb lactose. It also slows down gastric emptying and intestinal transport time, prolongs lactase digestion by staying in the small intestine, promotes lactose decomposition and absorption, increases colonic colitis, and improves lactose intolerance's clinical symptoms. Additionally, when the temperature is higher than 60 Celsius degrees, most probiotics will be inactivated, which will decrease the efficiency of supplement probiotics [16].

3. Conclusion

The lactose intolerance has become a nonnegligible problem in modern society while it will affect people's nutrition system and economic growth of dairy industry, or even threaten people's lives. Lactose intolerance is a common digestive problem that can be influenced by genetic, environmental, and age-related factors. Genetic factors are often linked to certain ethnic groups, such as Asians and Africans, while environmental factors like digestive health and dietary habits can also affect lactose intolerance. Additionally, as people age, their ability to digest lactose tends to decline. There are three main approaches to treating lactose intolerance. The first is to restrict lactose intake by avoiding foods that are high in lactose, such as milk, cheese, and yogurt. The second is to take lactase supplements to aid in lactose digestion, which is typically recommended for individuals with mild lactose intolerance. The third approach involves improving the composition of gut microbiota, such as by consuming probiotics or fermented foods, to increase lactose tolerance. In conclusion, lactose intolerance is a prevalent digestive issue that can be influenced by various factors. Effective treatment options for lactose intolerance include limiting lactose intake, taking lactase supplements, and improving gut microbiota composition. By following appropriate treatment plans, individuals with lactose intolerance can alleviate symptoms and improve their quality of life. The purpose of the paper is to introduce the principle and reason behind the existence of lactose intolerance, present the classification of the diseases and possible solutions under latest technology development to the public. Thus, the paper

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uses clear sort merge and simple words to ensure that the content is readable and understandable for normal people. Indeed, there are still limitations in the study so far. The modern technology still cannot detect lactose intolerance timely, which may cause sever outcome, especially for children who have congenital lactose intolerance since they cannot digest the essential food resource for infants, which is milk.

References

[1] KATOCH G K, NAIN N, KAUR S, et al. Lactose intolerance and its dietary management: An update[J]. Journal of the American Nutrition Association, 2021, 41(4): 424–434.
[2] LILLO-PÉREZ S, GUERRA-VALLE M, ORELLANA-PALMA P, et al. Probiotics in fruit and vegetable matrices: Opportunities for nondairy consumers[J]. LWT, 2021, 151: 112106.
[3] SZILAGYI A. Adult lactose digestion status and effects on disease[J]. Canadian Journal of Gastroenterology and Hepatology, 2015, 29(3): 149–156.
[4] UGIDOS-RODRÍGUEZ S, MATALLANA-GONZÁLEZ M C, SÁNCHEZ-MATA M C, et al. Lactose malabsorption and intolerance: A Review[J]. Food & Function, 2018, 9(8): 4056–4068.
[5] FASSIO F, FACIONI M, GUAGNINI F, et al. Lactose maldigestion, malabsorption, and intolerance: A comprehensive review with a focus on current management and future perspectives[J]. Nutrients, 2018, 10(11): 1599.
[6] STOUTEN K, WOLFHAGEN F, CASTEL R, et al. Testing for lactase non-persistence in a Dutch population: Genotyping versus the hydrogen breath test[J]. Annals of Clinical Biochemistry: International Journal of Laboratory Medicine, 2023: 000456322311592.
[7] GeeksforGeeks. Lactose Formula. November 18, 2022. Retrieved on March 13, 2023. Retrieved from: https://www.geeksforgeeks.org/lactose-formula/
[8] CHONG C K, BUNN J, NEWLAND P, et al. Lactose intolerance in infants: Harder to investigate now following discontinuation of Clinitest[J]. Archives of Disease in Childhood, 2010, 96(6).
[9] SILANIKOVE N, LEITNER G, MERIN U, et al. The interrelationships between lactose intolerance and the modern dairy industry: Global Perspectives in evolutional and historical backgrounds[J]. Nutrients, 2015, 7(9): 7312–7331.
[10] KLEMM P, DISCHEREIT G, LANGE U, et al. Adult lactose intolerance, calcium intake, bone metabolism and bone density in German-Turkish immigrants[J]. Journal of Bone and Mineral Metabolism, 2019, 38(3): 378–384.
[11] KORNIENKO E, DMITRIENKO M. SU1096 primary and secondary lactose intolerance in children[J]. Gastroenterology, 2013, 144(5).
[12] Edyta M., Ewa F., Jarosław W. LACTOSE INTOLERANCE – CURRENT STATE OF KNOWLEDGE. April 8, 2010.
[13] ProCon.org. Lactose Intolerance by Country - Milk - ProCon.org. Milk.December 6, 2022. Retrieved on March 13, 2023. Retrieved from: https://milk.procon.org/lactose-intolerance-by-country/
[14] Johns Hopkins Medicine. Lactose Intolerance. Retrieved on March 13, 2023. Retrieved from: https://www.hopkinsmedicine.org/health/conditions-and-diseases/lactose-intolerance
[15] Li D.D. Lactose intolerance and dietary nutrition management. October, 2022.
[16] Beijing Youth Daily. Suffering from lactose intolerance? Four ways to ease it. 2022.
[17] Zhang G.W. Why yogurt can overcome lactose intolerance. 2020.