



# **State of the Science Dairy Foods and Health**





This resource provides the current state of the science on dairy's role in:

- Health and wellness topics
- Emerging topics
- Chronic disease management and prevention

We hope you will please consider National Dairy Council as an ongoing resource should you have any future needs or questions about dairy foods, dairy science or education efforts.

**Katie Brown, EdD, RDN**

Senior Vice President, Scientific  
and Nutrition Affairs  
National Dairy Council

**Chris Cifelli, PhD**

Senior Vice President,  
Nutrition Research  
National Dairy Council

**National Dairy Council**, a non-profit organization founded by U.S. dairy farmers in 1915, is committed to research and education about dairy's role in the diet and its contributions to nutrition and health. The U.S. dairy community is working to be an environmental solution to enhance natural resources and ecosystems and has set environmental sustainability goals to achieve greenhouse gas neutrality and improve water usage and quality by 2050.



## Table of Contents

<b>Milk, Cheese, Yogurt and Health</b> .....	<b>2</b>
Yogurt and Health .....	<b>3</b>
Milk and Health .....	<b>7</b>
Cheese and Health .....	<b>11</b>
Milk as a Recommended Beverage .....	<b>15</b>
Dairy and Nutrient Contributions .....	<b>19</b>
Dairy in Healthy Eating Patterns .....	<b>22</b>
<hr/>	
<b>Emerging Topics</b> .....	<b>27</b>
Dairy Innovation .....	<b>28</b>
The Dairy Matrix .....	<b>32</b>
Dairy and Inflammation .....	<b>35</b>
<hr/>	
<b>Public Health Across the Lifespan</b> .....	<b>38</b>
Dairy and Blood Pressure .....	<b>39</b>
Dairy and Sarcopenia and Osteoporosis .....	<b>42</b>
Dairy and Type 2 Diabetes .....	<b>46</b>
Dairy and Bone Health .....	<b>50</b>
Dairy and Cardiovascular Disease .....	<b>54</b>
Dairy and Lactose Intolerance .....	<b>59</b>
Dairy and Infants and Toddlers .....	<b>67</b>





## Milk, Cheese, Yogurt and Health





# Science Summary

## Yogurt & Health



### Overview

Yogurt is a nutrient-rich food that has been nourishing people for centuries. Made by culturing milk, yogurt contributes essential nutrients such as protein, calcium, phosphorus, zinc, vitamin B12, pantothenic acid (B5) and riboflavin (B2) to recommended healthy dietary patterns. Different yogurts help meet different people's health, taste and cooking needs. Yogurt varieties available include low-fat, fat-free, flavored and sweetened options as well as different styles like Greek and Icelandic. Lactose-free yogurt is also available. Emerging research indicates that healthy

dietary patterns that include yogurt may be linked with a reduced risk for chronic diseases, long-term weight maintenance, improved bone health and reduced markers of chronic inflammation. The Dietary Guidelines for Americans (DGA) and the American Academy of Pediatrics (AAP) recommend eating low-fat or fat-free dairy foods like yogurt every day to help meet nutrient needs.

### Eating yogurt helps Americans meet dairy food recommendations

Dairy foods like yogurt are foundational foods in healthy dietary patterns. Healthy dietary patterns, which include dairy foods, are associated with reduced risk for several chronic diseases, including cardiovascular disease (strong evidence) and type 2 diabetes (moderate evidence).<sup>1-3</sup> The DGA also recognizes the importance of consuming dairy foods in healthy dietary patterns to achieve peak bone mineral density in childhood and adolescence.<sup>3-5</sup> The DGA recommends that Americans consume dairy foods as part of healthy dietary patterns throughout the lifespan, beginning in the complementary feeding stage. At about 6 months of age, small amounts of yogurt and cheese can be introduced to infants, depending on developmental readiness.<sup>3</sup> The DGA recommends 1⅔ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12-23 months no longer consuming human milk or infant formula as part of the Healthy U.S.-Style Dietary Pattern. It also recommends 2 daily servings of low-fat or fat-free dairy foods for children 2-3 years, 2½ for children 4-8 years and 3 for those 9 years and older in the Healthy U.S.-Style Dietary Pattern.<sup>3</sup> Young children come the closest to meeting DGA recommendations. Toddlers 12-23 months consume 2½ servings of dairy foods per day, on average.<sup>3</sup> Dairy food consumption tends to fall below recommended amounts by the time children go to school, and this trend carries forward through adolescence and into adulthood.<sup>6</sup> American adults 20 years and older average just 1½ servings of dairy foods daily. Overall, yogurt makes up only about 2 percent of the dairy foods consumed by Americans.<sup>6</sup> Encouraging adults and children to add 1 more daily serving of dairy foods like yogurt to their eating pattern is a practical way to help meet dairy recommendations.<sup>7,8</sup>



## Eating yogurt helps Americans meet nutrient recommendations

Yogurt contains nutrients important for the daily nutrition of Americans. Low-fat yogurt is an excellent source of calcium,<sup>9</sup> a nutrient of public health concern in the U.S. due to low consumption,<sup>6</sup> as well as protein, phosphorus, zinc, vitamin B12, pantothenic acid (B5) and riboflavin (B2).<sup>9\*</sup> Cross-sectional studies conducted in the U.S., Canada and the U.K. indicate that children and adults who ate yogurt on any given day had better diet quality than those who did not eat yogurt.<sup>10-12</sup> Yogurt eaters had a higher intake of several key nutrients including potassium, calcium, magnesium, vitamin D, riboflavin (B2) and fiber compared to non-eaters.<sup>11,12</sup> In children 2-18 years, yogurt provides, on average, about 19 percent of calcium, 11 percent of vitamin D, 12 percent of potassium, 14 percent of vitamin B12 and 10 percent of protein.<sup>12</sup> Among adults 19 years and older, yogurt provides 22 percent of calcium, 16 percent of vitamin D, 11 percent of potassium, 16 percent of vitamin B12 and 11 percent of protein, on average.<sup>12</sup>

Some yogurts contain added sugar to help reduce its natural tartness.<sup>9</sup> The DGA notes that a small amount of added sugar can improve the palatability of nutrient-dense foods, like low-fat and fat-free yogurt, within a healthy eating pattern.<sup>3</sup> Sweetened yogurt contributes to the added sugars intake of Americans in different amounts depending on age. Yogurt contributes about 18 percent of added sugars to the diets of infants 6-11 months, according to national survey data from 2005-2016.<sup>13</sup> Among toddlers 12-24 months, sweetened yogurt contributes 7 percent of added sugars, according to data from 2015-2016,<sup>6</sup> and yogurt contributes about 1 percent of added sugars to the diets of Americans 2 years and older, according to data from 2015-2018.<sup>14</sup>

## Choosing yogurt as a snack can improve the nutrient-density of dietary patterns

Yogurt is among the most nutrient-dense snacks eaten by Americans.<sup>15</sup> Yogurt, like milk and cheese, is a good source of high-quality protein, and as part of a diet higher in protein, yogurt may help promote satiety when eaten as a snack.<sup>16,17</sup> Eating dairy foods, including yogurt, as a snack is linked with better diet quality among young children 2 to 10 years.<sup>18</sup> Adults who regularly ate at least 5 servings of yogurt per week had healthier dietary patterns overall and consumed fewer sweets and sugar-sweetened beverages than adults who consumed less yogurt.<sup>19</sup> Snacking on yogurt can help Americans eat more nutrient-dense diets.

## Research indicates yogurt may be linked with lower risk for cardiovascular disease and type 2 diabetes

Eating yogurt has been linked with a range of health benefits, including a reduced risk for cardiovascular disease (CVD), type 2 diabetes (T2D) and less weight gain over time.<sup>20</sup> In adults, eating yogurt has been linked to a 10 percent lower risk of high blood pressure,<sup>21</sup> and one meta-analysis found that eating at least 7 ounces of yogurt per day was linked with a decreased risk for CVD compared to eating less yogurt.<sup>22</sup> High-quality evidence supports a link between eating yogurt and a reduced risk of T2D as well.<sup>1</sup> Results of two meta-analyses and a follow-up study of 3 large prospective cohort studies indicate that eating yogurt, or increasing yogurt consumption by ½ serving per day, is associated with an 11 to 27 percent lower risk of developing T2D in adults.<sup>2,23,24</sup> Another meta-analysis concluded that eating 60 grams of yogurt per day (245 grams yogurt = one 8-ounce cup) compared to eating no yogurt decreased T2D risk by 17 percent.<sup>25</sup> A recent cross-sectional study reported that, in adults, eating yogurt was associated with lower body weight and body mass index, as well as a 23 percent lower risk of being overweight or obese.<sup>12</sup>

\*USDA FoodData Central (FDC) ID: Low-fat vanilla yogurt 170888. One serving refers to one cup-equivalent. For yogurt, 1 cup-equivalent equals 1 cup.



## Eating yogurt is linked with decreased risk for obesity and inflammation

Emerging evidence indicates that eating yogurt may also support bone health and reduce markers of inflammation.<sup>20,26</sup> Eating yogurt has also been linked with improved markers of bone health in both younger and older adults.<sup>27,28</sup> A meta-analysis of three prospective cohort studies also concluded that eating yogurt was also linked to a reduced risk of hip fracture in older women.<sup>29</sup> Eating yogurt is also not linked to higher levels of inflammation and may help lower markers of inflammation. Healthy pre-menopausal women eating 1½ servings of low-fat yogurt every day for 9 weeks had reduced markers of chronic inflammation compared to women eating a yogurt (non-dairy) alternative.<sup>26</sup> In three additional randomized controlled trials, interventions including yogurt did not increase levels of biomarkers of inflammation.<sup>30–32</sup> More research is needed to confirm these findings.

## What to know about lactose in yogurt

Lactose intolerance (LI) may lead some individuals to avoid or decrease dairy food consumption. Dairy avoidance, whether due to LI or other reasons, can lead to inadequate consumption of important nutrients like calcium.<sup>33</sup> Yogurt does contain lactose; however, the cultures used to make it can help digest lactose in the body. While LI should be diagnosed and treated by a health care professional, the live cultures in yogurt can make it easier for people with LI to tolerate.<sup>34–36</sup> Greek-style and Icelandic-style yogurts are strained after being cultured, which can result in less lactose, more protein and less calcium than unstrained yogurts<sup>9,37,38\*</sup> Lactose-free varieties of yogurt are also available.

\*FDC ID: Traditional Icelandic skyr: 776018

## References

- <sup>1</sup> Drouin-Chartier J-P, Brassard D, Tessier-Grenier M, et al. Systematic Review of the Association between Dairy Product Consumption and Risk of Cardiovascular-Related Clinical Outcomes. *Adv Nutr An Int Rev J*. 2016;7(6):1026-1040. doi:10.3945/an.115.011403
- <sup>2</sup> Alvarez-Bueno C, Caverio-Redondo I, Martinez-Vizcaino V, Sotos-Prieto M, Ruiz JR, Gil A. Effects of Milk and Dairy Product Consumption on Type 2 Diabetes: Overview of Systematic Reviews and Meta-Analyses. *Adv Nutr*. 2019;10(suppl\_2):S154-S163. doi:10.1093/advances/nmy107
- <sup>3</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>4</sup> Kouvelioti R, Josse AR, Klentrou P. Effects of Dairy Consumption on Body Composition and Bone Properties in Youth: A Systematic Review. *Curr Dev Nutr*. 2017;1(8):e001214. doi:10.3945/cdn.117.001214
- <sup>5</sup> de Lamas C, de Castro MJ, Gil-Campos M, Gil Á, Couce ML, Leis R. Effects of Dairy Product Consumption on Height and Bone Mineral Content in Children: A Systematic Review of Controlled Trials. *Adv Nutr*. 2018;10(2):S88-S96. doi:10.1093/advances/nmy096
- <sup>6</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee. [https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport\\_of\\_the\\_2020DietaryGuidelinesAdvisoryCommittee\\_first-print.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf).
- <sup>7</sup> Quann EE, Fulgoni VL, Auestad N. Consuming the daily recommended amounts of dairy products would reduce the prevalence of inadequate micronutrient intakes in the United States: diet modeling study based on NHANES 2007-2010. *Nutr J*. 2015;14(1):90. doi:10.1186/s12937-015-0057-5
- <sup>8</sup> Hess JM, Fulgoni VL, Radlowski EC. Modeling the Impact of Adding a Serving of Dairy Foods to the Healthy Mediterranean-Style Eating Pattern Recommended by the 2015-2020 Dietary Guidelines for Americans. *J Am Coll Nutr*. August 2018:1-9. doi:10.1080/07315724.2018.1485527
- <sup>9</sup> USDA. FoodData Central. <https://fdc.nal.usda.gov/index.html>. Published 2019.
- <sup>10</sup> Hobbs DA, Givens DI, Lovegrove JA. Yogurt consumption is associated with higher nutrient intake, diet quality and favourable metabolic profile in children: a cross-sectional analysis using data from years 1-4 of the National diet and Nutrition Survey, UK. *Eur J Nutr*. 2019;58(1):409-422. doi:10.1007/s00394-017-1605-x
- <sup>11</sup> Vatanparast H, Islam N, Patil RP, et al. Consumption of yogurt in Canada and its contribution to nutrient intake and diet quality among Canadians. *Nutrients*. 2019;11(6). doi:10.3390/nu11061203
- <sup>12</sup> Cifelli CJ, Agarwal S, Fulgoni VL. Association of Yogurt Consumption with Nutrient Intakes, Nutrient Adequacy, and Diet Quality in American Children and Adults. *Nutrients*. 2020;12(11):3435. doi:10.3390/nu12113435
- <sup>13</sup> Herrick KA, Fryar CD, Hamner HC, Park S, Ogden CL. Added Sugars Intake among US Infants and Toddlers. *J Acad Nutr Diet*. 2020;120(1):23-32. doi:10.1016/j.jand.2019.09.007
- <sup>14</sup> National Dairy Council. NHANES 2015-2018. Hyattsville, MD; 2020.



- <sup>15</sup> Hess J, Rao G, Slavin J. The Nutrient Density of Snacks. *Glob Pediatr Heal*. 2017;4:2333794X1769852. doi:10.1177/2333794X17698525
- <sup>16</sup> Panahi S, Fernandez M, Marette A, Tremblay A. Yogurt, diet quality and lifestyle factors. *Eur J Clin Nutr*. 2016;71(10):573-579. doi:10.1038/ejcn.2016.214
- <sup>17</sup> Njike VY, Smith TM, Shuval O, et al. Snack Food, Satiety, and Weight. *Adv Nutr An Int Rev J*. 2016;7(5):866-878. doi:10.3945/an.115.009340
- <sup>18</sup> Iglesia I, Intemann T, De Miguel-Etayo P, et al. Dairy Consumption at Snack Meal Occasions and the Overall Quality of Diet during Childhood. Prospective and Cross-Sectional Analyses from the IDEFICS/I.Family Cohort. *Nutrients*. 2020;12(3):642. doi:10.3390/nu12030642
- <sup>19</sup> Crichton GE, Bogucki OE, Elias MF. Dairy food intake, diet patterns, and health: Findings from the Maine-Syracuse Longitudinal Study. *Int Dairy J*. 2019;91:64-70. doi:10.1016/j.idairyj.2018.12.009
- <sup>20</sup> Savaiano DA, Hutkins RW. Yogurt, cultured fermented milk, and health: a systematic review. *Nutr Rev*. 2020;0(0):1-16. doi:10.1093/nutrit/nuaa013
- <sup>21</sup> Buendia JR, Li Y, Hu FB, et al. Long-term yogurt consumption and risk of incident hypertension in adults. *J Hypertens*. 2018;36(8):1. doi:10.1097/HJH.0000000000001737
- <sup>22</sup> Wu L, Sun D. Consumption of Yogurt and the Incident Risk of Cardiovascular Disease: A Meta-Analysis of Nine Cohort Studies. *Nutrients*. 2017;9(3):315. doi:10.3390/nu9030315
- <sup>23</sup> Companys J, Pla-Pagà L, Calderón-Pérez L, et al. Fermented Dairy Products, Probiotic Supplementation, and Cardiometabolic Diseases: A Systematic Review and Meta-analysis. *Adv Nutr*. 2020;11(4):834-863. doi:10.1093/advances/nmaa030
- <sup>24</sup> Drouin-Chartier JP, Li Y, Ardisson Korat AV, et al. Changes in dairy product consumption and risk of type 2 diabetes: Results from 3 large prospective cohorts of US men and women. *Am J Clin Nutr*. 2019;110(5):1201-1212. doi:10.1093/ajcn/nqz180
- <sup>25</sup> Fan M, Li Y, Wang C, et al. Dietary Protein Consumption and the Risk of Type 2 Diabetes: A Dose-Response Meta-Analysis of Prospective Studies. *Nutrients*. 2019;11(11):2783. doi:10.3390/nu11112783
- <sup>26</sup> Pei R, DiMarco DM, Putt KK, et al. Low-fat yogurt consumption reduces biomarkers of chronic inflammation and inhibits markers of endotoxin exposure in healthy premenopausal women: a randomised controlled trial. *Br J Nutr*. November 2017;1-9. doi:10.1017/S0007114517003038
- <sup>27</sup> Bridge AD, Brown J, Snider H, Ward WE, Roy BD, Josse AR. Consumption of Greek yogurt during 12 weeks of high-impact loading exercise increases bone formation in young, adult males – A secondary analysis from a randomized trial. *Appl Physiol Nutr Metab*. 2020;45(1):91-100. doi:10.1139/apnm-2019-0396
- <sup>28</sup> Laird E, Molloy AM, McNulty H, et al. Greater yogurt consumption is associated with increased bone mineral density and physical function in older adults. *Osteoporos Int*. 2017;28(8):2409-2419. doi:10.1007/s00198-017-4049-5
- <sup>29</sup> Ong AM, Kang K, Weiler HA, Morin SN. Fermented Milk Products and Bone Health in Postmenopausal Women: A Systematic Review of Randomized Controlled Trials, Prospective Cohorts, and Case-Control Studies. *Adv Nutr*. 2020;11(2):251-265. doi:10.1093/advances/nmz108
- <sup>30</sup> Labonté M-È, Cyr A, Abdullah MM, et al. Dairy Product Consumption Has No Impact on Biomarkers of Inflammation among Men and Women with Low-Grade Systemic Inflammation. *J Nutr*. 2014;144(11):1760-1767. doi:10.3945/jn.114.200576
- <sup>31</sup> Dugan CE, Aguilar D, Park Y-K, Lee J-Y, Fernandez ML. Dairy Consumption Lowers Systemic Inflammation and Liver Enzymes in Typically Low-Dairy Consumers with Clinical Characteristics of Metabolic Syndrome. *J Am Coll Nutr*. 2016;35(3):255-261. doi:10.1080/07315724.2015.1022637
- <sup>32</sup> Eelderink C, Rietsema S, Van Vliet IMY, et al. The effect of high compared with low dairy consumption on glucose metabolism, insulin sensitivity, and metabolic flexibility in overweight adults: A randomized crossover trial. *Am J Clin Nutr*. 2019;109(6):1555-1568. doi:10.1093/ajcn/nqz017
- <sup>33</sup> Suchy F, Brannon P, Carpenter T, et al. NIH Lactose Intolerance Development Conference Statement: Lactose Intolerance and Health. *NIH Consens State Sci Conf Statement*. 2010;27:1-27. doi:10.7326/0003-4819-152-12-201006150-00248
- <sup>34</sup> Savaiano DA. Lactose digestion from yogurt: mechanism and relevance. *Am J Clin Nutr*. 2014;99(5 Suppl):1251S-5S. doi:10.3945/ajcn.113.073023
- <sup>35</sup> Micic D, Rao V, Rubin D. Clinical Approaches to Lactose Intolerance. *JAMA*. 2019. doi:10.1001/jama.2019.14740
- <sup>36</sup> Scientific Opinion on lactose thresholds in lactose intolerance and galactosaemia. *EFSA J*. 2010;8(9). doi:10.2903/j.efsa.2010.1777
- <sup>37</sup> What is Greek Yogurt? | Dairy Good. <https://dairygood.org/content/2016/what-is-greek-yogurt?ref=www.nationaldairycouncil.org>. Accessed October 19, 2017.
- <sup>38</sup> What Is Icelandic Yogurt? | U.S. Dairy. <https://www.usdairy.com/news-articles/what-is-icelandic-yogurt>.



# Science Summary

## Milk & Health



### Overview

Milk is a delicious and nutritious beverage produced fresh in every U.S. state. Milk is made possible by dairy farmers committed to responsibly producing milk to nourish Americans while remaining mindful of natural resources. Different milks help meet different people's health, taste and cooking needs. The variety of milks available includes whole, reduced-fat (2% milk fat), low-fat (1% milk fat), fat-free and flavored options. For people

with lactose intolerance (LI), there are lactose-free varieties as well. Milk is a nutrient-rich and affordable source of thirteen essential nutrients like protein, calcium, phosphorus, potassium, zinc, iodine, selenium, magnesium and vitamins A, D, B12, riboflavin (B2) and pantothenic acid (B5) in the U.S. diet. The Dietary Guidelines for Americans (DGA) and the American Academy of Pediatrics (AAP) recommend consuming low-fat or fat-free dairy foods like milk every day as part of healthy dietary patterns to help Americans 2 years and older meet their nutrient needs.

### Drinking milk helps Americans meet dairy food recommendations

Dairy foods like milk are foundational foods in healthy dietary patterns. Healthy dietary patterns, which include low-fat and fat-free dairy foods, are associated with a lower risk for cardiovascular disease, type 2 diabetes and obesity.<sup>1</sup> In adults, drinking milk has been linked to an 8 percent lower risk of high blood pressure and stroke.<sup>2,3</sup> Consuming dairy foods like milk is also linked to improved bone health throughout childhood and into adulthood.<sup>4-9</sup> For older adults, drinking milk and eating other dairy foods is associated with a lower risk of hip fracture in both men and women.<sup>7,9-13</sup>

While cow's milk should not be given to infants before 12 months of age, the 2020 DGA recommends providing small amounts of cheese and yogurt as complementary foods to infants beginning around 6 months of age and depending on developmental readiness. For toddlers 12-23 months who no longer consume human milk, the 2020 DGA recommends 1½ to 2 servings of whole- and reduced-fat dairy foods (whole milk, reduced-fat cheese and reduced-fat plain yogurt) as part of the Healthy U.S.-Style Dietary Pattern.<sup>1</sup> The DGA recommends that children transition to low-fat and fat-free milk, cheese and yogurt at 2 years of age and consume 2 servings of dairy foods daily from 2-3 years. The DGA recommends 2½ daily servings of low-fat or fat-free dairy foods for children 4-8 years and 3 servings for those 9 years and older in the Healthy U.S.-Style Dietary Pattern.<sup>1</sup>



Young children come the closest to meeting DGA recommendations. Toddlers 12-23 months consume 2½ servings of dairy foods per day, on average, most of which is milk.<sup>1</sup> Dairy consumption tends to fall below recommendations by the time children go to school, and this trend carries forward through adolescence and into adulthood.<sup>14</sup> American adults 19 years and older typically consume only 1½ servings of dairy foods daily, about half of which is milk.<sup>15</sup> Encouraging adults and children to add 1 more daily serving of dairy foods like milk to their dietary pattern is a practical way to help meet dairy recommendations.<sup>16,17</sup>

### **Drinking milk helps Americans get the essential nutrients their bodies need**

Milk makes important nutrient contributions to the U.S. diet.<sup>18-20</sup> Adults and children 2 years and older who meet dairy recommendations are less likely to be below recommendations for a number of essential nutrients including calcium, magnesium, phosphorus, protein, riboflavin, vitamin A, vitamin B12, vitamin D, selenium, potassium and choline.<sup>21</sup>

Milk is also the leading food source of three nutrients of public health concern (calcium, vitamin D, potassium) for children 2-18 years and is the leading food source of calcium and vitamin D for all Americans over the age of 2.<sup>15</sup> Milk provides, on average, over 34 percent of the daily vitamin D intake, 19 percent of the daily calcium intake and 9 percent of the daily potassium intake of Americans 2 years and older.<sup>15</sup> For school-age children and adults, adding 1 more serving of low-fat or fat-free dairy foods every day to their current dietary patterns would help meet nutrient needs.<sup>16,17</sup>

### **Nutrients from milk are difficult to replace with most milk alternatives**

Many alternative beverages to milk are available but often are not nutritionally equivalent to milk.<sup>22</sup> Milk contains 8 grams of high-quality protein per 8-ounce cup serving, while almond, rice and coconut “milks” contain 1 or fewer grams of protein per serving, unless fortified.<sup>23\*</sup> Proteins from animal food sources like milk are complete and high-quality because they provide all amino acids. Proteins from plant sources vary in quality.<sup>24</sup> Although the DGA includes soy beverages and yogurt in the dairy group if they are fortified with calcium and vitamins A and D, these fortified soy alternatives are not commonly consumed by Americans and contribute very little nutrition to the average U.S. diet.<sup>1,15</sup> Milk is also an affordable source of key nutrients like calcium and vitamin D.<sup>25</sup> Other beverages, like calcium-fortified orange juice, are not nutritionally equivalent to milk and are more expensive sources of calcium.<sup>25</sup> The DGA notes that alternative beverages, such as almond, rice, coconut and hemp “milks,” are also not nutritionally equivalent to milk and are therefore not included in the dairy group.<sup>1</sup>

### **Drinking milk every day is a healthy habit for children to develop**

Beverages make important contributions to children’s nutrition.<sup>14,18</sup> As children get older, they tend to choose less nutritious beverages, like sugar-sweetened beverages (SSBs), instead of milk.<sup>14</sup> The 2020 DGA recommends choosing water and unsweetened beverages like 100% fruit or vegetable juice or low-fat or fat-free milk or fortified soy beverages within healthy dietary patterns in place of SSBs like soda, fruit drinks, sports and energy drinks.<sup>1</sup> SSBs contribute 25 percent of added sugars in the diets of children 2-5 years<sup>18</sup> and up to 50 percent of added sugars in the diets of adolescents.<sup>26</sup> Flavored milk contributes, on average, approximately 5-6 percent of added sugars<sup>18</sup> to

\* FDC IDs: Almond beverage: 174832; Rice beverage: 171942; Coconut beverage: 174116



the diets of children 2-11 years and only 2 percent of added sugars for adolescents.<sup>26</sup> Through the School Breakfast Program and the National School Lunch Program, schools can offer low-fat and fat-free plain and flavored milks.<sup>27,28</sup> Children who eat school meals (breakfast or lunch) every day report consuming more servings of dairy foods and, subsequently, consume more calcium than children who do not regularly eat school meals.<sup>29</sup> School-aged children who drink flavored milk tend to have higher milk<sup>30</sup> and nutrient consumption (calcium and magnesium), but not necessarily higher added sugars intake, than children who drink only plain milk.<sup>31</sup> Drinking milk is an important habit to develop in childhood and carry forward into adulthood.

## What to know about lactose intolerance and milk allergy

Some people feel discomfort after drinking milk, which may be due to LI or possibly milk allergy (MA). Individuals who are sensitive to lactose (“lactose intolerant”) do not make enough lactase, an enzyme that breaks down lactose during digestion.<sup>32,33</sup> People with LI may experience discomfort like bloating or gas after consuming some dairy products. LI is different from MA, which is an immune reaction to milk protein(s) that can manifest with several different symptoms.<sup>34</sup> While MA is most common among young children, children often “outgrow” MA by early adolescence.<sup>35,36</sup> LI is less common among young children.<sup>33</sup> Dairy avoidance, whether due to MA, LI or other reasons, can lead to inadequate consumption of important nutrients.<sup>32,33</sup> While both MA and LI should be diagnosed and treated by a doctor, people with MA should avoid dairy foods<sup>35</sup> and ensure their diet includes other sources of the essential nutrients contained in dairy foods. Management strategies, like selecting lactose-free milk, consuming dairy foods in smaller servings and eating dairy foods with other foods can help most people with LI continue to enjoy dairy.<sup>33</sup>

Note: One serving refers to 1 cup-equivalent. For milk, 1 cup-equivalent equals 1 cup

## References

- <sup>1</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>2</sup> Soedamah-Muthu SS, de Goede J. Dairy Consumption and Cardiometabolic Diseases: Systematic Review and Updated Meta-Analyses of Prospective Cohort Studies. *Curr Nutr Rep.* 2018;7(4):171-182. doi:10.1007/s13668-018-0253-y
- <sup>3</sup> Buendia JR, Li Y, Hu FB, et al. Regular Yogurt Intake and Risk of Cardiovascular Disease Among Hypertensive Adults. *Am J Hypertens.* 2018;31(5):557-565. doi:10.1093/ajh/hpx220
- <sup>4</sup> Kouvelioti R, Josse AR, Klentrou P. Effects of Dairy Consumption on Body Composition and Bone Properties in Youth: A Systematic Review. *Curr Dev Nutr.* 2017;1(8):e001214. doi:10.3945/cdn.117.001214
- <sup>5</sup> de Lamas C, de Castro MJ, Gil-Campos M, Gil Á, Couce ML, Leis R. Effects of Dairy Product Consumption on Height and Bone Mineral Content in Children: A Systematic Review of Controlled Trials. *Adv Nutr.* 2018;10(2):S88-S96. doi:10.1093/advances/nmy096
- <sup>6</sup> Matia-Martin P, Torrego-Ellacuria M, Larrad-Sainz A, Fernandez-Perez C, Cuesta-Triana F, Rubio-Herrera MA. Effects of Milk and Dairy Products on the Prevention of Osteoporosis and Osteoporotic Fractures in Europeans and Non-Hispanic Whites from North America: A Systematic Review and Updated Meta-Analysis. *Adv Nutr.* 2019;10(2):S120-S143.
- <sup>7</sup> Ong AM, Kang K, Weiler HA, Morin SN. Fermented Milk Products and Bone Health in Postmenopausal Women: A Systematic Review of Randomized Controlled Trials, Prospective Cohorts, and Case-Control Studies. *Adv Nutr.* 2020;11(2):251-265. doi:10.1093/advances/nmz108
- <sup>8</sup> Savaiano DA, Hutkins RW. Yogurt, cultured fermented milk, and health: a systematic review. *Nutr Rev.* 2020;0(0):1-16. doi:10.1093/nutrit/nuaa013
- <sup>9</sup> Shi Y, Zhan Y, Chen Y, Jiang Y. Effects of dairy products on bone mineral density in healthy postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. *Arch Osteoporos.* 2020;15(1):1-8. doi:10.1007/s11657-020-0694-y
- <sup>10</sup> Hidayat K, Du X, Shi BM, Qin LQ. Systematic review and meta-analysis of the association between dairy consumption and the risk of hip fracture: critical interpretation of the currently available evidence. *Osteoporos Int.* 2020;31(8):1411-1425. doi:10.1007/s00198-020-05383-3
- <sup>11</sup> Fabiani R, Naldini G, Chiavarini M. Dietary patterns in relation to low bone mineral density and fracture risk: A systematic review and meta-analysis. *Adv Nutr.* 2019;10(2):219-236. doi:10.1093/advances/nmy073



- <sup>12</sup> Malmir H, Larijani B, Esmailzadeh A. Consumption of milk and dairy products and risk of osteoporosis and hip fracture: a systematic review and Meta-analysis. *Crit Rev Food Sci Nutr*. 2020;60(10):1722-1737. doi:10.1080/10408398.2019.1590800
- <sup>13</sup> Wallace TC, Bailey RL, Lappe J, et al. Dairy intake and bone health across the lifespan: a systematic review and expert narrative. *Crit Rev Food Sci Nutr*. 2020. doi:10.1080/10408398.2020.1810624
- <sup>14</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee. [https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport\\_of\\_the\\_2020DietaryGuidelinesAdvisoryCommittee\\_first-print.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf).
- <sup>15</sup> National Dairy Council. NHANES 2015-2018. Hyattsville, MD; 2020.
- <sup>16</sup> Quann EE, Fulgoni VL, Auestad N. Consuming the daily recommended amounts of dairy products would reduce the prevalence of inadequate micronutrient intakes in the United States: diet modeling study based on NHANES 2007-2010. *Nutr J*. 2015;14:90. doi:10.1186/s12937-015-0057-5
- <sup>17</sup> Hess JM, Fulgoni VL, Radlowski EC. Modeling the Impact of Adding a Serving of Dairy Foods to the Healthy Mediterranean-Style Eating Pattern Recommended by the 2015-2020 Dietary Guidelines for Americans. *J Am Coll Nutr*. August 2018;1-9. doi:10.1080/07315724.2018.1485527
- <sup>18</sup> O'Neil CE, Nicklas TA, Fulgoni VL, III. Food Sources of Energy and Nutrients of Public Health Concern and Nutrients to Limit with a Focus on Milk and other Dairy Foods in Children 2 to 18 Years of Age: National Health and Nutrition Examination Survey, 2011-2014. *Nutrients*. 2018;10(8). doi:10.3390/nu10081050
- <sup>19</sup> O'Neil C, Keast D, Fulgoni V, Nicklas T. Food Sources of Energy and Nutrients among Adults in the US: NHANES 2003-2006. *Nutrients*. 2012;4(12):2097-2120. doi:10.3390/nu4122097
- <sup>20</sup> Huth PJ, Fulgoni VL, Keast DR, Park K, Auestad N. Major food sources of calories, added sugars, and saturated fat and their contribution to essential nutrient intakes in the U.S. diet: data from the National Health and Nutrition Examination Survey (2003-2006). *Nutr J*. 2013;12:116. doi:10.1186/1475-2891-12-116
- <sup>21</sup> Hess JM, Cifelli CJ, Fulgoni III VL. Energy and Nutrient Intake of Americans according to Meeting Current Dairy Recommendations. *Nutrients*. 2020;12(10):3006. doi:10.3390/nu12103006
- <sup>22</sup> Scholz-Ahrens KE, Ahrens F, Barth CA. Nutritional and health attributes of milk and milk imitations. *Eur J Nutr*. 2020;59(1):19-34. doi:10.1007/s00394-019-01936-3
- <sup>23</sup> USDA. FoodData Central. <https://fdc.nal.usda.gov/index.html>. Published 2019.
- <sup>24</sup> Schaafsma G. The Protein Digestibility-Corrected Amino Acid Score. *J Nutr*. 2000;130(7):1865S - 1867. <http://jn.nutrition.org/content/130/7/1865S>. long. Accessed July 24, 2014.
- <sup>25</sup> Hess JM, Cifelli CJ, Agarwal S, Fulgoni VL. Comparing the cost of essential nutrients from different food sources in the American diet using NHANES 2011-2014. *Nutr J*. 2019;18(1):68. doi:10.1186/s12937-019-0496-5
- <sup>26</sup> Leme AC, Baranowski T, Thompson D, et al. Top food sources of percentage of energy, nutrients to limit and total gram amount consumed among US adolescents: National Health and Nutrition Examination Survey 2011-2014. *Public Health Nutr*. 2019;22(4):661-671. doi:10.1017/S1368980018002884
- <sup>27</sup> Department of Agriculture Food and Nutrition Service. Nutrition Standards in the National School Lunch and School Breakfast Programs. Vol 77.; 2012. <https://www.gpo.gov/fdsys/pkg/FR-2012-01-26/pdf/2012-1010.pdf>.
- <sup>28</sup> USDA Food and Nutrition Service. Child Nutrition Programs: Flexibilities for Milk, Whole Grains, and Sodium Requirements.; 2018. [www.gpo.gov/frsubs](http://www.gpo.gov/frsubs). Accessed December 1, 2020.
- <sup>29</sup> Au LE, Gurzo K, Gosliner W, Webb KL, Crawford PB, Ritchie LD. Eating School Meals Daily Is Associated with Healthier Dietary Intakes: The Healthy Communities Study. *J Acad Nutr Diet*. 2018;118(8):1474-1481.e1. doi:10.1016/j.jand.2018.01.010
- <sup>30</sup> Fayet-Moore F. Effect of flavored milk vs plain milk on total milk intake and nutrient provision in children. *Nutr Rev*. 2016;74(1):1-17. doi:10.1093/nutrit/nuv031
- <sup>31</sup> Nicklas TA, O'Neil C, Fulgoni V. Flavored Milk Consumers Drank More Milk and Had a Higher Prevalence of Meeting Calcium Recommendation Than Nonconsumers. *J Sch Health*. 2017;87(9):650-657. doi:10.1111/josh.12537
- <sup>32</sup> Silberman ES, Jin J. Lactose Intolerance. *JAMA - J Am Med Assoc*. 2019;322(16):1620. doi:10.1001/jama.2019.9608
- <sup>33</sup> Suchy F, Brannon P, Carpenter T, et al. NIH Lactose Intolerance Development Conference Statement: Lactose Intolerance and Health. *NIH Consens State Sci Conf Statement*. 2010;27:1-27. doi:10.7326/0003-4819-152-12-201006150-00248
- <sup>34</sup> Koletzko S, Niggemann B, Arato A, et al. Diagnostic Approach and Management of Cow's-Milk Protein Allergy in Infants and Children. *J Pediatr Gastroenterol Nutr*. 2012;55(2):221-229. doi:10.1097/MPG.0b013e31825c9482
- <sup>35</sup> National Academies of Sciences, Engineering and M. Finding a Path to Safety in Food Allergy. (Stallings VA, Oria MP, eds.). Washington, D.C.: National Academies Press; 2017. <https://www.nap.edu/read/23658/chapter/1>. Accessed September 15, 2017.
- <sup>36</sup> Savage J, Sicherer S, Wood R. The Natural History of Food Allergy. *J Allergy Clin Immunol Pract*. 2016;4(2):196-203. doi:10.1016/J.JAIP.2015.11.024



# Science Summary

## Cheese & Health



### Overview

Cheese is delicious and nutritious and can start with just 3 ingredients: milk, starter culture and salt. This process can be done in so many ways that there are nearly 2,000 varieties of cheese. Cheese is also a nutrient-rich food that contributes protein, calcium, phosphorus and vitamin A to the U.S. diet. For vegetarians, cheese and other dairy foods are important sources of high-quality protein. For people with lactose intolerance (LI), cheese can be a source of dairy nutrients with minimal lactose. Three servings of low-fat and fat-free dairy foods, including cheese, are recommended for Americans 9 years and older as part of the Healthy U.S.-Style and Healthy Vegetarian Dietary Patterns in the 2020 Dietary Guidelines for Americans (DGA). A 2016 systematic review concluded that eating cheese is not associated with cardiovascular disease (CVD) risk, based on high-quality evidence, and may be

associated with a lower risk for stroke and type 2 diabetes (T2D), based on moderate-quality evidence. Cheese can be an important and nutrient-dense part of healthy dietary patterns.

### Eating cheese helps Americans meet dairy food recommendations

Dairy foods like cheese are foundational foods in healthy dietary patterns. Healthy dietary patterns, which include low-fat and fat-free dairy foods, are associated with lower risk for both CVD and T2D.<sup>1</sup> Eating dairy foods is also linked to improved bone health, especially in children and adolescents.<sup>2,3</sup> Limited evidence also indicates that eating cheese daily is linked to a protective effect on bone health in adults as well.<sup>4</sup>

Cheese can be included in healthy dietary patterns across the lifespan. The 2020 DGA recommends providing small amounts of cheese and yogurt as complementary foods to infants beginning around 6 months of age, depending on developmental readiness. While cow's milk should not be given to infants before 12 months of age, the 2020 DGA recommends 1½ to 2 servings of whole- and reduced-fat dairy foods (whole milk, reduced-fat cheese and reduced-fat plain yogurt) for toddlers 12-23 months who no longer consume human milk as part of the Healthy U.S.-Style Dietary Pattern.<sup>1</sup> Children can transition to low-fat and fat-free dairy foods like cheese beginning at 2 years of age. The 2020 DGA recommends 2 daily servings of low-fat or fat-free dairy foods for children 2-3 years, 2½ for children 4-8 years and 3 for those 9 years and older in the Healthy U.S.-Style Dietary Pattern.<sup>1</sup>

Young children come the closest to meeting DGA recommendations. Toddlers 12-23 months years eat 2½ servings of dairy foods per day, on average.<sup>1</sup> Dairy food consumption tends to fall below recommended amounts by the time children go to school, and this trend carries forward through adolescence and into adulthood.<sup>1</sup> American adults 20 years and older average just 1½ servings of dairy foods daily.<sup>1</sup> Encouraging adults and children to add 1 more daily serving of dairy foods like cheese to their dietary patterns is a practical way to help meet dairy recommendations.<sup>5,6</sup>



## Eating cheese helps Americans meet nutrient recommendations

Cheese makes important nutrient contributions to the U.S. diet.<sup>7</sup> Cheese is a good source of high-quality protein and contributes other essential nutrients such as calcium, phosphorus and vitamin A to the U.S. diet.<sup>7,8</sup> Cheese provides about 28 percent of calcium, 9 percent of protein, 9 percent of vitamin D, 13 percent of vitamin A and 8 percent of vitamin B12 to the diets of Americans 2 years and older, on average, and contributes approximately 11 percent of total fat, 18 percent of saturated fat and 6 percent of total calories.<sup>9</sup> Cheese is the second leading food source of dietary calcium in the U.S. diet (after milk) for Americans 2 years and older.<sup>9</sup> With thousands of varieties of cheese available worldwide, there are many options for incorporating cheese into healthy dietary patterns.

For those with LI, avoiding dairy foods can lead to inadequate consumption of shortfall nutrients like calcium.<sup>10</sup> Eating small amounts of aged, hard cheeses such as Parmesan, Cheddar and Swiss, which contain minimal lactose, may be an effective approach to manage LI and still consume important dairy nutrients.<sup>10,11</sup> For vegetarians, cheese and other dairy foods can be important sources of high-quality protein. Even in the context of a plant-rich diet, it is important to consume adequate amounts of dairy foods such as cheese to meet nutrient needs.<sup>1</sup> Low-fat or fat-free dairy foods are included in all of the dietary patterns within the 2020 DGA, including the Healthy Vegetarian Dietary Pattern.<sup>1</sup>

---

## What to know about sodium in cheese

Sodium, in the form of salt, is essential to cheesemaking. It helps develop flavors, consistency and texture and helps preserve cheese and prevent spoilage.<sup>12</sup> Although cheese is a source of sodium in the U.S. diet,<sup>9</sup> different cheeses contain different amounts of sodium. Some cheeses like Swiss and ricotta cheese tend to be made with less sodium and are naturally low-sodium choices. Advances in food science have also made it possible to reduce the sodium in cheese while maintaining flavor, quality and safety.<sup>12</sup>

Reducing sodium consumption, increasing potassium consumption and engaging in regular physical activity can help lower blood pressure for those with prehypertension or hypertension.<sup>13</sup> A systematic review concluded that high-quality evidence indicates no link between cheese consumption and the risk for hypertension.<sup>14</sup> In other studies, cheese consumption was related to reduced blood pressure, as well as an 8 percent lower risk of developing high blood pressure.<sup>15</sup> Cheese can also be incorporated into the Dietary Approaches to Stop Hypertension (DASH) diet, a dietary pattern high in fruit, vegetables and low-fat dairy foods, recommended by the American Heart Association to lower blood pressure.<sup>16-19</sup> The 2020 DGA highlights the DASH diet and reduced sodium consumption as effective dietary strategies for adults who would benefit from lowering their blood pressure.<sup>1</sup>

---

## Eating cheese may be linked with health benefits

Eating cheese has also been linked with health benefits. Systematic reviews found that moderate-quality evidence indicates eating cheese may be associated with a lower risk for T2D.<sup>14,20</sup> Evidence from a meta-analysis also supports a link between eating cheese and a 10 percent lower risk for stroke, with the largest risk reductions observed with daily consumption of about 40 grams (~1½ ounce) of cheese.<sup>21</sup> Another study found that the risk of developing T2D may depend on the types and food sources of saturated fatty acids (SFA).<sup>22</sup> While there was no relationship between overall SFA intake and the risk of developing T2D, consumption of SFA commonly found in cheese was related to a lower risk of developing T2D.<sup>22</sup>



Links between cheese consumption and CVD risk differ from what would be expected based on the SFA content of cheese. A systematic review found that high-quality evidence from two meta-analyses and a prospective study indicated no association between cheese consumption and CVD risk.<sup>14</sup> Several additional studies concluded that eating cheese was linked to a lower risk of CVD, including stroke.<sup>23-26</sup> This difference in the expected versus observed health impacts of cheese may be due to the unique physical structure, or matrix, of protein, vitamins and minerals in cheese.<sup>27</sup> More research is needed to understand if the links between cheese and T2D and CVD are due to the amount of SFA in cheese, nutrients such as calcium or the physical structure of cheese.

## Cheese can be part of healthy dietary patterns

The DGA recommends low-fat or fat-free dairy foods for Americans ages 2 years and older.<sup>1</sup> The majority of cheese eaten in the U.S., however, is not low-fat or fat-free. Low-fat and fat-free cheese account for less than 1 percent of total cheese sales in the U.S.<sup>28</sup> However, food pattern modeling indicates that one serving of whole- or reduced-fat cheese can be incorporated into healthy dietary patterns while staying within recommended calorie and saturated fat levels.<sup>29</sup> Eating cheese can be part of a healthy dietary pattern.

## References

- <sup>1</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>2</sup> Kouvelioti R, Josse AR, Klentrou P. Effects of Dairy Consumption on Body Composition and Bone Properties in Youth: A Systematic Review. *Curr Dev Nutr*. 2017;1(8):e001214. doi:10.3945/cdn.117.001214
- <sup>3</sup> de Lamas C, de Castro MJ, Gil-Campos M, Gil Á, Couce ML, Leis R. Effects of Dairy Product Consumption on Height and Bone Mineral Content in Children: A Systematic Review of Controlled Trials. *Adv Nutr*. 2018;10(2):S88-S96. doi:10.1093/advances/nmy096
- <sup>4</sup> Ong AM, Kang K, Weiler HA, Morin SN. Fermented Milk Products and Bone Health in Postmenopausal Women: A Systematic Review of Randomized Controlled Trials, Prospective Cohorts, and Case-Control Studies. *Adv Nutr*. 2020;11(2):251-265. doi:10.1093/advances/nmz108
- <sup>5</sup> Quann EE, Fulgoni VL, Auestad N. Consuming the daily recommended amounts of dairy products would reduce the prevalence of inadequate micronutrient intakes in the United States: diet modeling study based on NHANES 2007-2010. *Nutr J*. 2015;14(1):90. doi:10.1186/s12937-015-0057-5
- <sup>6</sup> Hess JM, Fulgoni VL, Radlowski EC. Modeling the Impact of Adding a Serving of Dairy Foods to the Healthy Mediterranean-Style Eating Pattern Recommended by the 2015-2020 Dietary Guidelines for Americans. *J Am Coll Nutr*. August 2018;1-9. doi:10.1080/07315724.2018.1485527
- <sup>7</sup> Huth PJ, Fulgoni VL, Keast DR, Park K, Auestad N. Major food sources of calories, added sugars, and saturated fat and their contribution to essential nutrient intakes in the U.S. diet: data from the national health and nutrition examination survey (2003-2006). *Nutr J*. 2013;12(1):116. doi:10.1186/1475-2891-12-116
- <sup>8</sup> Hess JM, Cifelli CJ, Fulgoni III VL. Energy and Nutrient Intake of Americans according to Meeting Current Dairy Recommendations. *Nutrients*. 2020;12(10):3006. doi:10.3390/nu12103006
- <sup>9</sup> National Dairy Council. NHANES 2015-2018. Hyattsville, MD; 2020.
- <sup>10</sup> Silberman ES, Jin J. Lactose Intolerance. *JAMA - J Am Med Assoc*. 2019;322(16):1620. doi:10.1001/jama.2019.9608
- <sup>11</sup> Dekker P, Koenders D, Bruins M. Lactose-Free Dairy Products: Market Developments, Production, Nutrition and Health Benefits. *Nutrients*. 2019;11(3):551. doi:10.3390/nu11030551
- <sup>12</sup> Bansal V, Mishra SK. Reduced sodium cheeses: Implications of reducing sodium chloride on cheese quality and safety. *Compr Rev Food Sci Food Saf*. 2020;19(2):733-758. doi:10.1111/1541-4337.12524
- <sup>13</sup> Whelton PK, Appel LJ, Sacco RL, et al. Sodium, blood pressure, and cardiovascular disease: Further evidence supporting the American Heart Association sodium reduction recommendations. *Circulation*. 2012;126(24):2880-2889. doi:10.1161/CIR.0b013e318279acbf
- <sup>14</sup> Drouin-Chartier J-P, Brassard D, Tessier-Grenier M, et al. Systematic Review of the Association between Dairy Product Consumption and Risk of Cardiovascular-Related Clinical Outcomes. *Adv Nutr An Int Rev J*. 2016;7(6):1026-1040. doi:10.3945/an.115.011403
- <sup>15</sup> Buendia JR, Li Y, Hu FB, et al. Regular Yogurt Intake and Risk of Cardiovascular Disease Among Hypertensive Adults. *Am J Hypertens*. 2018;31(5):557-565. doi:10.1093/ajh/hpx220
- <sup>16</sup> Appel LJ, Moore TJ, Obarzanek E, et al. A Clinical Trial of the Effects of Dietary Patterns on Blood Pressure. *N Engl J Med*. 1997;336(16):1117-1124. doi:10.1056/NEJM199704173361601
- <sup>17</sup> Chobanian A V, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertens (Dallas, Tex 1979)*. 2003;42(6):1206-1252. doi:10.1161/01.HYP.0000107251.49515.c2



- <sup>18</sup> United States Department of Agriculture, United States Department of Health and Human Services, National Heart Lung and Blood Institute. In Brief: Your Guide to Lowering Your Blood Pressure with DASH. [https://www.nhlbi.nih.gov/files/docs/public/heart/dash\\_brief.pdf](https://www.nhlbi.nih.gov/files/docs/public/heart/dash_brief.pdf). Accessed December 13, 2017.
- <sup>19</sup> Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: a randomized controlled trial. *Am J Clin Nutr*. December 2015;ajcn.115.123281-. doi:10.3945/ajcn.115.123281
- <sup>20</sup> Alvarez-Bueno C, Cervero-Redondo I, Martinez-Vizcaino V, Sotos-Prieto M, Ruiz JR, Gil A. Effects of Milk and Dairy Product Consumption on Type 2 Diabetes: Overview of Systematic Reviews and Meta-Analyses. *Adv Nutr*. 2019;10(suppl\_2):S154-S163. doi:10.1093/advances/nmy107
- <sup>21</sup> Chen G-C, Wang Y, Tong X, et al. Cheese consumption and risk of cardiovascular disease: a meta-analysis of prospective studies. *Eur J Nutr*. 2017;56(8):2565-2575. doi:10.1007/s00394-016-1292-z
- <sup>22</sup> Liu S, van der Schouw YT, Soedamah-Muthu SS, Spijkerman AMW, Sluijs I. Intake of dietary saturated fatty acids and risk of type 2 diabetes in the European Prospective Investigation into Cancer and Nutrition-Netherlands cohort: associations by types, sources of fatty acids and substitution by macronutrients. *Eur J Nutr*. 2019;58(3):1125-1136. doi:10.1007/s00394-018-1630-4
- <sup>23</sup> Qin L-Q, Xu J-Y, Han S-F, Zhang Z-L, Zhao Y-Y, Szeto IM. Dairy consumption and risk of cardiovascular disease: an updated meta-analysis of prospective cohort studies. *Asia Pac J Clin Nutr*. 2015;24(1):90-100. doi:10.6133/apjcn.2015.24.1.09
- <sup>24</sup> Alexander DD, Bylsma LC, Vargas AJ, et al. Dairy consumption and CVD: a systematic review and meta-analysis. *Br J Nutr*. 2016;115(4):737-750. doi:10.1017/S0007114515005000
- <sup>25</sup> Soedamah-Muthu SS, de Goede J. Dairy Consumption and Cardiometabolic Diseases: Systematic Review and Updated Meta-Analyses of Prospective Cohort Studies. *Curr Nutr Rep*. 2018;7(4):171-182. doi:10.1007/s13668-018-0253-y
- <sup>26</sup> Johansson I, Esberg A, Nilsson LM, Jansson JH, Wennberg P, Winkvist A. Dairy product intake and cardiometabolic diseases in Northern Sweden: A 33-year prospective cohort study. *Nutrients*. 2019;11(2). doi:10.3390/nu11020284
- <sup>27</sup> Thorning TK, Bertram HC, Bonjour J-P, et al. Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. *Am J Clin Nutr*. 2017;105(5):1033-1045. doi:10.3945/ajcn.116.151548
- <sup>28</sup> IRI database, MULO+C (multi-outlets + c-stores); based on calendar years 2017 through October 2020.
- <sup>29</sup> Hess JM, Cifelli CJ, Fulgoni VL. Modeling the Impact of Fat Flexibility With Dairy Food Servings in the 2015–2020 Dietary Guidelines for Americans Healthy U.S.-Style Eating Pattern. *Front Nutr*. 2020;7:595880. doi:10.3389/fnut.2020.595880

**Note:** One serving refers to 1 cup-equivalent. For cheese, 1 cup-equivalent equals 1 ½-ounce portion of natural cheese (cheddar, mozzarella, Parmesan) or 2 oz processed cheese.



# Science Summary

## Milk as a Recommended Beverage



### Overview



Drinking milk helps children, adolescents and adults in the U.S. meet their nutrient needs, including for nutrients of public health concern. Leading health organizations recommend drinking milk as a critical component of healthy diets for young children, and the 2020 Dietary Guidelines for Americans (DGA) recommends choosing low-fat or fat-free milk as a beverage as part of healthy dietary patterns for Americans 2 years and older. Research indicates that consuming

dairy foods, including milk, is not related to an increased risk of obesity in children, adolescents or adults and may help reduce risk. Encouraging adults and children to add 1 more daily serving of dairy foods like milk to their dietary pattern is a practical way to help Americans meet dairy recommendations.

### Drinking milk is an affordable way for Americans to meet their nutrient needs

The 2020 DGA recommends 3 daily servings of low-fat or fat-free dairy foods, including milk, for those 9 years and older, 2 1/2 for children 4-8 years and 2 for children 2-3 years as part of the Healthy U.S.-Style Dietary Pattern.<sup>1</sup> It also recommends 1½ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12-23 months. While children under 12 months of age should not drink cow's milk, the DGA recommends providing small amounts of yogurt and cheese to infants 6-12 months, depending on developmental readiness.<sup>1</sup> Adults and children 2 years of age and older who meet dairy recommendations are less likely to be below recommendations for a number of essential nutrients including calcium, magnesium, phosphorus, protein, riboflavin, vitamin A, vitamin B12, vitamin D, selenium, potassium and choline.<sup>2</sup> Milk is also the leading food source of three nutrients of public health concern (calcium, vitamin D, potassium) for children 2-18 years and is the leading food source of calcium and vitamin D for all Americans over the age of two.<sup>3</sup> Milk provides, on average, over 35% of the daily vitamin D, 19% of the daily calcium and 9% of the daily potassium intake of Americans 2 years and older.<sup>3</sup>

Yet fewer than 1 in 3 children 2-18 years and roughly 1 in 7 adults 19 years and older meet recommendations for dairy intake.<sup>2</sup> On average, young children come the closest to meeting dairy recommendations, and dairy consumption tends to fall below recommended amounts by the time children go to school, a trend that continues through adolescence and into adulthood.<sup>4</sup> Toddlers 12-23 months years consume 2½ servings of dairy foods per



day, on average, most of which is milk.<sup>1</sup> American adults 19 years and older typically consume only 1½ servings of dairy foods daily, about half of which is milk.<sup>3</sup> Because a serving of low-fat milk costs about 20 cents,<sup>5\*</sup> drinking milk is also a practical and affordable way to help close or reduce nutrient gaps and meet dairy recommendations. Dairy foods including milk are the lowest cost sources of dietary calcium and vitamin D in the U.S. diet and are among the lowest cost sources of potassium, magnesium, vitamin A, riboflavin (B2) and vitamin B12.<sup>6,7</sup>

### **Drinking milk helps achieve nutrient adequacy within recommended limits for energy and added sugars**

The 2020 DGA recommends choosing water and unsweetened beverages like 100% fruit or vegetable juice or low-fat or fat-free milk or fortified soy beverages within healthy dietary patterns in place of sugar-sweetened beverages (SSBs) like soda, fruit drinks, sports and energy drinks.<sup>1</sup> SSBs are not a component of USDA Dietary Patterns and are not necessary in the child or adolescent diet.<sup>1</sup> Nonetheless, as children age, they tend to choose less nutritious beverages, like SSBs, instead of milk, a trend that carries through to adulthood.<sup>4</sup> Consumption of milk drops significantly with age, with milk accounting for almost one-third (32.1%) of beverage intake for 2–5 years of age but dropping to less than 15% of beverage intake among adolescents and teenagers 12–19 years.<sup>8</sup> Children 4–19 years who consume most of their beverage calories from sources other than milk and 100% fruit juice had lower diet quality scores and consumed more calories and added sugars than children who consumed most of their beverage calories from milk or 100% fruit juice.<sup>9</sup> The 2020 DGA notes, “increasing intakes of sugar-sweetened beverages and decreasing intakes of dairy are dietary components with notable and concerning shifts in consumption throughout youth.”<sup>1</sup>

Plain milk provides no added sugars and flavored milk provides, on average, 5–6% of added sugars<sup>10</sup> to the diets of children 2–11 years and about 2% of added sugars to the diets of adolescents.<sup>11</sup> The American Academy of Pediatrics (AAP) Policy Statement on snacks, sweetened beverages, added sugars and schools supports the addition of small amounts of sugars to nutrient-dense foods like milk to increase consumption by children.<sup>12</sup> The AAP uses flavored milk as an example of the balance needed to limit added sugars while still promoting nutrient-rich foods.

### **Leading health organizations recommend young children drink milk as part of a healthy dietary pattern**

Four leading health organizations, the Academy of Nutrition and Dietetics, the American Academy of Pediatric Dentistry, the AAP and the American Heart Association published Healthy Beverage Recommendations for children 0–5 years of age.<sup>13</sup> The statement recognizes milk as a “critical component of a healthy diet” and recommends 2–3 cups per day of whole milk for children 12–24 months, 2 cups of low-fat or fat-free milk for children 2–3 years and 2½ cups of low-fat or fat-free milk for children 4–5 years. The DGA and Healthy Beverage Recommendations statement align in their recommendations that children should not consume plant-based milk alternative beverages, except for fortified soy beverage. As the Healthy Beverage Recommendations statement asserts, non-soy plant-based beverages are inconsistently formulated, meaning they vary in nutrient and added sugar content, and are “not an equal substitute for cow’s milk.”<sup>13</sup>

\*Milk cost (approximately 20 cents per serving) based on U.S. average price of unflavored, branded and private label milk per gallon.



## Research indicates beneficial or neutral links between consuming dairy foods and obesity

Obesity is a critical public health concern in the U.S. and puts children and adults at risk for poor health in the immediate and long term.<sup>14</sup> The 2020 DGA states that healthy dietary patterns are associated with a lower risk of obesity. Research conducted since 2015 indicates that consuming dairy foods including milk in recommended amounts is linked with beneficial impacts on children's body mass index (BMI) and that children and adolescents consuming dairy foods as part of calorie-balanced dietary patterns are more likely to achieve a lean body type. Results of two meta-analyses,<sup>15,16</sup> one systematic review,<sup>17</sup> and seven prospective cohort and cross-sectional studies<sup>18-24</sup> indicate that consuming dairy foods, including milk, in recommended amounts is not related to measures of childhood obesity.

Drinking milk is also not related to an increased risk of being overweight in adults and may reduce the risk of becoming overweight or developing obesity. A systematic review including 16 studies on milk intake found that drinking milk reduced obesity risk in adults by 23%.<sup>16</sup> A meta-analysis of six studies found no evidence that consuming dairy foods, including milk, was linked with an increased risk of overweight and obesity in adults.<sup>25</sup> A second meta-analysis found that, in the context of an energy-restricted diet, higher intake of dairy foods like milk resulted in lower fat mass and body weight.<sup>26</sup>

Emerging evidence from randomized controlled trials and prospective observational studies also indicates a potential beneficial effect of consuming dairy foods, including milk, on adiposity measures in adult women.<sup>27-30</sup> More research is needed to fully describe the associations between consuming dairy foods as part of a calorie-balance healthy dietary pattern and healthy weight maintenance.

## References

- <sup>1</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>2</sup> Hess JM, Cifelli CJ, Fulgoni III VL. Energy and Nutrient Intake of Americans according to Meeting Current Dairy Recommendations. *Nutrients*. 2020;12(10):3006. doi:10.3390/nu12103006
- <sup>3</sup> National Dairy Council. Sources of Nutrients in the Diet of Americans- an Analysis of NHANES 2015-2018. Data Source Centers Dis Control Prev Natl Cent Heal Stat Natl Heal Nutr Exam Surv Data. 2020.
- <sup>4</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee. [https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport\\_of\\_the\\_2020DietaryGuidelinesAdvisoryCommittee\\_first-print.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf).
- <sup>5</sup> IRI Multi Outlet + Conv 2020, YTD ending 10-4-20.
- <sup>6</sup> Drewnowski A. The contribution of milk and milk products to micronutrient density and affordability of the U.S. diet. *J Am Coll Nutr*. 2011;30(5 Suppl 1):422S-8S. <http://www.ncbi.nlm.nih.gov/pubmed/22081688>. Accessed September 29, 2017.
- <sup>7</sup> Hess J, Cifelli C, Agarwal S, Fulgoni V, III. Comparing the Cost of Essential Nutrients from Different Food Sources in the American Diet (OR20-04-19). *Curr Dev Nutr*. 2019;3(Suppl 1). doi:10.1093/cdn/nzz047. OR20-04-19
- <sup>8</sup> Herrick KA, Terry AL, Afful J. Beverage Consumption Among Youth in the United States, 2013-2016.; 2018. [https://www.cdc.gov/nchs/data/databriefs/db320\\_table.pdf#2](https://www.cdc.gov/nchs/data/databriefs/db320_table.pdf#2). Accessed November 4, 2020.
- <sup>9</sup> Maillot M, Rehm CD, Vieux F, Rose CM, Drewnowski A. Beverage consumption patterns among 4-19 y old children in 2009-14 NHANES show that the milk and 100% juice pattern is associated with better diets. *Nutr J*. 2018;17(1):54. doi:10.1186/s12937-018-0363-9
- <sup>10</sup> O'Neil CE, Nicklas TA, Fulgoni VL, III. Food Sources of Energy and Nutrients of Public Health Concern and Nutrients to Limit with a Focus on Milk and other Dairy Foods in Children 2 to 18 Years of Age: National Health and Nutrition Examination Survey, 2011-2014. *Nutrients*. 2018;10(8). doi:10.3390/nu10081050
- <sup>11</sup> Leme AC, Baranowski T, Thompson D, et al. Top food sources of percentage of energy, nutrients to limit and total gram amount consumed among US adolescents: National Health and Nutrition Examination Survey 2011-2014. *Public Health Nutr*. 2019;22(4):661-671. doi:10.1017/S1368980018002884
- <sup>12</sup> Committee on Nutrition. Snacks, sweetened beverages, added sugars, and schools. *Pediatrics*. 2015;135(3):575-583. doi:10.1542/peds.2014-3902
- <sup>13</sup> Lott M, Callahan E, Welker Duffy E, Story M, Daniels S. Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Consensus Statement. Durham, NC; 2019. <https://healthyeatingresearch.org/wp-content/uploads/2019/09/HER-HealthyBeverage-ConsensusStatement.pdf>.



- <sup>14</sup> CDC. Adult Obesity Facts | Data | Adult | Obesity | DNPAO | CDC. <http://www.cdc.gov/obesity/data/adult.html>. Published 2016.
- <sup>15</sup> Kang K, Sotunde OF, Weiler HA. Effects of milk and milk-product consumption on growth among children and adolescents aged 6-18 years: A meta-analysis of randomized controlled trials. *Adv Nutr*. 2019;10(2):250-261. doi:10.1093/advances/nmy081
- <sup>16</sup> Wang W, Wu Y, Zhang D. Association of dairy products consumption with risk of obesity in children and adults: a meta-analysis of mainly cross-sectional studies. *Ann Epidemiol*. 2016;26(12):870-882.e2. doi:10.1016/j.annepidem.2016.09.005
- <sup>17</sup> O'Sullivan TA, Schmidt KA, Kratz M. Whole-Fat or Reduced-Fat Dairy Product Intake, Adiposity, and Cardiometabolic Health in Children: A Systematic Review. *Adv Nutr*. 2020;11(4):928-950. doi:10.1093/advances/nmaa011
- <sup>18</sup> Zheng M, Rangan A, Allman-Farinelli M, Rohde JF, Olsen NJ, Heitmann BL. Replacing sugary drinks with milk is inversely associated with weight gain among young obesity-predisposed children. *Br J Nutr*. 2015;114(09):1448-1455. doi:10.1017/S0007114515002974
- <sup>19</sup> Zheng M, Rangan A, Olsen NJ, et al. Substituting sugar-sweetened beverages with water or milk is inversely associated with body fatness development from childhood to adolescence. *Nutrition*. 2015;31(1):38-44. doi:10.1016/j.nut.2014.04.017
- <sup>20</sup> Keast DR, Hill Gallant KM, Albertson AM, Gugger CK, Holschuh NM. Associations between yogurt, dairy, calcium, and vitamin D intake and Obesity among U.S. children aged 8-18 years: NHANES, 2005-2008. *Nutrients*. 2015;7(3):1577-1593. doi:10.3390/nu7031577
- <sup>21</sup> Welsh JA, Wang Y, Figueroa J, Brumme C. Sugar intake by type (added vs. naturally occurring) and physical form (liquid vs. solid) and its varying association with children's body weight, NHANES 2009-2014. *Pediatr Obes*. 2018;13(4):213-221. doi:10.1111/ijpo.12264
- <sup>22</sup> Marabujo T, Ramos E, Lopes C. Dairy products and total calcium intake at 13 years of age and its association with obesity at 21 years of age. *Eur J Clin Nutr*. 2018;72(4):541-547. doi:10.1038/s41430-017-0082-x
- <sup>23</sup> Calleja M, Caetano Feitoza N, Falk B, et al. Increased dairy product consumption as part of a diet and exercise weight management program improves body composition in adolescent females with overweight and obesity—A randomized controlled trial. *Pediatr Obes*. June 2020:e12690-e12690. doi:10.1111/ijpo.12690
- <sup>24</sup> Marshall TA, Curtis AM, Cavanaugh JE, Warren JJ, Levy SM. Child and Adolescent Sugar-Sweetened Beverage Intakes Are Longitudinally Associated with Higher Body Mass Index z Scores in a Birth Cohort Followed 17 Years. *J Acad Nutr Diet*. 2019;119(3):425-434. doi:10.1016/j.jand.2018.11.003
- <sup>25</sup> Schlesinger S, Neuenschwander M, Schwedhelm C, et al. Food Groups and Risk of Overweight, Obesity, and Weight Gain: A Systematic Review and Dose-Response Meta-Analysis of Prospective Studies. *Adv Nutr*. 2019;10(2):205-218. doi:10.1093/advances/nmy092
- <sup>26</sup> López-Sobaler AM, Aparicio A, López Díaz-Ufano ML, Ortega RM, Álvarez-Bueno C. Effect of dairy intake with or without energy restriction on body composition of adults: overview of systematic reviews and meta-analyses of randomized controlled trials. *Nutr Rev*. 2020;78(11):901-913. doi:10.1093/nutrit/nuaa003
- <sup>27</sup> Fathi Y, Faghih S, Zibaenezhad MJ, Tabatabaei SHR. Kefir drink leads to a similar weight loss, compared with milk, in a dairy-rich non-energy-restricted diet in overweight or obese premenopausal women: a randomized controlled trial. *Eur J Nutr*. 2016;55(1):295-304. doi:10.1007/s00394-015-0846-9
- <sup>28</sup> Tomah S, Eldib AH, Tasabehji MW, et al. Dairy consumption and cardiometabolic risk factors in patients with type 2 diabetes and overweight or obesity during intensive multidisciplinary weight management: A prospective observational study. *Nutrients*. 2020;12(6). doi:10.3390/nu12061643
- <sup>29</sup> Konieczna J, Romaguera D, Pereira V, et al. Longitudinal association of changes in diet with changes in body weight and waist circumference in subjects at high cardiovascular risk: The PREDIMED trial. *Int J Behav Nutr Phys Act*. 2019;16(1):139. doi:10.1186/s12966-019-0893-3
- <sup>30</sup> Trichia E, Luben R, Khaw KT, Wareham NJ, Imamura F, Forouhi NG. The associations of longitudinal changes in consumption of total and types of dairy products and markers of metabolic risk and adiposity: Findings from the European Investigation into Cancer and Nutrition (EPIC)-Norfolk study, United Kingdom. *Am J Clin Nutr*. 2020;111(5):1018-1026. doi:10.1093/ajcn/nqz335



# Science Summary

## Nutrient Contributions of Dairy Foods



### Overview

Consuming dairy foods as part of a healthy dietary pattern helps people thrive at every age, from childhood through adulthood. Dairy foods help Americans meet recommendations for calcium, vitamin D and potassium, 3 of the 4 underconsumed nutrients of public health concern. Dairy foods also make important contributions to the intake of other nutrients, including protein, vitamin A, vitamin B12, riboflavin, phosphorus, zinc, iodine and selenium, in the U.S. diet. The nutrient contributions of dairy foods have been noted in the Dietary Guidelines for Americans (DGA) since the first DGA was released in

1980. On average, Americans do not meet recommendations for dairy food intake. Yet, even at current intake levels, dairy foods supply roughly half of the calcium and vitamin D in the U.S. diet. Meeting recommendations for dairy foods can help Americans close key nutrient gaps and contribute to overall healthy dietary patterns.

### Dairy foods are an important part of recommended healthy dietary patterns

The DGA recommends consuming dairy foods, such as milk, cheese and yogurt, as part of healthy dietary patterns associated with reduced risk for several chronic diseases, including type 2 diabetes and cardiovascular disease.<sup>1</sup> The 2020 DGA also recognizes the importance of consuming dairy foods in healthy dietary patterns to achieve peak bone mineral density in childhood and adolescence.<sup>1</sup> The Healthy U.S.-Style Dietary Pattern in the 2020 DGA recommends 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ servings for children 4-8 years and 2 servings for children 2-3 years.<sup>1</sup> It also 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 6 to 12 months, depending on developmental readiness.<sup>1</sup>

### Dairy foods make important nutrient contributions to the U.S. diet

Milk, cheese and yogurt contribute nutrients essential to the daily nutrition of all Americans. Milk is a nutrient-rich and affordable source of thirteen essential nutrients like protein, calcium, phosphorus, potassium, zinc, iodine, selenium, magnesium and vitamins A, D, B12, riboflavin (B2) and pantothenic acid (B5) in the U.S. diet. Milk is also the leading food source of three nutrients of public health concern (calcium, vitamin D and potassium) for children 2-18 years and the leading food source of calcium and vitamin D for all Americans over the age of 2.<sup>2</sup> Cheese is a good source of high-quality protein, the second leading food source of calcium in the U.S. diet (after milk) for Americans 2 years and older<sup>2</sup> and contributes phosphorus and vitamin A to the U.S. diet.<sup>3,4</sup> Low-fat yogurt is an excellent source of calcium and provides protein, phosphorus, zinc, vitamin B12, pantothenic acid (B5) and riboflavin (B2) as well.<sup>5\*</sup>

\*USDA FoodData Central (FDC) ID: Low-fat vanilla yogurt 170888



Adults and children 2 years of age and older who meet dairy recommendations are less likely to be below recommendations for a number of essential nutrients including calcium, magnesium, phosphorus, protein, riboflavin, vitamin A, vitamin B12, vitamin D, selenium, zinc, potassium and choline than Americans who do not meet dairy recommendations.<sup>4</sup> However, Americans over the age of 2 consume, on average, about 1½ cups of dairy foods daily, an amount below recommendations for most life stages.<sup>2</sup> Even at current consumption rates, milk, cheese and yogurt contribute, on average, about 52% of the calcium, 51% of the vitamin D, 14% of the potassium, 17% of the protein, 29% of the vitamin A, 28% of the vitamin B12, 21% of the riboflavin (B2), 27% of the phosphorus and 17% of the zinc to the diets of Americans ages 2 and older, while providing 11% of total calories, 26% of saturated fat and 11% of sodium.<sup>2</sup> Inadequate intake of calcium, phosphorus, protein, riboflavin, and vitamin B12 is close to zero among adults and children who meet dairy food recommendations.<sup>4</sup> Adding just 1 daily serving of dairy foods to individuals' current intakes can help Americans move closer to meeting dairy food recommendations and contribute to closing key nutrient gaps.

### **Current beverage intakes support recommendations for children to drink milk**

Drinking milk is an important habit to develop in childhood and carry forward into adulthood. Dairy consumption tends to fall below recommended amounts by the time children go to school, and this trend persists through adolescence and into adulthood.<sup>6</sup> The 2020 DGA recommends drinking milk with meals as one strategy to increase dairy consumption.<sup>1</sup> It also recommends choosing water and unsweetened beverages like 100% fruit or vegetable juice, low-fat or fat-free milk or fortified soy beverages within healthy dietary patterns in place of sugar-sweetened beverages (SSBs) like soda, fruit drinks, sports and energy drinks.<sup>1</sup> SSBs are not a component of USDA Dietary Patterns and are not necessary in the child or adolescent diet.<sup>1</sup> Among milk drinking children ages 2 to 18, milk contributes 32% the calcium, 55% of the vitamin D, 19% of the potassium and just 8% of the calories. White milk contributes no added sugars, and flavored milk contributes, on average, approximately 4% of added sugars to children's diets.<sup>2</sup>

### **Nutrients in dairy foods can be difficult to replace with other foods**

Replacing dairy foods with non-dairy, calcium-equivalent foods can have unintended nutritional consequences. Non-dairy beverages that contain similar amounts of calcium per cup as milk, such as calcium-fortified almond or rice beverage, can be lower in potassium and protein than milk.<sup>5\*</sup> More than 50% of the Americans who do not consume adequate amounts of dairy foods consume below the estimated average requirements for calcium, magnesium, vitamin A and vitamin D.<sup>4</sup> Because dairy foods are the lowest cost source of dietary calcium and among the lowest cost sources of riboflavin (B2) and vitamin B12 in the U.S. diet, they are a good value, too.<sup>7</sup>

Four leading health organizations (the Academy of Nutrition and Dietetics, the American Academy of Pediatric Dentistry, the American Academy of Pediatrics and the American Heart Association) recommend that children 1 to 5 years of age not consume plant-based milk alternative beverages except for fortified soy beverage. Their Healthy Beverage recommendations state that non-soy plant-based beverages are inconsistently formulated, meaning they vary in nutrient and added sugar content, and are "not an equal substitute for cow's milk."<sup>8</sup> The DGA similarly states that consuming almond, rice, coconut, oat and hemp 'milks' "does not contribute to meeting the dairy group recommendation," because the nutrient content of these plant-based beverages is not similar to dairy milk and fortified soy beverages.

\*FDC IDs: Almond beverage: 1097550; Rice beverage: 171942



## References

- <sup>1</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>2</sup> National Dairy Council. NHANES 2015-2018. Hyattsville, MD; 2020.
- <sup>3</sup> Huth PJ, Fulgoni VL, Keast DR, Park K, Auestad N. Major food sources of calories, added sugars, and saturated fat and their contribution to essential nutrient intakes in the U.S. diet: data from the national health and nutrition examination survey (2003–2006). *Nutr J.* 2013;12(1):116. doi:10.1186/1475-2891-12-116
- <sup>4</sup> Hess JM, Cifelli CJ, Fulgoni III VL. Energy and Nutrient Intake of Americans according to Meeting Current Dairy Recommendations. *Nutrients.* 2020;12(10):3006. doi:10.3390/nu12103006
- <sup>5</sup> USDA. FoodData Central. <https://fdc.nal.usda.gov/index.html>. Published 2019.
- <sup>6</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee. [https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport\\_of\\_the\\_2020DietaryGuidelinesAdvisoryCommittee\\_first-print.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf).
- <sup>7</sup> Hess JM, Cifelli CJ, Agarwal S, Fulgoni VL. Comparing the cost of essential nutrients from different food sources in the American diet using NHANES 2011–2014. *Nutr J.* 2019;18(1):68. doi:10.1186/s12937-019-0496-5
- <sup>8</sup> Lott M, Callahan E, Welker Duffy E, Story M, Daniels S. Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Consensus Statement. Durham, NC; 2019. <https://healthyeatingresearch.org/wp-content/uploads/2019/09/HER-HealthyBeverage-ConsensusStatement.pdf>.



# Science Summary

## Dairy in Healthy Dietary Patterns



### Overview



Dairy foods, such as milk, yogurt and cheese, are foundational foods included in multiple healthy dietary patterns. These include the Healthy Eating Patterns in the 2020 Dietary Guidelines for Americans (DGA), the Dietary Approaches to Stop Hypertension (DASH) eating plan, as well as those recommended by the American Heart Association (AHA) and guidelines from the National Osteoporosis Foundation. Dairy foods help meet nutrient needs and are associated with better bone health, especially in children and adolescents.

Healthy dietary patterns containing low-fat or fat-free dairy foods are also associated with lower risk for cardiovascular disease (CVD) and type 2 diabetes (T2D). Dairy foods can be affordable sources of key nutrients – including high-quality protein, calcium, potassium and vitamin D – and are available in a variety of options to help meet taste, health and wellness needs. By choosing the DGA-recommended daily servings of dairy foods as part of a healthy dietary pattern, Americans ages 6 months and above can enjoy the many benefits dairy foods provide.

---

### Dietary patterns have emerged as a valuable way to guide healthy eating

People eat and drink a variety of foods and beverages that collectively establish a dietary pattern.<sup>1</sup> Dietary patterns are defined as “quantities, proportions, variety or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed.”<sup>2</sup> Dietary patterns capture the synergistic and cumulative effects that combinations of foods and beverages – and the nutrients they contain – can have on health.<sup>2</sup> Because dietary patterns contain multiple foods and beverages that work together in relation to health, they may be more predictive of health than any one food or nutrient.<sup>1</sup>

---

### Dairy foods are foundational foods in multiple dietary patterns associated with better health

#### *Dietary Guidelines for Americans:*

Americans, on average, consume fewer dairy foods and plant-based foods, such as vegetables, fruits, and whole grains, than recommended in the Healthy U.S.-Style, Healthy Vegetarian and Healthy Mediterranean Style Eating



Patterns.<sup>1</sup> The DGA note that dairy consumption is also linked to improved bone health, especially in children and adolescents.<sup>1</sup> Based on consistent evidence from prospective cohort studies, systematic reviews and meta-analyses, the 2020 Dietary Guidelines Advisory Committee concluded that dietary patterns that include low-fat dairy foods are associated with a lower risk of all-cause mortality, cardiovascular disease, overweight, and obesity.<sup>2</sup>

The Healthy U.S. and Vegetarian-Style Dietary Patterns in the 2020 DGA recommend 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ servings for children 4-8 years and 2 servings for children 2-3 years.<sup>1</sup> It also 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 6 to 12 months, depending on developmental readiness.<sup>1</sup>

### *Vegetarian Style Eating Patterns*

The Healthy Vegetarian dietary pattern is defined by the DGA as a lacto-ovo-vegetarian diet which includes dairy foods. Adults age 20+ years who reported consuming this pattern had lower energy, saturated fat and sodium intakes.<sup>3</sup>

### *DASH and Mediterranean eating patterns:*

DASH and the Mediterranean diet are well-studied eating patterns that helped shape the DGA recommendations. The DASH eating plan is based on the DASH trial, which found that following a reduced-fat eating plan including 2-3 servings of dairy foods and 8-10 servings of fruits and vegetables per day lower blood pressure in adults with elevated blood pressure.<sup>4,5,6</sup>

Adults participating in the PREMIER study who increased their intakes of dairy products and consumed five or more servings of fruits and vegetables per day lost more weight and had greater reductions in blood pressure than other groups.<sup>7</sup> A review of 68 research and review papers found that prolonged adoption of the DASH diet was shown to have sustained beneficial effects on health.<sup>8</sup> While the original DASH diet trials included mostly low-fat dairy foods, results of a more recent trial showed that the DASH diet is equally effective if whole-fat dairy foods are substituted for low-fat dairy foods.<sup>9</sup>

Systematic reviews found that the DASH diet led to improvements in blood pressure among adults and adolescents as well as reductions in total cholesterol and LDL-C.<sup>10,11</sup> Prospective cohort studies also found lower risk of stroke, CVD and CVD-mortality among adults with high adherence to a DASH diet.<sup>12,13</sup> Several studies suggest that following the DASH dietary pattern is linked with lower risk of overweight and obesity in adolescents and adults.<sup>10,14,15,16</sup>

The Mediterranean diet is described in the scientific literature, generally, as containing high amounts of extra virgin olive oil, vegetables, fruits, cereals, nuts and pulses/legumes, moderate amounts of fish and other meat, dairy foods and red wine, and low amounts of eggs and sweets.<sup>17</sup> Prospective cohort trials indicate that Mediterranean eating patterns that include dairy foods are linked to reduced risk of CVD and diabetes.<sup>18,19,20,21</sup> In a randomized controlled trial of adults at high risk of cardiovascular disease, consuming a Mediterranean style diet with 3-4 daily servings of dairy foods, with no restrictions on fat levels of dairy foods, reduced blood pressure and improved lipid levels compared to a control group consuming a low-fat diet. The authors concluded that a



Mediterranean diet with additional dairy may be appropriate for an improvement in cardiovascular risk factors in a population at risk of CVD.<sup>22</sup>

The DGA Healthy Mediterranean Eating Pattern (HMEP) contains less dairy food than the other DGA healthy eating patterns. Results of a modeling study indicate that replacing one serving of refined grain foods in the HMEP for adults with a serving of low-fat or fat-free dairy foods brings the amounts of several shortfall vitamins and minerals (calcium, potassium, and vitamin D) closer to recommended levels without increasing saturated fat or sodium above recommended ranges.<sup>23</sup>

#### *Dietary patterns recommended by authoritative organizations:*

Dairy foods are also part of dietary patterns recommended by medical and health organizations.<sup>24,25,26,27,28,29</sup> The American Heart Association (AHA) emphasizes the importance of healthy dietary patterns to reduce the risk of cardiovascular disease morbidity and mortality. The AHA evidence-based dietary guidance advises choosing healthy sources of protein including low-fat or fat-free dairy products.<sup>24</sup> Furthermore, the AHA guidance states that evidence suggests potential cardiometabolic benefits of consuming fermented dairy such as yogurt, but states that the evidence remains inconclusive.

The 2019 American College of Cardiology/AHA Guidelines on the Primary Prevention of Cardiovascular Disease recommend the DASH diet to help prevent and treat hypertension. These guidelines recommend the DASH diet alongside the Mediterranean and vegetarian diets as heart- healthy eating patterns to help with weight loss and glycemic control with T2D.<sup>30</sup>

The American Academy of Pediatrics, the National Osteoporosis Foundation and the American Diabetes Association also include low-fat or fat-free dairy foods as foods to meet nutrient needs.<sup>26,27,28,29</sup> Dietary patterns outside the U.S. include dairy foods as part of healthy eating patterns. For example, the Southern European Atlantic Diet, the traditional dietary pattern of Northern Portugal and North-Western Spain, includes dairy foods and has been associated with lower risk of all causes of death among older Spanish adults.<sup>31</sup>

There are multiple ways to achieve a high-quality diet and research demonstrates significant associations with lower all-cause death and cardiovascular disease mortality.<sup>32</sup>

---

### **Three daily servings of dairy foods provide excellent nutritional value**

Americans are currently under consuming dairy foods, at about 2 dairy servings per day on average. Adding just 1 more daily serving can help fill shortfall nutrient gaps.<sup>23,33</sup> In the 2,000 calorie Healthy U.S.-Style Eating Pattern, 3 servings of low-fat or fat-free dairy foods contribute only 12% of daily calories, but 20-69% of many key nutrients, including calcium, vitamin D and potassium, nutrients of public health concern identified by the DGAC.<sup>2</sup> The unique nutrient profile of dairy foods can be difficult to replace with non-dairy foods, even calcium-equivalent foods.<sup>2,33</sup> Non-dairy beverages other than fortified soy beverage are not recommended for children because of variability in their nutrient content and lack of evidence for adequate bioavailability of nutrients.<sup>34</sup>



Researchers modeled the impact of replacing one of the three recommended servings of low-fat or fat-free dairy foods in the Healthy US-style eating pattern with a whole- or reduced-fat option and found that some reduced and whole-fat dairy foods, especially milk, can fit into calorie-balanced healthy eating patterns that align with saturated fat recommendations.<sup>35</sup> Allowing some flexibility in fat level of dairy food servings aligns with the recommendations that calories from solid fats and added sugars are best used to increase the palatability of nutrient-dense foods.<sup>35</sup> Similarly, replacing one serving of refined grain foods with one serving of low-fat, fat-free dairy foods in the Mediterranean diet brings the amounts of key nutrients closer to recommended levels without increasing saturated fat.<sup>23</sup>

### A variety of nutrient-dense dairy foods are available

Many dairy food options are available to help tailor healthy eating patterns to meet daily needs. These include lactose-free or lactose-reduced cow's milk and dairy foods made with less sodium, fat or added sugars. Yogurt varieties that contain more high-quality dairy protein, like Greek- or Icelandic-style products, and many cheese varieties are also available.

Dairy foods are often more affordable than replacements used to meet nutrient needs, such as fortified soy beverage and fortified orange juice. An analysis of NHANES data indicated that dairy foods were the least expensive sources of calcium and vitamin D in the American diet as well as low-cost sources for potassium, magnesium and vitamin A.<sup>36</sup>

## References

- <sup>1</sup> U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans 2020-2025. 9th Edition. December 2020.
- <sup>2</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.
- <sup>3</sup> Bowman SA. A Vegetarian-Style Dietary Pattern Is Associated with Lower Energy, Saturated Fat, and Sodium Intakes; and Higher Whole Grains, Legumes, Nuts, and Soy Intakes by Adults: National Health and Nutrition Examination Surveys 2013-2016. *Nutrients*. 2020 Sep 1;12(9).
- <sup>4</sup> U.S. Department of Agriculture, U.S. Department of Health and Human Services and the National Heart, Lung and Blood Institute. In brief: your guide to lowering your blood pressure with DASH. NIH Publication No 06-5834 2015.
- <sup>5</sup> Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, et al: A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med* 1997, 336:1117-1124.
- <sup>6</sup> Chiavaroli L, Viguioliuk E, Nishi SK, et al. DASH dietary pattern and cardiometabolic outcomes: An umbrella review of systematic reviews and meta-analyses. *Nutrients*. 2019;11(2).
- <sup>7</sup> Pickering RT, Bradlee ML, Singer MR, Moore LL. Baseline diet modifies the effects of dietary change. *Br J Nutr*. 2020 Apr 28;123(8):951-958. doi: 10.1017/S0007114520000112. Epub 2020 Jan 21.
- <sup>8</sup> Suri S, Kumar V, Kumar S, Goyal A, Tanwar B, Kaur J, Kaur J. DASH Dietary Pattern: A Treatment for Non-communicable Diseases. *Curr Hypertens Rev*. 2020;16(2):108-114.
- <sup>9</sup> Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: a randomized controlled trial. *Am J Clin Nutr [Internet]*. 2015;ajcn.115.123281-.
- <sup>10</sup> Bricarello LP, Poltronieri F, Fernandes R, Retondario A, de Moraes Trindade EBS, de Vasconcelos F de AG. Effects of the Dietary Approach to Stop Hypertension (DASH) diet on blood pressure, overweight and obesity in adolescents: A systematic review. *Clinical Nutrition ESPEN*. Elsevier Ltd; 2018. p. 1-11.
- <sup>11</sup> Siervo M, Lara J, Chowdhury S. Effects of the Dietary Approach to Stop Hypertension (DASH) diet on cardiovascular risk factors: a systematic review and meta-analysis. *J Nutr*. 2015;113:1-15.
- <sup>12</sup> Jones NRV, Forouhi NG, Khaw KT, Wareham NJ, Monsivais P. Accordance to the Dietary Approaches to Stop Hypertension diet pattern and cardiovascular disease in a British, population- based cohort. *Eur J Epidemiol*. Springer Netherlands; 2018;33:235-44.



- <sup>13</sup> Talaei M, Koh W-P, Yuan J-M, van Dam RM. DASH Dietary Pattern, Mediation by Mineral Intakes, and the Risk of Coronary Artery Disease and Stroke Mortality. *J Am Heart Assoc* [Internet]. 2019;8:e011054. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/30806152>
- <sup>14</sup> Soltani S, Shirani F, Chitsazi MJ, Salehi-Abargouei A. The effect of dietary approaches to stop hypertension (DASH) diet on weight and body composition in adults: A systematic review and meta-analysis of randomized controlled clinical trials. *Obes Rev*. 2016;17:442-54.
- <sup>15</sup> Kucharska A, Gajewska D, Kiedrowski M, Sińska B, Juszczak G, Czerw A, Augustynowicz A, Bobiński K, Deptała A, Niegowska J. The impact of individualised nutritional therapy according to DASH diet on blood pressure, body mass, and selected biochemical parameters in overweight/obese patients with primary arterial hypertension: a prospective randomised study. *Kardiol Pol. Via Medica*; 2018;76:158-65.
- <sup>16</sup> Wang T, Heianza Y, Sun D, Huang T, Ma W, Rimm EB, Manson JE, Hu FB, Willett WC, Qi L. Improving adherence to healthy dietary patterns, genetic risk, and long term weight gain: Gene- diet interaction analysis in two prospective cohort studies. *BMJ*. BMJ Publishing Group; 2018;360.
- <sup>17</sup> Davis C, Bryan J, Hodgson J, Murphy K: Definition of the Mediterranean diet; a literature review. *Nutrients* 2015, 7:9139-9153.
- <sup>18</sup> Tektonidis TG, Åkesson A, Gigante B, Wolk A, Larsson SC. A Mediterranean diet and risk of myocardial infarction, heart failure and stroke: A population-based cohort study. *Atherosclerosis* [Internet]. Elsevier; 2015;243:93-8
- <sup>19</sup> Tektonidis TG, Åkesson A, Gigante B, Wolk A, Larsson SC. Adherence to a Mediterranean diet is associated with reduced risk of heart failure in men. *Eur J Heart Fail* [Internet]. 2016;18:253-9.
- <sup>20</sup> Díaz-López A, Bulló M, Martínez-González MA, Corella D, Estruch R, Fitó M, Gómez-Gracia E, Fiol M, García de la Corte FJ, Ros E, et al. Dairy product consumption and risk of type 2 diabetes in an elderly Spanish Mediterranean population at high cardiovascular risk. *Eur J Nutr* [Internet]. 2016;55:349-60.
- <sup>21</sup> Guasch-Ferré M, Becerra-Tomás N, Ruiz-Canela M, Corella D, Schröder H, Estruch R, Ros E, Arós F, Gómez-Gracia E, Fiol M, et al. Total and subtypes of dietary fat intake and risk of type 2 diabetes mellitus in the Prevención con Dieta Mediterránea (PREDIMED) study. *Am J Clin Nutr* [Internet]. 2017;105:723-35.
- <sup>22</sup> Wade AT, Davis CR, Dyer KA, Hodgson JM, Woodman RJ, Murphy KJ. A Mediterranean diet supplemented with dairy foods improves markers of cardiovascular risk: results from the MedDairy randomized controlled trial. *Am J Clin Nutr* [Internet]. Narnia; 2018;108:1166-82.
- <sup>23</sup> Hess JM, Fulgoni VL, Radlowski EC. Modeling the Impact of Adding a Serving of Dairy Foods to the Healthy Mediterranean-Style Eating Pattern Recommended by the 2015-2020 Dietary Guidelines for Americans. *J Am Coll Nutr*. 2019 Aug 38:1, 59-67.
- <sup>24</sup> Lichtenstein AH, Appel LJ, Vadiveloo M, Hu FB, Kris-Etherton PM, Rebholz CM, Sacks FM, Thorndike AN, Van Horn L, Wylie-Rosett J; on behalf of the American Heart Association Council on Lifestyle and Cardiometabolic Health; Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; and Stroke Council. 2021 Dietary guidance to improve cardiovascular health: a scientific statement from the American Heart Association. *Circulation*. 2021;144:e•••-e•••.
- <sup>25</sup> Van Horn L, Carson JA, Appel LJ, Burke LE, Economos C, Kamally W, Lancaster K, Lichtenstein A, Johnson RK, Thomas RJ: Recommended dietary pattern to achieve adherence to the American Heart Association/American College of Cardiology (AHA/ACC) Guidelines: a scientific statement from the American Heart Association. *Circulation* 2016.
- <sup>26</sup> Golden NH, Abrams SA, Committee on Nutrition: Optimizing bone health in children and adolescents. *Pediatrics* 2014, 134:e1229-1243.
- <sup>27</sup> National Osteoporosis Foundation Website. Prevention and healthy living: food and your bones. <http://nof.org/learn/prevention>. Accessed on December 5, 2021.
- <sup>28</sup> Weaver CM, Gordon CM, Janz KF, Kalkwarf HJ, Lappe JM, Lewis R, O’Karma M, Wallace TC, Zemel BS: The National Osteoporosis Foundation’s position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporos Int* 2016, 27:1281-1386.
- <sup>29</sup> Evert AB, Dennison M, Gardner CD, Garvey WT, Lau KHK, MacLeod J, Mitri J, Pereira RF, Rawlings K, Robinson S, Saslow L, Uelman S, Urbanski PB, Yancy WS Jr. Nutrition Therapy for Adults With Diabetes or Prediabetes: A Consensus Report. *Diabetes Care*. 2019 May;42(5):731-754. doi: 10.2337/dci19-0014. Epub 2019 Apr 18.
- <sup>30</sup> Arnett DK, Blumenthal RS, Albert MA, et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines [published correction appears in *Circulation*. 2019 Sep 10;140(11):e649-e650] [published correction appears in *Circulation*. 2020 Jan 28;141(4):e60]
- <sup>31</sup> Carballo-Casla A, Orotola R, García-Esquinas E, Oliveira A, Sotos-Prieto M, Lopes C, Lopez-Garcia E, Rodríguez-Artalejo F. The Southern European Atlantic Diet and all-cause mortality in older adults. *BMC Med*. 2021 Feb 9;19(1):36.
- <sup>32</sup> Liese AD, Wambogo E, Lerman JL, Boushey CJ, Neuhaus ML, Wang S, Harmon BE, Tinker LF. Variations in Dietary Patterns Defined by the Healthy Eating Index 2015 and Associations with Mortality: Findings from the Dietary Patterns Methods Project. *J Nutr*. 2021 Nov 10.
- <sup>33</sup> Quann EE, Fulgoni VL & Auestad N. Consuming the daily recommended amounts of dairy products would reduce the prevalence of inadequate micronutrient intakes in the United States: diet modeling study based on NHANES 2007-2010. *Nutr J* 14, 90 (2015).
- <sup>34</sup> Lott M, Callahan E, Welker Duffy E, Story M, Daniels S. Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Consensus Statement [Internet]. Durham, NC; 2019.
- <sup>35</sup> Hess JM, Cifelli CJ, Fulgoni VL 3rd. Modeling the Impact of Fat Flexibility With Dairy Food Servings in the 2015-2020 Dietary Guidelines for Americans Healthy U.S.-Style Eating Pattern. *Front Nutr*. 2020;7:595880.
- <sup>36</sup> Hess J, Cifelli C, Agarwal S, Fulgoni V, III. Comparing the Cost of Essential Nutrients from Different Food Sources in the American Diet (OR20-04-19). *Curr Dev Nutr* [Internet]. American Society for Nutrition; 2019;3.





## Emerging Topics



# Science Summary

## Dairy Innovation



### Overview

Dairy foods such as milk, cheese and yogurt are foundational foods in healthy dietary patterns. Consuming dairy foods helps Americans meet recommendations for important shortfall nutrients, including calcium, vitamin D and potassium, and contributes several other essential nutrients, too. An emerging body of research indicates that eating dairy foods may also be linked with reduced risk of chronic diseases like type 2 diabetes (T2D) and cardiovascular disease (CVD).

However, most Americans do not meet the recommendations for dairy foods from the Dietary Guidelines for Americans (DGA). Lactose intolerance (LI) as well as concerns about added sugars and saturated fats may lead some individuals to avoid or reduce dairy food consumption, which can result in missing out on the essential nutrients in dairy foods and the health benefits linked with adequate dairy consumption. Recent evidence indicates that dairy foods with little- or no- lactose and/or added sugars are now widely available in the U.S. Evidence also indicates that whole- and reduced-fat dairy foods can be included in healthy dietary patterns. A variety of nutrient-dense milk, cheese and yogurt options are widely available so Americans can select dairy foods to meet their nutrient needs and taste preferences and move closer to meeting recommendations for healthy dietary patterns from the 2020-2025 DGA.

### Lactose-free dairy foods are widely available and an increasingly popular option for Americans

In addition to thirteen essential nutrients including protein, calcium, phosphorus, zinc, selenium, iodine and vitamins A, D, B12, riboflavin (B2), niacin (B3) and pantothenic acid (B5), milk contains a sugar called lactose, which individuals with LI are not able to digest. LI is medically defined as a group of symptoms, such as bloating, gas and diarrhea, that occur in some people after they consume certain dairy foods.<sup>1,2</sup> While some individuals with LI avoid dairy foods, LI does not have to be a barrier to adequate dairy intake. Consuming smaller amounts of dairy foods throughout the day and with other foods can help individuals with LI tolerate as much as 12 grams of lactose at a time, which is about the amount of lactose in one cup of milk.<sup>3,4</sup> The 2020-2025 DGA also notes that individuals with LI can select lactose-free or reduced-lactose dairy foods to meet dairy recommendations.<sup>5</sup> Lactose-free milk is another option for individuals with LI and is currently available in about 96 percent of U.S. retail food outlets.<sup>6-8</sup> About 18 percent of American households keep lactose-free milk in the refrigerator.<sup>6-8</sup>



Yogurt with live and active cultures is another option for individuals with LI.<sup>4,9,10</sup> The culturing process used to make yogurt helps break down lactose, which may make it easier for people with LI to digest. Natural cheeses such as Cheddar, Colby, mozzarella, and Monterey Jack are virtually lactose-free, because 90 percent of the lactose in the milk used to make these cheeses is removed along with the water and whey during the renneting process of cheesemaking. The remaining lactose is fermented into lactic acid.<sup>11</sup> While individuals with LI may choose to substitute milk with plant-based alternatives such as almond, rice and coconut beverages, these beverages vary in their nutrient composition, fortification levels and amounts of added sugars, as they are not subject to uniform standards.<sup>12</sup>

### **One serving of whole- or reduced-fat dairy foods can fit into recommended healthy dietary patterns**

Dairy foods are available in different varieties. Milk is available in whole, reduced-fat (2% milk fat), low-fat (1% milk fat), fat-free and flavored options. Yogurts and cheeses of different fat levels are also available. The 2020-2025 DGA recommends 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ for children 4-8 years and 2 for children 2-3 years in the Healthy U.S.-Style Dietary Pattern.<sup>5</sup> The DGA also recommends balancing calorie intake and limiting intake of saturated fats to less than 10 percent of calories per day as part of healthy dietary patterns. Yet Americans primarily choose whole- or reduced-fat dairy foods.<sup>13</sup> Whole- and reduced-fat dairy foods (milk, cheese and yogurt) contain more saturated fats and can contain more calories than low-fat and fat-free versions. However, results of a recent modeling study indicate that one of the three recommended servings of dairy foods for those 9 years and older can be a whole- or reduced-fat dairy food, while staying within saturated fat and calorie limits and meeting nutrient needs.<sup>14</sup> There is a growing body of evidence of a neutral or even beneficial role of whole- and reduced-fat dairy foods on cardiometabolic disease risk.<sup>15-21</sup> Dairy fat is the most complex naturally-occurring fats with over 400 types of fatty acids.<sup>22</sup> The complexity of dairy fat may help explain why consuming whole- and reduced-fat dairy foods is not linked to higher risk of CVD, T2D and overweight and obesity.

### **Many dairy options have reduced sugar or “no added sugar” and more Americans are choosing unflavored and unsweetened yogurt**

Eating yogurt has been associated with a range of health benefits, including a reduced risk for CVD and T2D, and emerging evidence also indicates that eating yogurt, including sweetened yogurt, may reduce markers of inflammation.<sup>23-26</sup> However, the 2020-2025 DGA recommends limiting intake of added sugars to no more than 10 percent of total calories for all Americans over the age of 2.<sup>5</sup> This recommendation is consistent with the Food and Drug Administration’s (FDA) daily value of not more than 50 grams per day of added sugars for children and adults aged 4 and above.<sup>27</sup> Yogurts without added sugars are available on the market to help Americans stay within added sugar limits while still having the option to choose yogurt to meet dairy recommendations. Between 2015 and 2019, yogurts with a “no added sugar” claim increased by over 32 percent and the number of yogurts with “less sugar” noted on the label increased by 33 percent.<sup>28</sup> Plain yogurt, which is both unsweetened and unflavored, has also become a popular choice for Americans. In 2019, plain yogurts comprised 13 percent of U.S. yogurt sales.<sup>29</sup>



## Conclusions

Nutrient-rich dairy foods are an important part of healthy dietary patterns.<sup>5</sup> Many options for dairy foods are widely available, including reduced-lactose and lactose-free products, whole-fat, reduced-fat, low-fat and fat-free products and products with reduced sugar or no added sugars. The wide range of milk, cheese and yogurt options helps to ensure that Americans of all ages can find dairy foods to meet their taste preferences and align with recommendations in the 2020-2025 DGA for healthy dietary patterns.

## References

- 1 Misselwitz B, Butter M, Verbeke K, Fox MR. Update on lactose malabsorption and intolerance: Pathogenesis, diagnosis and clinical management. *Gut*. 2019;68(11):2080-2091. doi:<http://dx.doi.org/10.1136/gutjnl-2019-318404>
- 2 Definition & Facts for Lactose Intolerance | NIDDK. <https://www.niddk.nih.gov/health-information/digestive-diseases/lactose-intolerance/definition-facts>. Accessed May 15, 2020.
- 3 Bailey RK, Fileti CP, Keith J, Tropez-Sims S, Price W, Allison-Otley SD. Lactose intolerance and health disparities among African Americans and Hispanic Americans: an updated consensus statement. *J Natl Med Assoc*. 2013;105(2):112-127. doi:10.1016/s0027-9684(15)30113-9
- 4 Shaikat A, Levitt MD, Taylor BC, et al. Systematic review: Effective management strategies for lactose intolerance. In: *Annals of Internal Medicine*. Vol 152. American College of Physicians; 2010:797-803. doi:10.7326/0003-4819-152-12-201006150-00241
- 5 USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- 6 Dekker P, Koenders D, Bruins M. Lactose-Free Dairy Products: Market Developments, Production, Nutrition and Health Benefits. *Nutrients*. 2019;11(3):551. doi:10.3390/nu11030551
- 7 Rizzo P V., Harwood WS, Drake MA. Consumer desires and perceptions of lactose-free milk. *J Dairy Sci*. 2020. doi:10.3168/jds.2019-17940
- 8 IRI, MULO+C (multi-outlets + c-stores); based on 4 weeks ending 11-3-2019. 2019.
- 9 Scientific Opinion on the substantiation of health claims related to live yoghurt cultures and improved lactose digestion (ID 1143, 2976) pursuant to Article 13(1) of Regulation (EC) No 1924/2006. *EFSA J*. 2010;8(10). doi:10.2903/J.EFSA.2010.1763
- 10 Savaiano DA. Lactose digestion from yogurt: mechanism and relevance. *Am J Clin Nutr*. 2014;99(5 Suppl):1251S-5S. doi:10.3945/ajcn.113.073023
- 11 Harju M, Kallioinen H, Tossavainen O. Lactose hydrolysis and other conversions in dairy products: Technological aspects. *Int Dairy J*. 2012;22(2):104-109. doi:10.1016/j.idairyj.2011.09.011
- 12 Lott M, Callahan E, Welker Duffy E, Story M, Daniels S. Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Consensus Statement. Durham, NC; 2019. <https://healthyeatingresearch.org/wp-content/uploads/2019/09/HER-HealthyBeverage-ConsensusStatement.pdf>.
- 13 National Dairy Council. NHANES 2011-2014. Hyattsville, MD; 2018. <https://www.usdairy.com/science-and-research/dairys-role-in-the-diet>.
- 14 Hess JM, Cifelli CJ, Nicholls J, Fulgoni V. Abstract P356: Modeling the Impact of Flexibility in Fat Levels of Dairy Foods Consumed to Meet Recommendations From the 2015 Dietary Guidelines for Americans Healthy U.S.-style Eating Pattern. *Circulation*. 2020;141(Suppl\_1). doi:10.1161/circ.141.suppl\_1.p356
- 15 Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: a randomized controlled trial. *Am J Clin Nutr*. 2016;103(2):341-347. doi:10.3945/ajcn.115.123281
- 16 Drouin-Chartier J-P, Brassard D, Tessier-Grenier M, et al. Systematic Review of the Association between Dairy Product Consumption and Risk of Cardiovascular-Related Clinical Outcomes. *Adv Nutr*. 2016;7(6):1026-1040. doi:10.3945/an.115.011403
- 17 Kratz M, Baars T, Guyenet S. The relationship between high-fat dairy consumption and obesity, cardiovascular, and metabolic disease. *Eur J Nutr*. 2013;52(1):1-24. doi:10.1007/s00394-012-0418-1
- 18 Rautiainen S, Wang L, Lee I-M, Manson JE, Buring JE, Sesso HD. Dairy consumption in association with weight change and risk of becoming overweight or obese in middle-aged and older women: a prospective cohort study. *Am J Clin Nutr*. 2016;103(4):979-988. doi:10.3945/ajcn.115.118406
- 19 Santiago S, Sayón-Orea C, Babio N, et al. Yogurt consumption and abdominal obesity reversion in the PREDIMED study. *Nutr Metab Cardiovasc Dis*. 2016;26(6):468-475. doi:10.1016/j.numecd.2015.11.012
- 20 Rosell M, Håkansson NN, Wolk A. Association between dairy food consumption and weight change over 9 y in 19 352 perimenopausal women. *Am J Clin Nutr*. 2006;84(6):1481-1488. doi:10.1093/ajcn/84.6.1481
- 21 Mozaffarian D, Hao T, Rimm EB, Willett WC, Hu FB. Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men. *N Engl J Med*. 2011;364(25):2392-2404. doi:10.1056/NEJMoa1014296
- 22 Månsson HL. Fatty acids in bovine milk fat. *Food Nutr Res*. 2008;52. doi:10.3402/fnr.v52i0.1821
- 23 Drouin-Chartier J-P, Brassard D, Tessier-Grenier M, et al. Systematic Review of the Association between Dairy Product Consumption and Risk of Cardiovascular-Related Clinical Outcomes. *Adv Nutr An Int Rev J*. 2016;7(6):1026-1040. doi:10.3945/an.115.011403
- 24 Pei R, DiMarco DM, Putt KK, et al. Low-fat yogurt consumption reduces biomarkers of chronic inflammation and inhibits markers of endotoxin exposure in healthy premenopausal women: a randomised controlled trial. *Br J Nutr*. November 2017;1-9. doi:10.1017/S0007114517003038



<sup>25</sup> Wu L, Sun D. Consumption of Yogurt and the Incident Risk of Cardiovascular Disease: A Meta-Analysis of Nine Cohort Studies. *Nutrients*. 2017;9(3):315. doi:10.3390/nu9030315

<sup>26</sup> Pei R, DiMarco DM, Putt KK, et al. Premeal Low-Fat Yogurt Consumption Reduces Postprandial Inflammation and Markers of Endotoxin Exposure in Healthy Premenopausal Women in a Randomized Controlled Trial. *J Nutr*. 2018;148(6):910-916.

<sup>27</sup> CFR 121.101.9. <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=101.9>. Accessed September 26, 2017.

<sup>28</sup> IRI Market Advantage, 4wk period ending 3-22-2020.

<sup>29</sup> IRI database, MULO+C (multi-outlets + c-stores); based on calendar year 2019 ending 12-29-19.



# Science Summary

## Dairy Matrix



### Overview



The 2020-2025 Dietary Guidelines for Americans (DGA) recommends including dairy foods like milk, cheese and yogurt in healthy dietary patterns to meet nutrient needs and reduce the risk for chronic diseases. Historically, the DGA has recommended that most Americans choose low-fat or fat-free dairy foods, because whole- and reduced-fat dairy foods contain more calories as well as more saturated fat, a type of fat that increases blood levels of low-density lipoprotein cholesterol (LDL-C), a blood biomarker used to predict CVD risk.<sup>1,2</sup> Emerging evidence that will be described in this summary indicates that consuming dairy

foods, even whole-fat dairy foods, is not linked to higher risk for CVD and, in some cases, is linked to lower risk. Considering the physical structure of dairy foods alongside their nutrient and non-nutrient components may help explain why whole-milk dairy foods have different health impacts than would be expected based on their saturated fat content alone. This science summary explores the emerging body of research on the food structure or food matrix and the bioactive components of food, both potential reasons why sometimes foods, including dairy foods, and nutrients, like saturated fats, do not always have a predictable impact on health.

### People eat food, not nutrients: defining the food matrix

The food matrix refers to the relationships between the nutrient and non-nutrient components of foods, including vitamins, minerals and bioactive components as well as physical structure, texture and form (e.g., solid, gel, liquid).<sup>3</sup> The food matrix concept can be used to address how the relationships between nutrient and non-nutrient components impact digestion, absorption and physiological functions important for health. In a commonly cited study about the matrix effect,<sup>4</sup> researchers assessed how well carotenoids (beta-carotene and alpha-carotene) were released and available for absorption in a model of the human digestion system when different preparations of carrots (raw bite size pieces, cooked bite size pieces, raw pulp, raw pulp with oil, cooked pulp, cooked pulp with oil) were added. Even though the same food with the same nutrients was used in each case, cooking, pulping and adding oil all affected the amount of beta-carotene accessible for absorption. The preparation of the carrots and changes to their physical structure impacted how much of their nutrients were available for use by the human body. A similar study found that the manner in which almonds were prepared (whole unroasted almonds, whole roasted almonds, chopped roasted almonds and almond butter) affected the amount of calories available for absorption.<sup>5</sup> The “matrix effect” occurs with other foods as well, including dairy foods.



## Food structure may explain why whole-fat dairy foods have different health impacts than expected

The examples with carrots and almonds illustrate how food form can affect digestion and absorption of nutrients. The matrix concept applied to dairy foods may help explain why whole-fat dairy foods do not have the same impact on CVD risk as other foods that contain saturated fat. Results of two randomized controlled trials,<sup>6,7</sup> a prospective cohort trial,<sup>8</sup> and a meta-analysis<sup>9</sup> provide a snapshot of the evidence that indicates consuming dairy foods like milk, cheese and yogurt is not linked with higher CVD risk, even when whole-fat options are selected instead of low-fat or fat-free ones. A randomized crossover trial compared the impacts on blood lipids of drinking 2 cups of whole milk or 2 cups of fat-free milk daily.<sup>6</sup> After three weeks, the group drinking whole milk had higher levels of high-density lipoprotein cholesterol (HDL-C), but there were no other differences between the two groups.<sup>6</sup> Another randomized controlled trial<sup>7</sup> compared a modified Dietary Approaches to Stop Hypertension (DASH) diet containing 2-3 daily servings of whole-fat dairy foods to the standard DASH diet, which includes 2-3 servings per day of low-fat or fat-free dairy foods.<sup>10</sup> The modified DASH diet with whole-fat dairy foods lowered blood pressure, reduced blood levels of triglycerides, did not increase total cholesterol or LDL-C and also did not decrease HDL-C, effects similar to those observed with a standard DASH diet.<sup>7</sup>

A prospective cohort trial found that consuming saturated fat from dairy foods posed a lower risk for developing CVD than consuming saturated fat from meat.<sup>8</sup> The authors note that the “health effects of the entire food rather than the content of any single nutrient might be most relevant to understanding associations between dietary consumption and health outcomes.” Finally, a meta-analysis by Chen et al. indicates that eating cheese, even regular-fat cheese, was not linked with an increased risk for total CVD or coronary heart disease.<sup>9</sup> These studies indicate that consuming whole-fat milk, cheese and yogurt is not linked with higher risk for CVD. The fat in milk is the most complex fat naturally occurring in food with over 400 types of fatty acids.<sup>11</sup> This complexity of dairy fat, part of the dairy matrix, might help explain why the link between dairy food consumption and CVD risk is independent of saturated fat content. However, research in this area is ongoing, and there is not yet a precise understanding of the mechanisms involved.

---

## Dairy foods are more than the sum of their nutrients: introducing dairy bioactives

As researchers seek to understand how dairy foods impact chronic disease risk, there is increasing interest in the myriad of unique non-vitamin and non-mineral components in dairy foods known as bioactive compounds. All dairy foods begin as milk, a complex food designed by nature to provide life-sustaining nutrition. Milk contains hundreds of bioactive compounds embedded within its macronutrients (fat, carbohydrates, protein) and inherent physical structure. These bioactive compounds may help explain why saturated fat from whole- and reduced-fat cheese, milk and yogurt does not have the same physiological effects as non-dairy sources of saturated fat. Bioactive peptides, or protein fragments, that may benefit health are among the most well-known of milk’s bioactive compounds.<sup>12</sup> While most of the research to date has been conducted in animal or *in vitro* studies rather than human clinical trials, milk-based bioactive peptides have been shown to exhibit antihypertensive, antimicrobial, antithrombotic, immunomodulatory, antioxidant and mineral binding functions, with some peptides having bioactivity in multiple areas.<sup>12-14</sup> There is also some research on bioactive dairy lipids and carbohydrates but, as with bioactive peptides, much of this research has not been conducted in humans. This emerging area of research on dairy bioactives may help progress understanding of the mechanisms behind the health benefits linked with consuming dairy foods.



## References

- <sup>1</sup> USDA, HHS. 2015-2020 Dietary Guidelines - health.gov. <http://health.gov/dietaryguidelines/2015/guidelines/>. Published 2016. Accessed January 8, 2016.
- <sup>2</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>3</sup> United States Department of Agriculture. Glossary of agricultural terms. <https://agclass.nal.usda.gov/glossary.shtml>.
- <sup>4</sup> Hedrén E, Diaz V, Svanberg U. Estimation of carotenoid accessibility from carrots determined by an in vitro digestion method. *Eur J Clin Nutr*. 2002;56(5):425-430. doi:10.1038/sj.ejcn.1601329
- <sup>5</sup> Gebauer SK, Novotny JA, Bornhorst GM, Baer DJ. Food processing and structure impact the metabolizable energy of almonds. *Food Funct*. 2016;7(10):4231-4238.
- <sup>6</sup> Engel S, Elhauge M, Tholstrup T. Effect of whole milk compared with skimmed milk on fasting blood lipids in healthy adults: A 3-week randomized crossover study. *Eur J Clin Nutr*. 2018;72(2):249-254. doi:10.1038/s41430-017-0042-5
- <sup>7</sup> Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: a randomized controlled trial. *Am J Clin Nutr*. 2016;103(2):341-347. doi:10.3945/ajcn.115.123281
- <sup>8</sup> de Oliveira Otto MC, Mozaffarian D, Kromhout D, et al. Dietary intake of saturated fat by food source and incident cardiovascular disease: the Multi-Ethnic Study of Atherosclerosis. *Am J Clin Nutr*. 2012;96(2):397-404. doi:10.3945/ajcn.112.037770
- <sup>9</sup> Chen G-C, Wang Y, Tong X, et al. Cheese consumption and risk of cardiovascular disease: a meta-analysis of prospective studies. *Eur J Nutr*. 2017;56(8):2565-2575. doi:10.1007/s00394-016-1292-z
- <sup>10</sup> Appel LJ, Moore TJ, Obarzanek E, et al. A Clinical Trial of the Effects of Dietary Patterns on Blood Pressure. *N Engl J Med*. 1997;336(16):1117-1124. doi:10.1056/NEJM199704173361601
- <sup>11</sup> Månsson HL. Fatty acids in bovine milk fat. *Food Nutr Res*. 2008;52. doi:10.3402/fnr.v52i0.1821
- <sup>12</sup> Park YW, Nam MS. Bioactive Peptides in Milk and Dairy Products: A Review. *Korean J Food Sci Anim Resour*. 2015;35(6):831-840. doi:10.5851/kosfa.2015.35.6.831
- <sup>13</sup> Nielsen SD, Beverly RL, Qu Y, Dallas DC. Milk bioactive peptide database: A comprehensive database of milk protein-derived bioactive peptides and novel visualization. *Food Chem*. 2017;232:673-682. doi:10.1016/j.foodchem.2017.04.056
- <sup>14</sup> Jayathilakan K, Ahirwar R, Pandey MC. Bioactive Compounds and Milk Peptides for Human Health-A Review. doi:10.31031/NTNF.2018.01.000525



# Science Summary

## Dairy and Inflammation



### Overview

Dairy foods such as milk, cheese and yogurt are foundational foods in healthy dietary patterns recommended by the Dietary Guidelines for Americans (DGA). Healthy dietary patterns that include dairy foods are linked with lower risk of key chronic diseases such as type 2 diabetes, cardiovascular disease and obesity. These noncommunicable diseases are sometimes called “inflammatory diseases,” because they often co-occur with chronic, systemic inflammation. Lifestyle factors such as diet may impact chronic inflammation. Emerging evidence indicates that consuming dairy foods, including whole- and reduced-fat dairy foods, is not linked to increased levels of inflammatory markers. Some research indicates that consuming certain dairy foods may be linked to lower levels of some inflammatory markers.

### Healthy dietary patterns with dairy can help lower risk for chronic diseases linked with inflammation

Chronic diseases like cardiovascular disease (CVD), type 2 diabetes (T2D) and obesity affect millions of Americans and result in high healthcare costs and lost productivity.<sup>1-3</sup> These conditions are also associated with higher levels of inflammatory markers.<sup>4,5</sup> A healthy diet is the foundation for prevention and management of several chronic diseases, including CVD, T2D and obesity.<sup>5-10</sup> The Scientific Report of the 2020 Dietary Guidelines Advisory Committee emphasizes this point, stating that risk factors for CVD, such as inflammatory markers, are “favorably influenced by habitual adherence to dietary patterns that include fruits, vegetables, whole grains, legumes, nuts, unsaturated vegetable oils, fish, seafood, [and] lower fat dairy products.”<sup>11</sup> The Healthy U.S.-Style Dietary Pattern in the 2020 DGA includes these foods, recommending 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ servings for children 4-8 years and 2 servings for children 2-3 years.<sup>10</sup> It also recommends 1½ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12-23 months and small amounts of yogurt and cheese for infants 6 to 12 months, depending on developmental readiness.<sup>10</sup>

### Eating dairy foods is not linked to inflammatory markers in systematic reviews or meta-analyses

Eating dairy foods does not increase levels of inflammatory biomarkers in individuals without a milk protein allergy, according to results of two meta-analyses and three systematic reviews. Six of the randomized controlled trials of healthy adults included in a meta-analysis by Benatar et al.<sup>12-18</sup> assessed the impact of low-fat or high-fat dairy foods on levels of C-reactive protein (CRP), a commonly used biomarker of inflammation produced by the liver. There were no differences in CRP levels between the dairy-rich diets and the control diets in four of these studies, even when higher-fat dairy foods were included in the dairy intervention. Zemel et al. reported lower levels of CRP at the end of a 28-day study,<sup>16</sup> and Stancliffe et al. also reported significantly lower CRP levels in the group consuming 3.5 daily servings of dairy foods.<sup>14</sup> Another meta-analysis used an “inflammatory score,” which combines many biomarkers



of inflammation into a single metric, to evaluate the results of 52 trials on dairy intake and inflammation.<sup>19</sup> This meta-analysis concluded that diets containing dairy foods, especially fermented dairy foods, had a modest anti-inflammatory effect most apparent in individuals with metabolic disorders like obesity. Three systematic reviews reported similar results, concluding that eating dairy foods had a beneficial impact or no impact on levels of inflammatory markers in both healthy individuals<sup>20,21</sup> and those with metabolic disorders.<sup>20-22</sup>

### **Clinical trials find that consuming dairy foods exerts no change or favorable change on some biomarkers of inflammation**

In addition to the studies covered in meta-analyses and systematic reviews, at least five additional randomized controlled trials<sup>23-27</sup> have been published on the links between dairy foods and inflammation. These studies provide additional evidence that eating dairy foods does not cause inflammation in adults.

In one study, 139 adults with risk factors for metabolic syndrome ate either ~3 ounces of whole-fat cheese, low-fat cheese or a bread and jam control with the same amount of calories for 12 weeks.<sup>23</sup> There were no differences in CRP levels between these groups, indicating that a dairy-rich diet, even with whole-fat cheese, was not linked with increased inflammation. In another study<sup>24</sup> completed by 52 middle-aged adults, participants consumed an energy-deficit diet providing either high or low amounts of dairy foods for 24 weeks. There were no differences in CRP levels between the two groups after the intervention. In a similar randomized crossover study,<sup>25</sup> 45 middle-aged, overweight men and postmenopausal women consumed a high-dairy diet (5-6 daily servings of dairy foods) or a low-dairy diet (<1 daily serving of dairy foods) for 6 weeks. There was no significant difference in CRP levels between the two groups following the intervention. A randomized crossover trial of 92 men and women with abdominal obesity also found no differences in CRP levels after participants ate a diet rich in saturated fat from cheese, a diet rich in saturated fat from butter, a diet rich in monounsaturated fatty acids, a diet rich in polyunsaturated fatty acids, or a low-fat high carbohydrate diet for 4 weeks.<sup>27</sup> Another randomized controlled trial assessed the impact of eating yogurt on markers of chronic inflammation in healthy women with and without obesity.<sup>26</sup> Women consumed 12 ounces of either low-fat yogurt or soy pudding for 9 weeks. Eating yogurt led to decreased levels of several, but not all, markers of inflammation measured in this study in both the women with obesity and the women without obesity.

### **Dairy foods are scored as neutral or “anti-inflammatory” by dietary inflammation scoring system**

A new, validated approach to assessing dietary and lifestyle factors that affect systemic inflammation was published in 2019.<sup>28</sup> The research team used food frequency questionnaires and levels of inflammatory biomarkers to assess dietary intake and create an inflammation biomarker score. They validated this score with 3 study populations including over 14,000 Americans. Both high-fat dairy foods (including whole- and reduced-fat milk, yogurt, cheese and ice cream) and low-fat dairy foods (including low- and fat-free milk, low-fat cheeses and ice cream) received negative scores (-0.14 and -0.12, respectively), indicating an anti-inflammatory effect. This scoring system, in conjunction with the other published literature on the topic, indicates that dairy foods do not cause inflammation and are either neutral or mildly anti-inflammatory.



## References

- <sup>1</sup> Adult Obesity Facts | Overweight & Obesity | CDC. <https://www.cdc.gov/obesity/data/adult.html>. Accessed November 20, 2019.
- <sup>2</sup> Centers for Disease Control and Prevention. Division of Diabetes Translation At A Glance. <https://www.cdc.gov/chronicdisease/resources/publications/aag/diabetes.htm>. Published 2019.
- <sup>3</sup> Benjamin EJ, Muntner P, Alonso A, et al. Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association. *Circulation*. 2019;139(10):e56-e528. doi:10.1161/CIR.0000000000000659
- <sup>4</sup> Inflammation and Heart Disease | American Heart Association. <https://www.heart.org/en/health-topics/consumer-healthcare/what-is-cardiovascular-disease/inflammation-and-heart-disease>. Accessed November 17, 2020.
- <sup>5</sup> McLaughlin T, Ackerman SE, Shen L, Engleman E. Role of innate and adaptive immunity in obesity-associated metabolic disease. *J Clin Invest*. 2017;127(1):5-13. doi:10.1172/JCI88876
- <sup>6</sup> Diabetes Basics | CDC. <https://www.cdc.gov/diabetes/basics/>. Accessed August 19, 2020.
- <sup>7</sup> Eckel RH, Jakicic JM, Ard JD, et al. 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2014;63(25 Pt B):2960-2984. doi:10.1016/j.jacc.2013.11.003
- <sup>8</sup> Van Horn L, Carson JAS, Appel LJ, et al. Recommended Dietary Pattern to Achieve Adherence to the American Heart Association/American College of Cardiology (AHA/ACC) Guidelines: A Scientific Statement From the American Heart Association. *Circulation*. 2016;134(22). doi:10.1161/CIR.0000000000000462
- <sup>9</sup> CDC. Adult Obesity Facts | Data | Adult | Obesity | DNPAO | CDC. <http://www.cdc.gov/obesity/data/adult.html>. Published 2016. Accessed December 4, 2015.
- <sup>10</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>11</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee. [https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport\\_of\\_the\\_2020DietaryGuidelinesAdvisoryCommittee\\_first-print.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf).
- <sup>12</sup> Benatar JR, Sidhu K, Stewart RAH. Effects of High and Low Fat Dairy Food on Cardio-Metabolic Risk Factors: A Meta-Analysis of Randomized Studies. *PLoS One*. 2013;8(10):1-12. doi:10.1371/journal.pone.0076480
- <sup>13</sup> G.E. C, P.R.C. H, J.D. B, A.M. C, K.J. M. Dairy consumption and cardiometabolic health: Outcomes of a 12-month crossover trial. *Nutr Metab*. 2012;9:1-11. doi:10.1186/1743-7075-9-19
- <sup>14</sup> Stancliffe RA, Thorpe T, Zemel MB. Dairy attenuates oxidative and inflammatory stress in metabolic syndrome. *Am J Clin Nutr*. 2011;94(2):422-430. doi:10.3945/ajcn.111.013342
- <sup>15</sup> Wennersberg MH, Smedman A, Turpeinen AM, et al. Dairy products and metabolic effects in overweight men and women: results from a 6-mo intervention study. *Am J Clin Nutr*. 2009;90(4):960-968. doi:10.3945/ajcn.2009.27664
- <sup>16</sup> Zemel MB, Sun X, Sobhani T, Wilson B. Effects of dairy compared with soy on oxidative and inflammatory stress in overweight and obese subjects. *Am J Clin Nutr*. 2010;91(1):16-22. doi:10.3945/ajcn.2009.28468
- <sup>17</sup> van Meijl LEC, Mensink RP. Effects of low-fat dairy consumption on markers of low-grade systemic inflammation and endothelial function in overweight and obese subjects: an intervention study. *Br J Nutr*. 2010;104(10):1523-1527. doi:10.1017/S0007114510002515
- <sup>18</sup> Benatar JR, Jones E, White H, Stewart RAH. A randomized trial evaluating the effects of change in dairy food consumption on cardio-metabolic risk factors. *Eur J Prev Cardiol*. 2014;21(11):1376-1386. doi:10.1177/2047487313493567
- <sup>19</sup> Bordonni A, Danesi F, Dardevet D, et al. Dairy products and inflammation: A review of the clinical evidence. *Crit Rev Food Sci Nutr*. 2017;57(12):2497-2525. doi:10.1080/10408398.2014.967385
- <sup>20</sup> Ulven SM, Holven KB, Gil A, Rangel-Huerta OD. Milk and Dairy Product Consumption and Inflammatory Biomarkers: An Updated Systematic Review of Randomized Clinical Trials. *Adv Nutr*. 2019;10(suppl\_2):S239-S250. doi:10.1093/advances/nmy072
- <sup>21</sup> Nieman KM, Anderson BD, Cifelli CJ. The Effects of Dairy Product and Dairy Protein Intake on Inflammation: A Systematic Review of the Literature. 2020. doi:10.1080/07315724.2020.1800532
- <sup>22</sup> Labonté M-È, Couture P, Richard C, Desroches S, Lamarche B. Impact of dairy products on biomarkers of inflammation: a systematic review of randomized controlled nutritional intervention studies in overweight and obese adults. *Am J Clin Nutr*. 2013;97(4):706-717. doi:10.3945/ajcn.112.052217
- <sup>23</sup> Raziani F, Tholstrup T, Kristensen MD, et al. High intake of regular-fat cheese compared with reduced-fat cheese does not affect LDL cholesterol or risk markers of the metabolic syndrome: a randomized controlled trial. *Am J Clin Nutr*. 2016;104(4):973-981. doi:10.3945/ajcn.116.134932
- <sup>24</sup> Bendtsen LQ, Blædel T, Holm JB, et al. High intake of dairy during energy restriction does not affect energy balance or the intestinal microflora compared with low dairy intake in overweight individuals in a randomized controlled trial. *Appl Physiol Nutr Metab*. 2018;43(1):1-10. doi:10.1139/apnm-2017-0234
- <sup>25</sup> Eelderink C, Rietsema S, Van Vliet IMY, et al. The effect of high compared with low dairy consumption on glucose metabolism, insulin sensitivity, and metabolic flexibility in overweight adults: A randomized crossover trial. *Am J Clin Nutr*. 2019;109(6):1555-1568. doi:10.1093/ajcn/nqz017
- <sup>26</sup> Pei R, DiMarco DM, Putt KK, et al. Low-fat yogurt consumption reduces biomarkers of chronic inflammation and inhibits markers of endotoxin exposure in healthy premenopausal women: a randomised controlled trial. *Br J Nutr*. November 2017;1-9. doi:10.1017/S0007114517003038
- <sup>27</sup> Brassard D, Tessier-Grenier M, Allaire J, et al. Comparison of the impact of SFAs from cheese and butter on cardiometabolic risk factors: A randomized controlled trial. *Am J Clin Nutr*. 2017;105(4):800-809. doi:10.3945/ajcn.116.150300
- <sup>28</sup> Byrd DA, Judd SE, Flanders D, Hartman TJ, Fedirko V, Bostick RM. The Journal of Nutrition Nutritional Epidemiology Development and Validation of Novel Dietary and Lifestyle Inflammation Scores. doi:10.1093/jn/nxz165



# Public Health Across the Lifespan





# Science Summary

## Dairy and Blood Pressure



### Overview

Dairy foods such as milk, cheese and yogurt are foundational foods in healthy dietary patterns. Low-fat and fat-free dairy foods are part of the Dietary Guidelines for Americans (DGA) and American Heart Association (AHA) recommended healthy dietary patterns for Americans 2 years and older. A growing body of evidence indicates that consuming dairy foods is linked with reduced risk for high blood pressure and may help maintain or lower elevated blood pressure. This summary provides an overview of the research published since 2015 on the link between consuming dairy foods and blood pressure.

### Healthy dietary patterns can help lower risk for high blood pressure and decrease healthcare costs

High blood pressure is a major risk factor for cardiovascular disease (CVD).<sup>1</sup> Over 45 percent of American adults have high blood pressure, and between 2014–2015, total healthcare costs and lost productivity associated with high blood pressure was \$55.9 billion.<sup>1</sup> Lifestyle guidelines for prevention of cardiovascular risk factors, including high blood pressure, emphasize weight control, physical activity, smoking avoidance, limited alcohol consumption and healthy dietary patterns.<sup>1</sup> The Dietary Approaches to Stop Hypertension (DASH) diet, a reduced-fat diet containing up to three servings of low-fat dairy foods and 8 to 10 servings of fruits and vegetables, lowers elevated blood pressure.<sup>2,3</sup> The 2020 DGA describes the DASH diet as a “healthy dietary pattern.”<sup>4</sup> The AHA recommends the DASH diet to reduce elevated blood pressure.<sup>5</sup> It also recommends including low-fat and fat-free dairy foods in healthy dietary patterns to reduce elevated blood pressure and CVD risk.<sup>5</sup>

The 2020 DGA states that healthy eating is associated with lower blood pressure in adults, including older adults,<sup>4</sup> and recommends 3 daily servings of low-fat or fat-free dairy foods for those 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 Dietary Pattern.<sup>4</sup> The DGA also recommends 1⅔ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12–23 months who no longer consume human milk as part of the Healthy U.S.-Style Dietary Pattern.<sup>4</sup> Small amounts of yogurt and cheese are recommended as complementary foods for infants 6 to 12 months, depending on developmental readiness.<sup>4</sup>

### Eating dairy foods linked to lower blood pressure in systematic reviews and meta-analyses

Since 2015, 2 systematic reviews and meta-analyses, 5 prospective cohort studies and 9 trials have been published that contribute to the body of science on the links between dairy intake and healthy blood pressure in adults and adolescents. In 2016, a systematic review<sup>6</sup> of prospective research on the links between dairy and cardiovascular



health, including blood pressure, found that high-quality evidence consistently indicates that total dairy food consumption is associated with a reduced risk of hypertension. This review also found that high-quality evidence indicates cheese consumption is not associated with the risk of hypertension, and moderate-quality evidence indicates that milk consumption may be associated with a reduced risk of hypertension. A 2017 systematic review and meta-analysis summarized the evidence on the relationship of the intakes of 12 major food groups, including dairy, with the risk of hypertension.<sup>7</sup> This meta-analysis identified 9 prospective studies that assess the link between dairy foods and hypertension.<sup>7</sup> In a dose-response analysis, increasing dairy intake by about 1 cup per day was associated with a 5 percent reduction in hypertension risk.<sup>7</sup> Systematic reviews and meta-analyses published since 2015<sup>6,7</sup> indicate that total dairy food as well as milk consumption is linked to lower risk of elevated blood pressure. Specific dairy foods like cheese are not linked with hypertension risk, though these findings need confirmation.

---

### **Prospective evidence indicates consuming dairy foods is linked with reduced risk for high blood pressure**

Prospective cohort studies have also been used to assess the impact of dairy food intake on blood pressure. Like the systematic reviews and meta-analyses on the topic, evidence from prospective cohort studies consistently reports a beneficial relationship or no relationship between consuming dairy foods and blood pressure. In 37,124 Chinese adults assessed as part of the Singapore Chinese Health Study, daily milk drinkers had a lower risk of hypertension than nondrinkers did.<sup>8</sup> Another prospective cohort study that evaluated dairy intake and blood pressure in nearly 180,000 Americans found that participants who consumed at least 3 servings of dairy per day (versus less than ½ serving per day) had a 13 percent lower risk of high blood pressure.<sup>9</sup> In 57,547 adults from 21 countries, consuming at least 2 servings of dairy per day was linked with a lower incidence of high blood pressure.<sup>10</sup> In a study of 40,526 French women, overall dairy consumption was not linked with high blood pressure, but risk of hypertension increased with processed cheese consumption.<sup>11</sup>

---

### **Clinical trials find eating low-fat or whole-fat dairy foods helps maintain or lower elevated blood pressure**

Clinical studies indicate that consuming recommended amounts of dairy foods does not increase blood pressure and, in some studies, especially studies conducted in adults at risk for elevated blood pressure, consuming dairy foods was linked to lower blood pressure. Results of 5 randomized clinical trials also indicate that consuming dairy foods has neutral or beneficial links with blood pressure in adults.<sup>12-16</sup> In one large randomized intervention trial of the DASH diet, adults who both increased their dairy intake to more than 1½ servings per day and consumed more than 5 servings of fruits and vegetables per day had the greatest reductions in blood pressure.<sup>12</sup> A crossover trial with overweight adults found that a diet including up to 6 servings of dairy foods daily reduced both systolic and diastolic blood pressure compared to a diet with less than 1 daily serving of dairy foods.<sup>13</sup> Rietsema et al. noted that this effect may have been due to the calcium content of the high dairy versus the low dairy diet.<sup>13</sup> Similarly, a randomized crossover trial of 49 adults with hypertension found that adding 4 or more daily servings of fat-free dairy foods reduced systolic blood pressure and improved vascular function compared to a similar diet without dairy foods.<sup>14</sup>

Whole-fat dairy products have also been found to have neutral or beneficial impacts on blood pressure. In a study of 36 healthy adults, when a standard DASH diet was compared with a higher-fat DASH diet including whole milk dairy



foods, both the higher fat and standard DASH diets resulted in lowered blood pressure.<sup>15</sup> In a crossover clinical trial, 60 participants who added 4 servings per day of whole-fat dairy products (milk, cheese, yogurt) to their normal diet had no significant changes in blood pressure compared to participants adding 4 servings per day of plant-based foods (coconut milk, peanuts, orange juice, applesauce).<sup>16</sup>

## References

- <sup>1</sup> Benjamin EJ, Muntner P, Alonso A, et al. Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association. *Circulation*. 2019;139(10):e56-e528. doi:10.1161/CIR.0000000000000659
- <sup>2</sup> Chiavaroli L, Viguioliuk E, Nishi SK, et al. DASH dietary pattern and cardiometabolic outcomes: An umbrella review of systematic reviews and meta-analyses. *Nutrients*. 2019;11(2). doi:10.3390/nu11020338
- <sup>3</sup> United States Department of Agriculture, United States Department of Health and Human Services, National Heart Lung and Blood Institute. In Brief: Your Guide to Lowering Your Blood Pressure with DASH. [https://www.nhlbi.nih.gov/files/docs/public/heart/dash\\_brief.pdf](https://www.nhlbi.nih.gov/files/docs/public/heart/dash_brief.pdf). Accessed December 13, 2017.
- <sup>4</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>5</sup> Chobanian A V, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertens (Dallas, Tex 1979)*. 2003;42(6):1206-1252. doi:10.1161/01.HYP.0000107251.49515.c2
- <sup>6</sup> Drouin-Chartier J-P, Brassard D, Tessier-Grenier M, et al. Systematic Review of the Association between Dairy Product Consumption and Risk of Cardiovascular-Related Clinical Outcomes. *Adv Nutr*. 2016;7(6):1026-1040. doi:10.3945/an.115.011403
- <sup>7</sup> Schwingshackl L, Schwedhelm C, Hoffmann G, et al. Food Groups and Risk of Hypertension: A Systematic Review and Dose-Response Meta-Analysis of Prospective Studies. *Adv Nutr*. 2017;8(6):793-803. doi:10.3945/an.117.017178
- <sup>8</sup> Talaei M, Pan A, Yuan J-M, Koh W-P. Dairy Food Intake Is Inversely Associated with Risk of Hypertension: The Singapore Chinese Health Study. *J Nutr*. 2016;147(2):235-241. doi:10.3945/jn.116.238485
- <sup>9</sup> Buendia JR, Li Y, Hu FB, et al. Long-term yogurt consumption and risk of incident hypertension in adults. *J Hypertens*. 2018;36(8):1. doi:10.1097/HJH.0000000000001737
- <sup>10</sup> Bhavadharini B, Dehghan M, Mente A, et al. Association of dairy consumption with metabolic syndrome, hypertension and diabetes in 147 812 individuals from 21 countries. *BMJ Open Diabetes Res Care*. 2020;8(1):826. doi:10.1136/bmjdr-2019-000826
- <sup>11</sup> Villaverde P, Lajous M, MacDonald CJ, Fagherazzi G, Boutron-Ruault MC, Bonnet F. Dairy product consumption and hypertension risk in a prospective French cohort of women. *Nutr J*. 2020;19(1):12. doi:10.1186/s12937-020-0527-2
- <sup>12</sup> Pickering RT, Bradlee ML, Singer MR, Moore LL. Baseline diet modifies the effects of dietary change. *Br J Nutr*. 2020;123(8):951-958. doi:10.1017/S0007114520000112
- <sup>13</sup> Rietsema S, Eelderink C, Joustra ML, et al. Effect of high compared with low dairy intake on blood pressure in overweight middle-aged adults: Results of a randomized crossover intervention study. *Am J Clin Nutr*. 2019;110(2):340-348. doi:10.1093/ajcn/nqz116
- <sup>14</sup> Machin DR, Park W, Alkatan M, Mouton M, Tanaka H. Effects of non-fat dairy products added to the routine diet on vascular function: A randomized controlled crossover trial. *Nutr Metab Cardiovasc Dis*. 2015;25(4):364-369. doi:10.1016/j.numecd.2015.01.005
- <sup>15</sup> Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: a randomized controlled trial. *Am J Clin Nutr*. 2016;103(2):341-347. doi:10.3945/ajcn.115.123281
- <sup>16</sup> Roy SJ, Lapierre SS, Baker BD, Delfausse LA, Machin DR, Tanaka H. High dietary intake of whole milk and full-fat dairy products does not exert hypotensive effects in adults with elevated blood pressure. *Nutr Res*. 2019;64:72-81. doi:10.1016/j.nutres.2019.01.003



# Science Summary

## Dairy and Sarcopenia and Osteoporosis



### Overview

Including dairy foods in healthy dietary patterns can help people thrive at every age, including older adulthood. Eating dairy foods, a source of high-quality protein and other essential nutrients, may reduce the risk of age-related conditions such as sarcopenia (loss of muscle mass and strength) and frailty. Consuming dairy foods may also help older adults maintain healthy bones by reducing the risk of bone mineral density loss and lowering

the risk of osteoporosis-related falls and fractures. The 2020-2025 Dietary Guidelines for Americans (DGA) recommends that adults consume 3 servings of low-fat or fat-free dairy foods daily as part of the Healthy U.S.-Style Dietary Pattern.

### Dairy foods help support the nutritional needs of older adults

As the population of older adults in the U.S. continues to grow, the nutrition challenges these adults face will become even more serious public health concerns. Older adults may struggle with healthy eating due to age-related changes and obstacles including socioeconomic factors, depression, changes in taste, physical ability to chew and swallow and body composition, along with reductions in appetite from medications and reduced mobility, among other challenges.<sup>1-5</sup> While men and women 70 years and older consume sufficient calories, on average, they do not consume enough of the nutrients of public health concern for Americans 2 years and older—calcium, vitamin D, fiber and potassium—and tend to exceed recommendations for daily sodium and saturated fat intake.<sup>6</sup> Older adults are also at risk for low intakes of protein and vitamin B12.<sup>6</sup>

Consuming dairy foods as part of healthy dietary patterns can help older adults thrive. Dairy foods like milk, yogurt and cheese are important sources of several shortfall nutrients for older adults, including protein, calcium, potassium, vitamin D and vitamin B12.<sup>7</sup> Dairy foods also provide high-quality nutrition at an affordable price<sup>8</sup> and are available in a variety of textures and flavors that may appeal to older adults experiencing physical challenges with eating. However, Americans 70 years and older consume, on average, less than 1½ servings of dairy foods per day.<sup>9</sup> The 2020 DGA recommends that all Americans 9 years and older consume 3 daily servings of low-fat or fat-free dairy foods in the Healthy U.S.-Style Dietary Pattern.<sup>6</sup> Adding at least one more daily serving of dairy foods to the dietary patterns of older adults can help bring them closer to meeting dairy recommendations.<sup>10,11</sup>



## **Dairy foods are an important source of high-quality protein that can help meet the unique nutrition needs of older adults**

Older adults have low intakes of protein relative to the Estimated Average Requirement (EAR),<sup>7</sup> and the 2020 DGA identifies dairy foods as a source of dietary protein for older adults.<sup>6</sup> Milk, cheese and yogurt are good sources of high-quality protein, which helps support bone health and preserve muscle mass and physical function in older adults as part of healthy dietary patterns.<sup>12</sup> Milk provides 8 grams (g) of high-quality protein per cup, and hard cheeses such as Cheddar and Colby provide 10 g or more of protein per 1½ ounce serving.<sup>13\*</sup> Some styles of yogurt like Greek yogurt can provide more than 20 g of protein per cup.<sup>13\*</sup> A modeling study examining the effect of increasing plant-based foods or dairy foods on protein intake in older adults found that doubling the intake of dairy foods could help older adults meet their protein needs. In contrast, doubling intake of plant-based foods resulted in an approximate 22 percent decline in protein consumption.<sup>14</sup> Because older adults currently do not meet dairy food recommendations, adding one more serving of dairy foods to their current diets would move them closer to both protein intake recommendations and dairy recommendations from the 2020 DGA.<sup>6,10,11</sup>

## **Eating dairy foods may lessen risk of sarcopenia and frailty among older adults**

Sarcopenia, or the loss of skeletal muscle strength and mass, accelerates with age, contributes to adverse health outcomes in older adults and may lead to substantial healthcare costs.<sup>15,16</sup> Frailty is also a common clinical syndrome in older adults, and it carries increased risks for poor health outcomes including institutionalization, falls, hospitalization and mortality.<sup>17</sup> Nutritional factors such as inadequate protein and energy intake play a role in the development of both sarcopenia and frailty.<sup>14,18-21</sup> Results of systematic reviews and prospective cohort studies indicate that consuming dairy foods like milk, cheese and yogurt in recommended amounts throughout older adulthood may help reduce the risk of sarcopenia and frailty by supporting muscle mass and muscle strength.

Results of two systematic reviews indicate that consuming dairy foods (low-fat milk, cheese and yogurt) may be beneficial for preserving muscle mass and muscle strength in adults 50 years and older, thereby reducing the risk of sarcopenia.<sup>15,22</sup> Two prospective cohort studies also reported similar results. One prospective cohort study found that consuming more than 7 servings per week of low-fat milk and yogurt versus less than 1 serving per week was linked with lower risk of frailty, slow walking speed and weight loss.<sup>23</sup> Another prospective cohort study concluded that consuming more meat and dairy foods was linked with a lower risk of developing physical frailty.<sup>24</sup>

## **Dairy foods may help support bone health in older adults**

Eating dairy foods may also help older adults maintain healthy bones. Osteoporosis, the condition of porous, brittle and fragile bone, affects approximately 54 million Americans.<sup>25</sup> One out of every two postmenopausal women will experience an osteoporosis-related fracture at some point in her lifetime.<sup>26</sup> While some factors that affect peak bone mass are not modifiable (gender, ethnicity, genetics), others such as nutritional status, physical activity and body composition are modifiable. Unfortunately, older adults tend to fall short of meeting recommendations for nutrition needs associated with bone health like adequate calcium, vitamin D and potassium intake.<sup>7</sup>

\*FDC IDs: Cheddar: 1098009; Colby: 173416; Greek Yogurt: 1097564



Results of meta-analyses, a systematic review and longitudinal cohort studies indicate that eating dairy foods may be beneficial for bone health in older adults. Meta-analyses and systematic reviews as well as a prospective cohort study provide evidence that dairy foods can increase bone mineral density and reduce the risk of hip fracture.<sup>27-33</sup> A large systematic review with data from 91 publications concluded that moderate evidence indicates that daily intake of low-fat or fat-free dairy foods as part of a healthy dietary pattern may be associated with improved bone mineral density and fewer fractures in adults 50 years and older.<sup>32</sup> In two U.S. cohorts of approximately 43,000 men and 80,000 postmenopausal women aged 50 years and followed for up to 32 years, each 1 cup daily serving of milk was associated with an 8 percent lower risk of hip fracture.<sup>33</sup> Total dairy intake, about half of which was milk, was associated with a 6 percent lower risk of hip fracture per daily serving.<sup>33</sup> Some research reports that consuming dairy foods may not have an impact on certain indicators of bone health in older adults, such as bone mineral density, risk of falling and osteoporotic fractures.<sup>34-37</sup> These results indicate a need for continued research to further explain the links between dairy food intake and bone health in older adults.

## References

- <sup>1</sup> Choosing Healthy Meals As You Get Older. <https://www.nia.nih.gov/health/choosing-healthy-meals-you-get-older>. Accessed December 3, 2019.
- <sup>2</sup> Walls AWG, Steele JG. The relationship between oral health and nutrition in older people. *Mech Ageing Dev.* 2004;125(12 SPEC.ISS.):853-857. doi:10.1016/j.mad.2004.07.011
- <sup>3</sup> Brownie S. Why are elderly individuals at risk of nutritional deficiency? *Int J Nurs Pract.* 2006;12(2):110-118. doi:10.1111/j.1440-172X.2006.00557.x
- <sup>4</sup> Morris H. Dysphagia in the elderly--a management challenge for nurses. *Br J Nurs.* 2006;15(10):558-562. doi:10.12968/bjon.2006.15.10.21132
- <sup>5</sup> Morley JE. Novel Approaches to Nutrition in Older Persons. *Clin Geriatr Med.* 2015;31(3):xiii-xiv. doi:10.1016/j.cger.2015.05.001
- <sup>6</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>7</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee. [https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport\\_of\\_the\\_2020DietaryGuidelinesAdvisoryCommittee\\_first-print.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-07/ScientificReport_of_the_2020DietaryGuidelinesAdvisoryCommittee_first-print.pdf).
- <sup>8</sup> Hess JM, Cifelli CJ, Agarwal S, Fulgoni VL. Comparing the cost of essential nutrients from different food sources in the American diet using NHANES 2011-2014. *Nutr J.* 2019;18(1):68. doi:10.1186/s12937-019-0496-5
- <sup>9</sup> National Dairy Council. NHANES 2015-2018. Hyattsville, MD; 2020.
- <sup>10</sup> Quann EE, Fulgoni VL, Auestad N. Consuming the daily recommended amounts of dairy products would reduce the prevalence of inadequate micronutrient intakes in the United States: diet modeling study based on NHANES 2007-2010. *Nutr J.* 2015;14(1):90. doi:10.1186/s12937-015-0057-5
- <sup>11</sup> Hess JM, Fulgoni VL, Radlowski EC. Modeling the Impact of Adding a Serving of Dairy Foods to the Healthy Mediterranean-Style Eating Pattern Recommended by the 2015-2020 Dietary Guidelines for Americans. *J Am Coll Nutr.* August 2018;1-9. doi:10.1080/07315724.2018.1485527
- <sup>12</sup> Phillips SM, Martinson W. Nutrient-rich, high-quality, protein-containing dairy foods in combination with exercise in aging persons to mitigate sarcopenia. *Nutr Rev.* 2019;77(4):2.16-2.29. doi:10.1093/nutrit/nuy062
- <sup>13</sup> USDA. FoodData Central. <https://fdc.nal.usda.gov/index.html>. Published 2019.
- <sup>14</sup> Houchins JA, Cifelli CJ, Demmer E, Fulgoni VL. Diet modeling in older Americans: The impact of increasing plant-based foods or dairy products on protein intake. *J Nutr Health Aging.* 2017;21(6):673-680. doi:10.1007/s12603-016-0819-6
- <sup>15</sup> Granic A, Dismore L, Hurst C, Robinson SM, Sayer AA. Myoprotective whole foods, muscle health and sarcopenia: A systematic review of observational and intervention studies in older adults. *Nutrients.* 2020;12(8):1-32. doi:10.3390/nu12082257
- <sup>16</sup> Bruyère O, Beaudart C, Ethgen O, Reginster JY, Locquet M. The health economics burden of sarcopenia: a systematic review. *Maturitas.* 2019;119:61-69. doi:10.1016/j.maturitas.2018.11.003
- <sup>17</sup> Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: Evidence for a phenotype. *Journals Gerontol - Ser A Biol Sci Med Sci.* 2001;56(3). doi:10.1093/gerona/56.3.m146
- <sup>18</sup> Yeung SSY, Trappenburg MC, Meskers CGM, Maier AB, Reijnierse EM. Inadequate energy and protein intake in geriatric outpatients with mobility problems. *Nutr Res.* 2020. doi:10.1016/j.nutres.2020.09.007
- <sup>19</sup> Geirsdottir OG, Arnarson A, Ramel A, Jonsson P V, Thorsdottir I. Dietary protein intake is associated with lean body mass in community-dwelling older adults. *Nutr Res.* 2013;33(8):608-612. doi:10.1016/j.nutres.2013.05.014
- <sup>20</sup> McLean RR, Mangano KM, Hannan MT, Kiel DP, Sahni S. Dietary Protein Intake Is Protective Against Loss of Grip Strength Among Older Adults in the Framingham Offspring Cohort. *Journals Gerontol - Ser A Biol Sci Med Sci.* 2016;71(3):356-361. doi:10.1093/gerona/glv184
- <sup>21</sup> Isanejad M, Mursu J, Sirola J, et al. Dietary protein intake is associated with better physical function and muscle strength among elderly women. *Br J Nutr.* 2016;115(7):1281-1291. doi:10.1017/S000711451600012X



- <sup>22</sup> Cuesta-Triana F, Verdejo-Bravo C, Fernández-Pérez C, Martín-Sánchez FJ. Effect of Milk and Other Dairy Products on the Risk of Frailty, Sarcopenia, and Cognitive Performance Decline in the Elderly: A Systematic Review. *Adv Nutr*. 2019;10(suppl\_2):S105-S119. doi:10.1093/advances/nmy105
- <sup>23</sup> Lana A, Rodríguez-Artalejo F, López-García E. Dairy consumption and risk of frailty in older adults: A prospective cohort study. *J Am Geriatr Soc*. 2015;63(9):1852-1860. doi:10.1111/jgs.13626
- <sup>24</sup> Otsuka R, Tange C, Tomida M, et al. Dietary Factors Associated with the Development of Physical Frailty in Community-Dwelling Older Adults. *J Nutr Heal Aging*. 2019;23(1):89-95. doi:10.1007/s12603-018-1124-3
- <sup>25</sup> Learn What Osteoporosis Is and What It's Caused by. <https://www.nof.org/patients/what-is-osteoporosis/>. Accessed December 10, 2019.
- <sup>26</sup> US Office of the Surgeon General. Bone Health and Osteoporosis. Office of the Surgeon General (US); 2004. <http://www.ncbi.nlm.nih.gov/pubmed/20945569>. Accessed April 4, 2018.
- <sup>27</sup> Shi Y, Zhan Y, Chen Y, Jiang Y. Effects of dairy products on bone mineral density in healthy postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. *Arch Osteoporos*. 2020;15(1):1-8. doi:10.1007/s11657-020-0694-y
- <sup>28</sup> Hidayat K, Du X, Shi BM, Qin LQ. Systematic review and meta-analysis of the association between dairy consumption and the risk of hip fracture: critical interpretation of the currently available evidence. *Osteoporos Int*. 2020;31(8):1411-1425. doi:10.1007/s00198-020-05383-3
- <sup>29</sup> Ong AM, Kang K, Weiler HA, Morin SN. Fermented Milk Products and Bone Health in Postmenopausal Women: A Systematic Review of Randomized Controlled Trials, Prospective Cohorts, and Case-Control Studies. *Adv Nutr*. 2020;11(2):251-265. doi:10.1093/advances/nmz108
- <sup>30</sup> Fabiani R, Naldini G, Chiavarini M. Dietary patterns in relation to low bone mineral density and fracture risk: A systematic review and meta-analysis. *Adv Nutr*. 2019;10(2):219-236. doi:10.1093/advances/nmy073
- <sup>31</sup> Malmir H, Larijani B, Esmailzadeh A. Consumption of milk and dairy products and risk of osteoporosis and hip fracture: a systematic review and Meta-analysis. *Crit Rev Food Sci Nutr*. 2020;60(10):1722-1737. doi:10.1080/10408398.2019.1590800
- <sup>32</sup> Wallace TC, Bailey RL, Lappe J, et al. Dairy intake and bone health across the lifespan: a systematic review and expert narrative. *Crit Rev Food Sci Nutr*. 2020. doi:10.1080/10408398.2020.1810624
- <sup>33</sup> Feskanich D, Meyer HE, Fung TT, Bischoff-Ferrari HA, Willett WC. Milk and other dairy foods and risk of hip fracture in men and women. *Osteoporos Int*. 2018;29(2):385-396. doi:10.1007/s00198-017-4285-8
- <sup>34</sup> Aslam H, Holloway-Kew KL, Mohebbi M, Jacka FN, Pasco JA. Association between dairy intake and fracture in an Australian-based cohort of women: A prospective study. *BMJ Open*. 2019;9(11). doi:10.1136/bmjopen-2019-031594
- <sup>35</sup> Wallace TC, Jun S, Zou P, et al. Dairy intake is not associated with improvements in bone mineral density or risk of fractures across the menopause transition: data from the Study of Women's Health Across the Nation. *Menopause*. 2020;27(8):879-886. doi:10.1097/GME.0000000000001555
- <sup>36</sup> Machado-Fragua MD, Struijk EA, Caballero FF, et al. Dairy consumption and risk of falls in 2 European cohorts of older adults. *Clin Nutr*. 2020;39(10):3140-3146. doi:10.1016/j.clnu.2020.01.025
- <sup>37</sup> Matía-Martín P, Torrego-Ellacuría M, Larrad-Sainz A, Fernández-Pérez C, Cuesta-Triana F, Rubio-Herrera MÁ. Effects of Milk and Dairy Products on the Prevention of Osteoporosis and Osteoporotic Fractures in Europeans and Non-Hispanic Whites from North America: A Systematic Review and Updated Meta-Analysis. *Adv Nutr*. 2019;10(suppl\_2):S120-S143. doi:10.1093/advances/nmy097



# Science Summary

## Dairy and Type 2 Diabetes



### Overview

Dairy foods such as milk, cheese and yogurt are foundational foods in healthy dietary patterns. The dairy group contributes important shortfall nutrients, including calcium, vitamin D and potassium to the American diet. Low-fat and fat-free dairy foods are part of the Dietary Guidelines for Americans (DGA) recommendations for healthy dietary patterns for Americans 2 years and older. A growing body of research indicates that consuming dairy foods is associated with multiple health benefits, including a reduced risk of type 2 diabetes (T2D). This

summary provides an overview of studies conducted since 2015 on the links between dairy food consumption and T2D and provides further support for consuming dairy foods as recommended in the 2020 DGA.

### Healthy dietary patterns can help lower risk for T2D and decrease public health costs

T2D affects the lives of more than 30 million American adults and accounts for 90–95 percent of all diagnosed cases of diabetes.<sup>1</sup> Another 84 million American adults have prediabetes, putting them at greater risk of developing T2D.<sup>2</sup> Poor-quality diet and physical inactivity are recognized as key contributors to the epidemics of overweight, obesity and other diet-related chronic diseases including T2D.<sup>3–5</sup> A healthy diet is part of the foundation for T2D prevention, treatment and management.<sup>6</sup> Milk, cheese and yogurt, regardless of fat content, are recommended parts of healthy dietary patterns, within calorie limits, according to the Joslin Diabetes Center's 2018 clinical nutrition guidelines for overweight and obese adults with T2D or prediabetes or those at risk for developing T2D.<sup>7</sup> The 2020 DGA states that healthy dietary patterns are associated with reduced risk for several chronic diseases, including T2D,<sup>5</sup> and the DGA's Healthy U.S.-Style Dietary Pattern recommends 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ servings for children 4–8 years and 2 servings for children 2–3 years.<sup>5</sup> It also recommends 1⅓ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12–23 months and small amounts of yogurt and cheese for infants 6 to 12 months, depending on developmental readiness.<sup>5</sup>

### Research continues to explore links between dairy food consumption and lower risk for T2D

The 2020 DGA recommendations to include dairy foods in healthy dietary patterns builds on conclusions from previous DGAs as well as from the body of scientific evidence published on the topic. Since 2015, 1 meta-analysis,<sup>8</sup> 2 systematic reviews,<sup>9,10</sup> 4 systematic reviews with meta analyses,<sup>11–14</sup> 14 prospective studies<sup>15–28</sup> and 2 longitudinal studies<sup>29,30</sup> have been published on the links between consuming dairy foods and T2D risk. These studies, discussed in the following sections, indicate that consuming dairy foods has beneficial or neutral associations with T2D incidence in adults and that these associations vary with specific dairy foods.



## Low-fat dairy foods linked to reduced T2D risk in systematic reviews and meta-analyses

Six systematic reviews of prospective cohort studies or randomized control trials report that consuming dairy foods, especially yogurt and low-fat dairy foods, is linked with a reduced risk of T2D.<sup>8-13</sup> A systematic review<sup>9</sup> concluded that high-quality evidence indicates that consuming low-fat dairy foods, as well as eating yogurt, is associated with lower risk for T2D. It also indicated that total dairy food consumption, as well as cheese consumption, is associated with lower risk for T2D, based on moderate-quality evidence. Three reviews that conducted meta-analyses<sup>8,10,12</sup> assessed results of over 15 cohort studies and found that both total and low-fat dairy consumption were linked with a reduced risk of T2D. Mishali et al.<sup>12</sup> also concluded that women consuming the highest amounts of dairy compared to women consuming the lowest amounts of dairy were 13 percent less likely to develop T2D. This finding was not observed in males in this meta-analysis. Alvarez-Bueno et al. found that consuming 200-400 grams (g) of dairy foods per day led to the largest reduction in T2D risk.<sup>10</sup> Results of three meta-analyses<sup>8,11,13</sup> found that eating yogurt was linked to lower risk of T2D. In one study, eating 80 g of yogurt daily (245 g yogurt = one 8-ounce cup) was linked with a 14 percent lower risk for T2D.<sup>8</sup> In the second study, eating yogurt regularly (daily or weekly) was associated with a 27 percent lower risk for T2D in seven prospective cohort studies.<sup>11</sup> In the third study, Fan et al. concluded that eating 60 g of yogurt per day decreased T2D risk by 17 percent, and drinking 200 g of milk per day decreased the risk for developing T2D by 9 percent.<sup>13</sup>

## Prospective evidence indicates beneficial or neutral links between dairy intake and T2D

Results of 12 of the prospective cohort studies explored the relationship between dairy consumption and T2D, primarily reporting beneficial and neutral associations.<sup>15-18,21,22,25-30</sup> Large cohort studies in the U.S., Europe and Australia found no association between total dairy,<sup>15</sup> dairy fat,<sup>16</sup> yogurt<sup>30</sup> or milk<sup>25</sup> intake with T2D risk. In an Australian cohort, a healthy dietary pattern with adequate fruit and dairy food intake was linked with reduced risk of T2D and could have prevented 23-37 percent of cases.<sup>26</sup> Total intake of dairy foods, as well as eating yogurt and drinking low-fat milk, were associated with lower T2D risk in a Mediterranean cohort of older adults.<sup>19</sup> Results of other studies also indicate that total intake of dairy foods, including whole-fat dairy foods like milk, cheese and yogurt, is associated with a lower risk of T2D.<sup>17,27,28</sup> Consuming whole-fat yogurt was linked to lower rates of T2D in one prospective cohort study.<sup>20</sup> A cohort study of 8,574 Korean adults found that eating yogurt was associated with reduced risk of T2D, though consuming milk, cheese and other sources of calcium was not linked with T2D risk.<sup>18</sup> In a smaller study of 699 adults, participants who consumed more yogurt (1 or more servings per week) had a lower incidence of T2D than less frequent consumers.<sup>29</sup>

Among a cohort of Swedish adults, higher intakes of cheese, fermented milk and butter were associated with lower T2D risk.<sup>21</sup> One study of three large U.S. cohorts concluded that decreasing total dairy intake by one or more servings daily was linked with a higher risk of T2D. This study also found that eating more yogurt (½ cups or more) daily decreased T2D risk by 11 percent while eating more cheese (½ servings or more daily) increased T2D risk by 9 percent.<sup>22</sup> Similarly, Guasch-Ferré et al. found that drinking whole milk was not associated with T2D risk, while consuming 1 serving of either butter or cheese was associated with higher risk.<sup>20</sup>



## Fatty acid biomarkers of dairy food intake also associated with lower T2D risk

Results of a systematic review and meta-analysis and two additional prospective cohort studies indicate that biomarkers of dairy fatty acid consumption or consuming dairy fat in cheese may be linked with lower risk of T2D. A systematic review and meta-analysis found that individuals with higher blood levels of the biomarker trans-palmitoleic acid, a fatty acid principally derived from dairy, were less likely to develop T2D.<sup>14</sup> Results from two large prospective cohorts also indicate that higher levels of dairy fat biomarkers in plasma were associated with lower incidence of T2D.<sup>23,24</sup> One of these studies found that higher levels of saturated fatty acids derived from cheese were linked with a lower risk of T2D but this same relationship was not observed in milk-derived saturated fatty acids.<sup>24</sup> More research is needed to better understand these links.

## References

- <sup>1</sup> Type 2 Diabetes | CDC. <https://www.cdc.gov/diabetes/basics/type2.html>. Accessed February 1, 2021.
- <sup>2</sup> Centers for Disease Control and Prevention. Division of Diabetes Translation At A Glance. <https://www.cdc.gov/chronicdisease/resources/publications/aag/diabetes.htm>. Published 2019.
- <sup>3</sup> Malik VS, Willett WC, Hu FB. Global obesity: trends, risk factors and policy implications. *Nat Rev Endocrinol*. 2013;9(1):13-27. doi:10.1038/nrendo.2012.199
- <sup>4</sup> Oggioni C, Lara J, Wells JCK, Soroka K, Siervo M. Shifts in population dietary patterns and physical inactivity as determinants of global trends in the prevalence of diabetes: An ecological analysis. *Nutr Metab Cardiovasc Dis*. 2014;24(10):1105-1111. doi:10.1016/j.numecd.2014.05.005
- <sup>5</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>6</sup> Diabetes Basics | CDC. <https://www.cdc.gov/diabetes/basics/>. Accessed August 19, 2020.
- <sup>7</sup> Hamdy O, Ganda O, Maryniuk M, Gabbay R, Members of the Joslin Clinical Oversight Committee. Evidence Based Diabetes Management: Joslin Clinical Guidelines. *Am J Manag Care*. 2018;24(7). <https://www.ajmc.com/view/chapter-2-clinical-nutrition-guideline-for-overweight-and-obese-adults-with-type-2-diabetes-t2d-or-prediabetes-or-those-at-high-risk-for-developing-t2d>.
- <sup>8</sup> Gijsbers L, Ding EL, Malik VS, de Goede J, Geleijnse JM, Soedamah-Muthu SS. Consumption of dairy foods and diabetes incidence: a dose-response meta-analysis of observational studies. *Am J Clin Nutr*. 2016;103(4):1111-1124. doi:10.3945/ajcn.115.123216
- <sup>9</sup> Drouin-Chartier J-P, Brassard D, Tessier-Grenier M, et al. Systematic Review of the Association between Dairy Product Consumption and Risk of Cardiovascular-Related Clinical Outcomes. *Adv Nutr*. 2016;7(6):1026-1040. doi:10.3945/an.115.011403
- <sup>10</sup> Alvarez-Bueno C, Caverio-Redondo I, Martinez-Vizcaino V, Sotos-Prieto M, Ruiz JR, Gil A. Effects of Milk and Dairy Product Consumption on Type 2 Diabetes: Overview of Systematic Reviews and Meta-Analyses. *Adv Nutr*. 2019;10(suppl\_2):S154-S163. doi:10.1093/advances/nmy107
- <sup>11</sup> Companys J, Pla-Pagà L, Calderón-Pérez L, et al. Fermented Dairy Products, Probiotic Supplementation, and Cardiometabolic Diseases: A Systematic Review and Meta-analysis. *Adv Nutr*. 2020;11(4):834-863. doi:10.1093/advances/nmaa030
- <sup>12</sup> Mishali M, Prizant-Passal S, Avrech T, Shoenfeld Y. Association between dairy intake and the risk of contracting type 2 diabetes and cardiovascular diseases: A systematic review and meta-analysis with subgroup analysis of men versus women. *Nutr Rev*. 2019;77(6):417-429. doi:10.1093/nutrit/nuz006
- <sup>13</sup> Fan M, Li Y, Wang C, et al. Dietary Protein Consumption and the Risk of Type 2 Diabetes: A Dose-Response Meta-Analysis of Prospective Studies. *Nutrients*. 2019;11(11):2783. doi:10.3390/nu11112783
- <sup>14</sup> de Souza RJ, Mente A, Maroleanu A, et al. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. *BMJ*. 2015;351:h3978. doi:10.1136/bmj.h3978
- <sup>15</sup> Brouwer-Brolsma EM, van Woudenberg GJ, Oude Elferink SJWH, et al. Intake of different types of dairy and its prospective association with risk of type 2 diabetes: The Rotterdam Study. *Nutr Metab Cardiovasc Dis*. 2016;26(11):987-995. doi:10.1016/j.numecd.2016.08.003
- <sup>16</sup> Ardisson Korat A V., Li Y, Sacks F, et al. Dairy fat intake and risk of type 2 diabetes in 3 cohorts of US men and women. *Am J Clin Nutr*. 2019;110(5):1192-1200. doi:10.1093/ajcn/nqz176
- <sup>17</sup> Bhavadharini B, Dehghan M, Mente A, et al. Association of dairy consumption with metabolic syndrome, hypertension and diabetes in 147 812 individuals from 21 countries. *BMJ Open Diabetes Res Care*. 2020;8(1):826. doi:10.1136/bmjdr-2019-000826
- <sup>18</sup> Jeon J, Jang J, Park K. Effects of Consuming Calcium-Rich Foods on the Incidence of Type 2 Diabetes Mellitus. *Nutrients*. 2018;11(1):31. doi:10.3390/nu11010031
- <sup>19</sup> Díaz-López A, Bulló M, Martínez-González MA, et al. Dairy product consumption and risk of type 2 diabetes in an elderly Spanish Mediterranean population at high cardiovascular risk. *Eur J Nutr*. 2016;55(1):349-360. doi:10.1007/s00394-015-0855-8
- <sup>20</sup> Guasch-Ferre M, Becerra-Tomas N, Ruiz-Canela M, et al. Total and subtypes of dietary fat intake and risk of type 2 diabetes mellitus in the Prevenció con Dieta Mediterrània (PREDIMED) study. *Am J Clin Nutr*. 2017;105(3):723-735. doi:10.3945/ajcn.116.142034
- <sup>21</sup> Johansson I, Esberg A, Nilsson LM, Jansson JH, Wennberg P, Winkvist A. Dairy product intake and cardiometabolic diseases in Northern Sweden: A 33-year prospective cohort study. *Nutrients*. 2019;11(2). doi:10.3390/nu11020284



- <sup>22</sup> Drouin-Chartier JP, Li Y, Ardisson Korat AV, et al. Changes in dairy product consumption and risk of type 2 diabetes: Results from 3 large prospective cohorts of US men and women. *Am J Clin Nutr.* 2019;110(5):1201-1212. doi:10.1093/ajcn/nqz180
- <sup>23</sup> Yakoob MY, Shi P, Willett WC, et al. Circulating Biomarkers of Dairy Fat and Risk of Incident Diabetes Mellitus Among Men and Women in the United States in Two Large Prospective Cohorts. *Circulation.* 2016;133(17):1645-1654. doi:10.1161/CIRCULATIONAHA.115.018410
- <sup>24</sup> Liu S, van der Schouw YT, Soedamah-Muthu SS, Spijkerman AMW, Sluijs I. Intake of dietary saturated fatty acids and risk of type 2 diabetes in the European Prospective Investigation into Cancer and Nutrition-Netherlands cohort: associations by types, sources of fatty acids and substitution by macronutrients. *Eur J Nutr.* 2019;58(3):1125-1136. doi:10.1007/s00394-018-1630-4
- <sup>25</sup> Vissers LET, Sluijs I, van der Schouw YT, et al. Dairy product intake and risk of type 2 diabetes in EPIC-interact: A mendelian randomization study. *Diabetes Care.* 2019;42(4):568-575. doi:10.2337/dc18-2034
- <sup>26</sup> Dow C, Balkau B, Bonnet F, et al. Strong adherence to dietary and lifestyle recommendations is associated with decreased type 2 diabetes risk in the AusDiab cohort study. *Prev Med (Baltim).* 2019;123:208-216. doi:10.1016/j.ypmed.2019.03.006
- <sup>27</sup> Ericson U, Hellstrand S, Brunkwall L, et al. Food sources of fat may clarify the inconsistent role of dietary fat intake for incidence of type 2 diabetes. *Am J Clin Nutr.* 2015;101(5):1065-1080. doi:10.3945/ajcn.114.103010
- <sup>28</sup> Kummer K, Jensen PN, Kratz M, et al. Full-Fat Dairy Food Intake is Associated with a Lower Risk of Incident Diabetes Among American Indians with Low Total Dairy Food Intake. *J Nutr.* 2019;149(7):1238-1244. doi:10.1093/jn/nxz058
- <sup>29</sup> Crichton GE, Bogucki OE, Elias MF. Dairy food intake, diet patterns, and health: Findings from the Maine-Syracuse Longitudinal Study. *Int Dairy J.* 2019;91:64-70. doi:10.1016/j.idairyj.2018.12.009
- <sup>30</sup> Buziau AM, Soedamah-Muthu SS, Geleijnse JM, Mishra GD. Total Fermented Dairy Food Intake Is Inversely Associated with Cardiovascular Disease Risk in Women. *J Nutr.* 2019;149(10):1797-1804. doi:10.1093/jn/nxz128



# Science Summary

## Dairy and Bone Health



### Overview

Daily consumption of dairy foods like milk, cheese and yogurt is part of the Dietary Guidelines for Americans (DGA) recommendations for children, adolescents and adults. Research indicates that dairy foods are integral dietary components for building and maintaining healthy bones throughout the lifespan, from early childhood to late adulthood. Dairy foods contain

nutrients essential for bone growth and development, including calcium, vitamin D, phosphorus, potassium and magnesium. Consuming adequate amounts of dairy foods daily helps ensure that children and adolescents achieve peak bone mass, which is associated with reduced risk for osteoporosis later in life. Consuming dairy foods throughout adulthood, including older adulthood, can help ensure the maintenance of healthy bones and is linked with reduced fracture risk. Research published since 2015, highlighted below, provides further support for the 2020 DGA recommendations that all Americans ages 9 and older consume three servings of low-fat or fat-free dairy foods as part of the Healthy U.S.-Style Dietary Pattern, accompanied by adequate physical activity, to support bone health.

### Leading health organizations recommend eating dairy foods daily to achieve peak bone mass

Developing peak bone mass by young adulthood with good nutrition, including adequate calcium and vitamin D intake, and physical activity is one strategy to optimize bone health and reduce the risk of bone diseases later in life.<sup>1,2</sup> The importance of consuming dairy foods as part of healthy dietary patterns to achieve peak bone mineral density in childhood and adolescence has been recognized by numerous health professional organizations as well as the 2020 DGA.<sup>3</sup> The Healthy U.S.-Style Dietary Pattern in the 2020 DGA recommends 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ servings for children 4-8 years and 2 servings for children 2-3 years.<sup>3</sup> It also recommends 1½ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12-23 months and small amounts of yogurt and cheese for infants 6 to 12 months, depending on developmental readiness.<sup>3</sup> Milk is the top food source of important nutrients for bone health, including calcium, vitamin D and potassium, among Americans 2 years and older.<sup>4-6</sup> The National Institutes of Health (NIH) stress the importance of calcium for bone development and highlight that consuming the recommended 3 servings of dairy foods per day during childhood and adolescence can help meet calcium requirements.<sup>7</sup> The American Academy of Pediatrics (AAP) recommends that pediatricians “encourage increased dietary intake of calcium- and vitamin D-containing foods and beverages,” such as dairy products.<sup>2</sup> Like the 2020 DGA, the AAP recommends that children 4 to 8 years consume “2 to 3 servings of dairy products” or calcium-equivalent foods daily and that adolescents consume 4 servings per day of dairy or calcium-equivalent foods.<sup>2</sup>



## Consuming dairy foods is linked with improved bone mineral density in children and adolescents

Three systematic reviews<sup>1,8,9</sup> and a clinical trial<sup>10</sup> demonstrate the importance of consuming dairy foods for children and adolescents to achieve peak bone mass. One systematic review indicated that consuming dairy foods was linked with greater bone mineral content during childhood in 6 of the 7 trials it reviewed.<sup>9</sup> Similarly, a second systematic review showed that, in 8 of 11 randomized controlled trials, consuming dairy foods was associated with greater bone mineral content and density in children and adolescents.<sup>8</sup> A 2016 systematic review and position statement from the National Osteoporosis Foundation (NOF) also indicated a beneficial role of dairy foods for bone mineral density from childhood through late adolescence.<sup>1</sup> After the authors of the NOF review assessed over 150 studies on lifestyle factors related to peak bone mass in children, adolescents and young adults, they determined that the links between calcium and bone health and between physical activity and bone mass and density were supported by the strongest evidence (“grade A”). Good evidence, “grade B,” supported the links between dairy intake and bone health, vitamin D intake and bone health and physical activity and bone structure.<sup>1</sup>

A clinical trial assessed the impact of consuming an additional 3 servings of dairy foods daily (in addition to usual dairy food intake) on bone mass accrual, comparing it to usual intakes of dairy foods in boys and girls from 8 to 16 years of age.<sup>10</sup> The only difference between the two groups is that the group consuming additional servings of dairy foods had greater gains in bone mineral content of the tibia.<sup>11</sup> This study reinforces the importance of adequate calcium intake for bone health in childhood and adolescence.

## Consuming dairy foods is linked to better bone mineral density and bone mass maintenance in adults

Research indicates that consuming dairy foods helps maintain bone mass throughout adulthood and is associated with reduced fracture risk and greater bone mineral density. Results of four systematic reviews indicate the importance of meeting dairy recommendations to help maintain bone mineral density in adulthood.<sup>12–15</sup> Among women, low milk intake during adolescence was associated with a 1.7% to 3% lower hip bone mineral density in adulthood.<sup>12</sup> Two reviews found that eating yogurt was linked to better bone health.<sup>13,14</sup> In one of these reviews, higher yogurt intake (compared with low or no intake) was linked with reduced risk of hip fracture, and eating cheese daily was linked with higher bone mineral density.<sup>13</sup> A meta-analysis found that eating dairy foods increased bone mineral density in women, concluding that “dairy product consumption should be considered an effective public health measure to prevent osteoporosis in postmenopausal women.”<sup>15</sup>

Evidence from prospective cohort studies and clinical trials indicates that consuming dairy foods does not negatively impact bone health outcomes and may be linked to improved bone health. According to one prospective cohort study, higher intakes of milk, milk and yogurt, and milk, yogurt and cheese were linked to greater bone mineral density in men.<sup>16</sup> Similarly, a study that assessed bone health in 1,955 women across the menopausal transition found that dairy food intake was not linked with loss of bone mineral density or fracture risk.<sup>17</sup> Dairy food intake was low overall among study participants, with 65% consuming less than 1.5 servings of dairy foods per day. Another prospective study found that consuming dairy foods was not linked with bone mineral density over a 4 year period.<sup>18</sup> Results of two clinical trials indicate that eating yogurt may benefit bone mineral density in older adults<sup>19</sup> and may benefit bone turnover and bone metabolism in young adult males when paired with regular physical activity.<sup>20</sup> In a third clinical trial, eating dairy foods and taking calcium and vitamin D supplements led to greater bone calcium retention in postmenopausal women.<sup>21</sup>



## Dairy foods may help maintain bone mineral density with weight loss

Obesity affects nearly 42% of U.S. adults.<sup>22</sup> However, treating obesity with weight loss can decrease bone mineral density, especially in women.<sup>23</sup> Emerging evidence indicates that consuming dairy foods as part of a healthy dietary pattern in weight-reduction programs may help maintain bone health. In one clinical trial, post-menopausal women participating in a weight loss study consumed either 4-5 servings of low-fat dairy foods per day or calcium and vitamin D supplements. Participants consuming dairy foods had better bone health outcomes than those in the control group.<sup>24</sup> A second trial of 35 adolescent girls with overweight or obesity found that the 19 girls assigned to consume 4 servings of dairy foods per day had better bone health markers (decreased bone resorption) than the 16 girls assigned to consume less than 2 servings of dairy foods daily.<sup>25</sup>

## References

- <sup>1</sup> Weaver CM, Gordon CM, Janz KF, et al. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporos Int.* 2016;27(4):1281-1386. doi:10.1007/s00198-015-3440-3
- <sup>2</sup> Golden NH, Abrams SA, Committee on Nutrition CO. Optimizing bone health in children and adolescents. *Pediatrics.* 2014;134(4):e1229-43. doi:10.1542/peds.2014-2173
- <sup>3</sup> USDA and HHS. 2020-2025 Dietary Guidelines for Americans.; 2020. [https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary\\_Guidelines\\_for\\_Americans\\_2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf).
- <sup>4</sup> Nicklas TA, O'Neil CE, Fulgoni VL. Beverage Consumption in the Diets of Children is Not Consistently Associated with Weight: National Health and Nutrition Examination Survey 2007-2014. *Int J Child Heal Nutr.* 2018;7:47-62. <http://lifescienceglobal.com/pms/index.php/ijchn/article/viewFile/5398/3036>. Accessed June 18, 2018.
- <sup>5</sup> O'Neil C, Keast D, Fulgoni V, Nicklas T. Food Sources of Energy and Nutrients among Adults in the US: NHANES 2003-2006. *Nutrients.* 2012;4(12):2097-2120. doi:10.3390/nu4122097
- <sup>6</sup> Ilich JZ, Kerstetter JE. Nutrition in Bone Health Revisited: A Story Beyond Calcium. *J Am Coll Nutr.* 2000;19(6):715-737. doi:10.1080/07315724.2000.10718070
- <sup>7</sup> National Institute of Child Health & Human Development. Building Strong Bones: Calcium Information for Health Care Providers. [https://www.nichd.nih.gov/sites/default/files/publications/pubs/documents/NICHD\\_MM\\_HC\\_FS\\_rev.pdf](https://www.nichd.nih.gov/sites/default/files/publications/pubs/documents/NICHD_MM_HC_FS_rev.pdf).
- <sup>8</sup> Kouvelioti R, Josse AR, Klentrou P. Effects of Dairy Consumption on Body Composition and Bone Properties in Youth: A Systematic Review. *Curr Dev Nutr.* 2017;1(8):e001214. doi:10.3945/cdn.117.001214
- <sup>9</sup> de Lamas C, de Castro MJ, Gil-Campos M, Gil Á, Couce ML, Leis R. Effects of Dairy Product Consumption on Height and Bone Mineral Content in Children: A Systematic Review of Controlled Trials. *Adv Nutr.* 2018;10(2):S88-S96. doi:10.1093/advances/nmy096
- <sup>10</sup> Vogel KA, Martin BR, McCabe LD, et al. The effect of dairy intake on bone mass and body composition in early pubertal girls and boys: a randomized controlled trial. *Am J Clin Nutr.* 2017;105(5):1214-1229. doi:10.3945/ajcn.116.140418
- <sup>11</sup> WWEIA NHANES 2015-2016. Nutrient Intakes from Food and Beverages: Mean Amounts Consumed per Individual, by Gender and Age, in the United States, 2015-2016.; 2015. [www.ars.usda.gov/nea/bhnrc/fsrg](http://www.ars.usda.gov/nea/bhnrc/fsrg). Accessed December 16, 2019.
- <sup>12</sup> Matia-Martin P, Torrego-Ellacuria M, Larrad-Sainz A, Fernandez-Perez C, Cuesta-Triana F, Rubio-Herrera MA. Effects of Milk and Dairy Products on the Prevention of Osteoporosis and Osteoporotic Fractures in Europeans and Non-Hispanic Whites from North America: A Systematic Review and Updated Meta-Analysis. *Adv Nutr.* 2019;10(2):S120-S143.
- <sup>13</sup> Ong AM, Kang K, Weiler HA, Morin SN. Fermented Milk Products and Bone Health in Postmenopausal Women: A Systematic Review of Randomized Controlled Trials, Prospective Cohorts, and Case-Control Studies. *Adv Nutr.* 2020;11(2):251-265. doi:10.1093/advances/nmz108
- <sup>14</sup> Savaiano DA, Hutkins RW. Yogurt, cultured fermented milk, and health: a systematic review. *Nutr Rev.* 2020;0(0):1-16. doi:10.1093/nutrit/nuaa013
- <sup>15</sup> Shi Y, Zhan Y, Chen Y, Jiang Y. Effects of dairy products on bone mineral density in healthy postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. *Arch Osteoporos.* 2020;15(1):1-8. doi:10.1007/s11657-020-0694-y
- <sup>16</sup> van Dongen LH, Kiel DP, Soedamah-Muthu SS, Bouxsein ML, Hannan MT, Sahni S. Higher Dairy Food Intake Is Associated With Higher Spine Quantitative Computed Tomography (QCT) Bone Measures in the Framingham Study for Men But Not Women. *J Bone Miner Res.* March 2018. doi:10.1002/jbmr.3414
- <sup>17</sup> Wallace TC, Jun S, Zou P, et al. Dairy intake is not associated with improvements in bone mineral density or risk of fractures across the menopause transition: data from the Study of Women's Health Across the Nation. *Menopause.* 2020;27(8):879-886. doi:10.1097/GME.0000000000001555
- <sup>18</sup> Sahni S, Mangano KM, Kiel DP, Tucker KL, Hannan MT. Dairy Intake Is Protective against Bone Loss in Older Vitamin D Supplement Users: The Framingham Study. *J Nutr.* 2017;147(4):645-652. doi:10.3945/jn.116.240390
- <sup>19</sup> Laird E, Molloy AM, McNulty H, et al. Greater yogurt consumption is associated with increased bone mineral density and physical function in older adults. *Osteoporos Int.* 2017;28(8):2409-2419. doi:10.1007/s00198-017-4049-5
- <sup>20</sup> Bridge AD, Brown J, Snider H, Ward WE, Roy BD, Josse AR. Consumption of Greek yogurt during 12 weeks of high-impact loading exercise increases bone formation in young, adult males – A secondary analysis from a randomized trial. *Appl Physiol Nutr Metab.* 2020;45(1):91-100. doi:10.1139/apnm-2019-0396



- <sup>21</sup> Rogers TS, Garrod MG, Peerson JM, et al. Is bone equally responsive to calcium and vitamin D intake from food vs. supplements? Use of <sup>41</sup>calcium tracer kinetic model. *Bone Reports*. 2016;5:117-123. doi:10.1016/j.bonr.2016.05.001
- <sup>22</sup> Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity and Severe Obesity Among Adults: United States, 2017-2018. *NCHS Data Brief*. <https://www.cdc.gov/nchs/products/databriefs/db360.htm>. Published 2020.
- <sup>23</sup> Choksi P, Rothberg A, Kraftson A, et al. Weight loss and bone mineral density in obese adults: a longitudinal analysis of the influence of very low energy diets. *Clin Diabetes Endocrinol*. 2018;4(1). doi:10.1186/s40842-018-0063-6
- <sup>24</sup> Ilich JZ, Kelly OJ, Liu PY, et al. Role of calcium and low-fat dairy foods in weight-loss outcomes revisited: Results from the randomized trial of effects on bone and body composition in overweight/obese postmenopausal women. *Nutrients*. 2019;11(5). doi:10.3390/nu11051157
- <sup>25</sup> Josse AR, Ludwa IA, Kouvelioti R, et al. Dairy product intake decreases bone resorption following a 12-week diet and exercise intervention in overweight and obese adolescent girls. *Pediatr Res*. 2020. doi:10.1038/s41390-020-0834-5



# Science Summary

## Whole- and Reduced-fat Dairy Foods and Cardiovascular Disease



### Overview



The 2020–2025 Dietary Guidelines for Americans (DGA) recommends choosing low-fat or fat-free milk, yogurt and cheese as part of healthy eating patterns. Dairy foods such as milk, yogurt and cheese make significant nutrient contributions to the diets of Americans. Recommendations to reduce saturated fat consumption are intended to lower rates of cardiovascular disease (CVD), including coronary heart disease (CHD; commonly resulting in a heart attack) and cerebrovascular disease

(commonly resulting in a stroke). Current evidence indicates dairy food consumption, regardless of fat content, is not associated with risk for CVD. The growing evidence base supports reassessing the role of full- and reduced-fat dairy foods in healthy eating patterns to inform future nutrition guidance regarding CVD and other cardiometabolic diseases.

### Dietary guidelines recommend dairy foods as part of healthy eating patterns to lower risk for cardiovascular disease

The 2020–2025 DGA states, “the dietary pattern may better predict overall health status and disease risk than individual foods or nutrients” and is based on evidence that demonstrates a healthy eating pattern is associated with beneficial outcomes for CVD.<sup>1</sup> Low-fat or fat-free dairy foods are included in healthy eating patterns in the DGA, as well as in recommended eating patterns from other authoritative bodies in the United States (U.S.) and around the world.<sup>1–3</sup> The unique nutrient package of dairy foods helps meet nutrient recommendations and may help contribute to overall diet quality.<sup>4</sup>

### Recommendations are to replace saturated fat with unsaturated fat to reduce cardiovascular risk

Current recommendations from the DGA and the American College of Cardiology/American Heart Association Guidelines are to limit saturated fat consumption and replace saturated fat with unsaturated fats in the diet.<sup>1,5</sup> Strategies offered by the DGA and American Heart Association to meet current recommendations include switching to low-fat and fat-free dairy foods and choosing fat-free or low-fat milk instead of 2% or whole milk and lower fat cheese in place of regular cheese.<sup>1,6</sup> Heart disease is the leading cause of death in the U.S.,<sup>7</sup> and the link



between saturated fat consumption and low-density lipoprotein (LDL) cholesterol (an established risk factor for CVD)<sup>8</sup> has been a primary rationale for recommending low-fat or fat-free dairy foods. However, research evaluating the link between dairy food consumption and health outcomes like heart attack and stroke has yielded different conclusions than research on the impact of saturated fat consumption on biomarkers of disease, such as LDL-cholesterol. Current evidence indicates that dairy food consumption is not linked to risk of CVD, and in some cases is linked to reduced risk.<sup>9</sup>

### **Dairy food consumption, regardless of fat content, does not increase risk for cardiovascular disease: systematic reviews and meta-analyses**

Authoritative guidance advises reducing saturated fat consumption in general. At the same time, a large body of evidence published over the last two decades indicates that total dairy consumption, whether full-fat or low-fat, does not increase risk for CVD.<sup>9,10</sup> A systematic review published in 2016, based on meta-analyses of prospective cohort studies, concluded total dairy consumption was not associated with risk for CVD (based on moderate-quality evidence).<sup>9</sup> In 2017, a meta-analysis of 29 cohort studies with 938,465 participants reported no association between total dairy consumption, including high- and low-fat varieties, and CHD or CVD.<sup>11</sup> Three other recent meta-analyses of prospective cohort studies also reported dairy consumption had an inverse association with CVD risk<sup>12</sup> and CVD mortality<sup>13</sup> or a neutral association with CHD risk.<sup>14</sup> A 2021 French prospective study found no association between dairy consumption and CVD or CHD risk.<sup>15</sup> A 2021 meta-analysis of 55 prospective cohort studies found that total dairy consumption was associated with lower risk for CHD, stroke and hypertension.<sup>16</sup> Similarly, a 2021 systematic review and meta-analysis reported consumption of total dairy, low-fat dairy (including milk and yogurt with fat content lower than full-fat equivalents and low-fat cheese) and full-fat dairy (including full-fat milk and yogurt and high-fat cheese) had no association with CHD or ischemic stroke.<sup>17</sup>

### **Potential underlying mechanisms behind the relationship between dairy fat consumption and CVD risk: randomized controlled trials**

#### ***Blood lipids***

Randomized controlled trials (RCTs) have been designed to test the potential mechanisms underlying the observed benefits of total and full-fat dairy consumption on risk for CVD. In 2021, one meta-analysis of RCTs found that dairy consumption had no significant effect on lipids, including total, LDL and high-density lipoprotein (HDL) cholesterol, and triglycerides (TG).<sup>18</sup> A year prior, another meta-analysis of RCTs found that probiotic yogurt consumption significantly reduced total and LDL-cholesterol in subjects with mild to moderate hypercholesterolemia without significant effects on HDL cholesterol and TG.<sup>19</sup> Recent RCTs have similarly indicated that full-fat dairy consumption does not adversely affect blood lipids.<sup>20–22</sup> For instance, Engel et al. demonstrated that when healthy adults consumed 0.5 liters of full-fat or fat-free milk per day for three weeks as part of their habitual diet, there were no significant differences in effects on total and LDL-cholesterol or TG concentrations.<sup>23</sup> When comparing reduced- or full-fat versus low-fat dairy consumption, Mitri et al. demonstrated no differences in lipid parameters in subjects with type 2 diabetes after six months.<sup>24</sup> Lastly, Schmidt et al. showed that over three servings of full-fat milk, cheese and yogurt daily for twelve weeks did not affect blood lipids, including total, LDL and HDL cholesterol or TG when compared with a low-dairy and low-fat dairy diet in men and women with metabolic syndrome.<sup>25</sup>



### **Blood pressure**

RCTs indicate a neutral<sup>20,22,24-26</sup> or beneficial<sup>27,28</sup> effect of dairy fat consumption on blood pressure. For example, compared with no dairy consumption, consuming full-fat dairy for four weeks did not significantly affect blood pressure or vascular function.<sup>26</sup> When researchers compared a high-dairy diet with a low-dairy diet for six weeks, the high-dairy diet (composed of reduced-fat dairy foods) resulted in lower systolic and diastolic blood pressure in overweight men and women.<sup>27</sup> McDonald et al. showed that milk consumption, regardless of fat content, attenuated impairments in vascular endothelial function by limiting oxidative stress in individuals with prediabetes.<sup>29</sup> A trial conducted in adolescent boys who were regular soda drinkers showed that consuming reduced-fat milk instead of soda for three weeks resulted in significantly lower systolic blood pressure.<sup>28</sup>

---

### **Milk is a complex food: The unique role of dairy fat and the dairy food matrix in health**

The fat in milk is the most complex of all naturally occurring fats.<sup>30,31</sup> Bovine milk fat contains over 400 types of fatty acids, including short-, medium- and long-chain fatty acids ranging in length from four to 24 carbons.<sup>30</sup> Only about 15 of the identified fatty acids are present at levels of 1 percent or higher which underscores the intricate complexity of the lipid composition of milk.<sup>30</sup> The unique composition of milk fat in whole-fat dairy foods is a topic of ongoing research investigation.

Evidence indicates that the food matrix of dairy foods may modulate the effects of dairy fat on CVD biomarkers and associated risk.<sup>32,33</sup> A case-cohort study across nine European countries observed that CHD incidence was higher per 1% increase in energy consumption of saturated fat from red meat and butter, whereas it was lower per 1% increase in energy consumption of saturated fat from yogurt and cheese.<sup>34</sup> Other research has reported that consumption of saturated fats from dairy foods is associated with differential effects on cardiometabolic risk factors,<sup>35</sup> including favorable effects on CVD<sup>36</sup> and ischemic heart disease<sup>37</sup> risk. In addition, emerging evidence suggests that milk polar lipids, a class of fats unique to dairy, play a beneficial role on cardiometabolic health through mechanisms that modulate lipid metabolism, gut health and systemic inflammation.<sup>38</sup> Thus, the complexity of dairy fat, which is part of the total food matrix of milk, yogurt and cheese, might help explain why the link between dairy food consumption and neutral or lower CVD risk is independent of saturated fat content. Research in this area is ongoing, and there is not yet a precise understanding of the mechanisms involved.

---

### **Conclusion**

The current body of evidence indicates dairy foods, regardless of fat content, contribute beneficial nutrients to the diet and are not associated with increased risk for CVD. As Drouin-Chartier et al. concluded, “although there are still key research gaps to address, evidence suggests either a neutral or a favorable association between dairy intake and cardiovascular-related outcomes. These data are consistent with current dietary guidelines, which place dairy as one of the pillars of healthy eating. However, the review also emphasized that the recommendation to focus on low-fat in place of regular- and high-fat dairy is currently not evidence-based. Further research is needed to specifically address this key research gap.”<sup>9</sup>



## References

- <sup>1</sup> U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary guidelines for Americans, 2020-2025. 9th Edition [Internet] [cited 2022 Jan 18]; Available from: <https://www.dietaryguidelines.gov/>.
- <sup>2</sup> van Horn L, Carson JAS, Appel LJ, Burke LE, Economos C, Karmally W, Lancaster K, Lichtenstein AH, Johnson RK, Thomas RJ, et al. Recommended dietary pattern to achieve adherence to the American Heart Association/American College of Cardiology (AHA/ACC) guidelines: A scientific statement from the American Heart Association. *Circulation*; 2016;134:e505-29.
- <sup>3</sup> Comerford KB, Miller GD, Boileau AC, Masiello Schuette SN, Giddens JC, Brown KA. Global review of dairy recommendations in food-based dietary guidelines. *Frontiers in Nutrition*; 2021;8:247.
- <sup>4</sup> Fulgoni VL, Keast DR, Auestad N, Quann EE. Nutrients from dairy foods are difficult to replace in diets of Americans: food pattern modeling and analyses of the National Health and Nutrition Examination Survey 2003-2006. *Nutrition Research*; 2011;31:759-65.
- <sup>5</sup> Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, Himmelfarb CD, Khera A, Lloyd-Jones D, McEvoy JW, et al. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation*; 2019;140:e596-646.
- <sup>6</sup> The American Heart Association diet and lifestyle recommendations [Internet]. American Heart Association. [cited 2022 Jan 18]. Available from: <https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/nutrition-basics/aha-diet-and-lifestyle-recommendations>.
- <sup>7</sup> Murphy SL, Kochanek KD, Xu J, Arias E. Mortality in the United States, 2020 (NCHS Data Brief No. 427) [Internet]. 2021 Dec. Available from: <https://www.cdc.gov/nchs/products/databriefs/db427.htm>.
- <sup>8</sup> Virani SS, Alonso A, Aparicio HJ, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, Chamberlain AM, Cheng S, Delling FN, et al. Heart disease and stroke statistics—2021 update. *Circulation*; 2021;E254-743.
- <sup>9</sup> Drouin-Chartier JP, Brassard D, Tessier-Grenier M, Côté JA, Labonté MÉ, Desroches S, Couture P, Lamarche B. Systematic review of the association between dairy product consumption and risk of cardiovascular-related clinical outcomes. *Advances in Nutrition*; 2016;7:1026-40.
- <sup>10</sup> Fontecha J, Calvo MV, Juarez M, Gil A, Martínez-Vizcaino V. Milk and dairy product consumption and cardiovascular diseases: An overview of systematic reviews and meta-analyses. *Advances in Nutrition*; 2019;10:S164-89.
- <sup>11</sup> Guo J, Astrup A, Lovegrove JA, Gijssels L, Givens DI, Soedamah-Muthu SS. Milk and dairy consumption and risk of cardiovascular diseases and all-cause mortality: Dose-response meta-analysis of prospective cohort studies. *European Journal of Epidemiology*; 2017;32:269-87.
- <sup>12</sup> Mishali M, Prizant-Passal S, Avrech T, Shoenfeld Y. Association between dairy intake and the risk of contracting type 2 diabetes and cardiovascular diseases: a systematic review and meta-analysis with subgroup analysis of men versus women. *Nutrition Reviews*; 2019;77:417-29.
- <sup>13</sup> Naghshi S, Sadeghi O, Larijani B, Esmaillzadeh A. High vs. low-fat dairy and milk differently affects the risk of all-cause, CVD, and cancer death: A systematic review and dose-response meta-analysis of prospective cohort studies. *Critical Reviews in Food Science and Nutrition*; 2021; 1-15.
- <sup>14</sup> Bechthold A, Boeing H, Schwedhelm C, Hoffmann G, Knüppel S, Iqbal K, de Henauw S, Michels N, Devleesschauwer B, Schlesinger S, et al. Food groups and risk of coronary heart disease, stroke and heart failure: A systematic review and dose-response meta-analysis of prospective studies. *Critical Reviews in Food Science and Nutrition*; 2019;59:1071-90.
- <sup>15</sup> Sellem L, Srouf B, Jackson KG, Hercberg S, Galan P, Kesse-Guyot E, Julia C, Fezeu LK, Deschasaux M, Lovegrove J, et al. Consumption of dairy products and CVD risk: Results from the French prospective cohort NutriNet-Santé. *The British Journal of Nutrition*; 2021;1-11.
- <sup>16</sup> Chen Z, Ahmed M, Ha V, Jefferson K, Malik V, Ribeiro PAB, Zuchinali P, Drouin-Chartier J-P. Dairy product consumption and cardiovascular health: A systematic review and meta-analysis of prospective cohort studies. *Advances in Nutrition*; 2021; nmab118.
- <sup>17</sup> Jakobsen MU, Trolle E, Outzen M, Mejbørn H, Grønberg MG, Lyndgaard CB, Stockmarr A, Venø SK, Bysted A. Intake of dairy products and associations with major atherosclerotic cardiovascular diseases: A systematic review and meta-analysis of cohort studies. *Scientific Reports*; 2021;11:1-28.
- <sup>18</sup> Derakhshandeh-Rishehri SM, Ghobadi S, Akhlaghi M, Faghhi S. No adverse effects of dairy products on lipid profile: A systematic review and meta-analysis of randomized controlled clinical trials. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*; 2021;15.
- <sup>19</sup> Pourrajab B, Fatahi S, Dehnad A, Kord Varkaneh H, Shidfar F. The impact of probiotic yogurt consumption on lipid profiles in subjects with mild to moderate hypercholesterolemia: A systematic review and meta-analysis of randomized controlled trials. *Nutrition, Metabolism, and Cardiovascular Diseases*; 2020;30:11-22.
- <sup>20</sup> Raziani F, Tholstrup T, Kristensen MD, Svanegaard ML, Ritz C, Astrup A, Raben A. High intake of regular-fat cheese compared with reduced-fat cheese does not affect LDL cholesterol or risk markers of the metabolic syndrome: A randomized controlled trial. *The American Journal of Clinical Nutrition*; 2016;104:973-81.
- <sup>21</sup> Chiu S, Bergeron N, Williams PT, Bray GA, Sutherland B, Krauss RM. Comparison of the DASH (Dietary Approaches to Stop Hypertension) diet and a higher-fat DASH diet on blood pressure and lipids and lipoproteins: A randomized controlled trial. *The American Journal of Clinical Nutrition*; 2016;103:341-7.
- <sup>22</sup> Nicholl A, Deering KE, Eveleigh K, Lyons-Wall P, Lawrence D, Mori TA, Kratz M, O'Sullivan TA. Whole-fat dairy products do not adversely affect adiposity or cardiometabolic risk factors in children in the Milky Way Study: A double-blind randomized controlled pilot study. *The American Journal of Clinical Nutrition*; 2021;114:2025.
- <sup>23</sup> Engel S, Elhauge M, Tholstrup T. Effect of whole milk compared with skimmed milk on fasting blood lipids in healthy adults: A 3-week randomized crossover study. *European Journal of Clinical Nutrition*; 2017;72:249-54.
- <sup>24</sup> Mitri J, Tomah S, Mottalib A, Salsberg V, Ashrafzadeh S, Pober DM, Eldib AH, Tasabehji MW, Hamdy O. Effect of dairy consumption and its fat content on glycemic control and cardiovascular disease risk factors in patients with type 2 diabetes: A randomized controlled study. *The American Journal of Clinical Nutrition*; 2020;112:293-302.



- <sup>25</sup> Schmidt KA, Cromer G, Burhans MS, Kuzma JN, Hagman DK, Fernando I, Murray M, Utzschneider KM, Holte S, Kraft J, et al. Impact of low-fat and full-fat dairy foods on fasting lipid profile and blood pressure: exploratory endpoints of a randomized controlled trial. *The American Journal of Clinical Nutrition*; 2021;114:882-92.
- <sup>26</sup> Roy SJ, Fico BG, Baker BD, Lapierre SS, Shah JA, Gourley DD, Delfausse LA, Tanaka H. Effects of full-fat dairy products on subclinical vascular function in adults with elevated blood pressure: A randomized clinical trial. *European Journal of Clinical Nutrition*; 2019;74:9-16.
- <sup>27</sup> Rietsema S, Eelderink C, Joustra ML, van Vliet IMY, van Londen M, Corpeleijn E, Singh-Povel CM, Geurts JMW, Kootstra-Ros JE, Westerhuis R, et al. Effect of high compared with low dairy intake on blood pressure in overweight middle-aged adults: Results of a randomized crossover intervention study. *The American Journal of Clinical Nutrition*; 2019;110:340-8.
- <sup>28</sup> Chiu S, Siri-Tarino P, Bergeron N, Suh JH, Krauss RM. A randomized study of the effect of replacing sugar-sweetened soda by reduced fat milk on cardiometabolic health in male adolescent soda drinkers. *Nutrients*; 2020;12:405.
- <sup>29</sup> McDonald JD, Mah E, Dey P, Olmstead BD, Sasaki GY, Villamena FA, Bruno RS. Dairy milk, regardless of fat content, protects against postprandial hyperglycemia-mediated impairments in vascular endothelial function in adults with prediabetes by limiting oxidative stress responses that reduce nitric oxide bioavailability. *The Journal of Nutritional Biochemistry*; 2019;63:129-39.
- <sup>30</sup> Månsson HL. Fatty acids in bovine milk fat. *Food & Nutrition Research*; 2008;52. doi: 10.3402/fnr.v52i0.1821.
- <sup>31</sup> Jensen RG. The composition of bovine milk lipids: January 1995 to December 2000. *Journal of Dairy Science*; 2002;85:295-350.
- <sup>32</sup> Thorning TK, Bertram HC, Bonjour JP, de Groot L, Dupont D, Feeney E, Ipsen R, Lecerf JM, Mackie A, McKinley MC, et al. Whole dairy matrix or single nutrients in assessment of health effects: Current evidence and knowledge gaps. *The American Journal of Clinical Nutrition*; 2017;105:1033-45.
- <sup>33</sup> Astrup A, Magkos F, Bier DM, Brenna JT, de Oliveira Otto MC, Hill JO, King JC, Mente A, Ordovas JM, Volek JS, et al. Saturated fats and health: A reassessment and proposal for food-based recommendations: JACC state-of-the-art review. *Journal of the American College of Cardiology*; 2020;76:844-57.
- <sup>34</sup> Steur M, Johnson L, Sharp SJ, Imamura F, Sluijs I, Key TJ, Wood A, Chowdhury R, Guevara M, Jakobsen MU, et al. Dietary fatty acids, macronutrient substitutions, food sources and incidence of coronary heart disease: Findings from the EPIC-CVD case-cohort study across nine European countries. *Journal of the American Heart Association*; 2021;10.
- <sup>35</sup> Duarte C, Boccardi V, Amaro Andrade P, Souza Lopes AC, Jacques PF. Dairy versus other saturated fats source and cardiometabolic risk markers: Systematic review of randomized controlled trials. *Critical Reviews in Food Science and Nutrition*; 2021;61:450-61.
- <sup>36</sup> de Oliveira Otto MC, Mozaffarian D, Kromhout D, Bertoni AG, Sibley CT, Jacobs DR, Nettleton JA. Dietary intake of saturated fat by food source and incident cardiovascular disease: The Multi-Ethnic Study of Atherosclerosis. *The American Journal of Clinical Nutrition*; 2012;96:397-404.
- <sup>37</sup> Praagman J, Beulens JWJ, Alsema M, Zock PL, Wanders AJ, Sluijs I, van der Schouw YT. The association between dietary saturated fatty acids and ischemic heart disease depends on the type and source of fatty acid in the European Prospective Investigation into Cancer and Nutrition-Netherlands cohort. *The American Journal of Clinical Nutrition*; 2016;103:356-65.
- <sup>38</sup> Bruno RS, Pokala A, Torres-Gonzalez M, Blesso CN. Cardiometabolic health benefits of dairy-milk polar lipids. *Nutrition Reviews*; 2021;79:16-35.



# Science Summary

## Lactose Intolerance



### 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.<sup>1</sup> 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.<sup>1,2</sup> 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.<sup>1</sup> Additionally, the DGA recommends 1⅓ 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).<sup>1</sup>

### 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.<sup>3,4</sup>

**Table 1. Definitions of Lactose and Lactase<sup>4</sup>**

<b>Lactose</b>	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.
<b>Lactase</b>	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,<sup>5,6</sup> and sometime after age two, individuals will typically experience a natural decline in intestinal lactase activity (also known as *lactase non-persistence*).<sup>3,4,7,8</sup> 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.<sup>8</sup>

*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.<sup>9-11</sup> 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.<sup>3</sup>

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

Lactase non-persistence is reported in nearly 70% of the global adult population,<sup>12</sup> signifying lactose malabsorption is not a disease but a common characteristic of human genetics (Table 2).<sup>4,12</sup> Lactase non-persistence is least common in northern Europe, with less than 10% of adults being lactase non-persistent in Sweden and Denmark.<sup>12</sup> The frequency of lactase non-persistence increases in southern Europe, with 50% of adults being lactase non-persistent in Spain and Italy.<sup>12</sup> Lactase non-persistence is extremely high in Asian countries; greater than 99 percent of adults in China are lactase non-persistent.<sup>12</sup> 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.<sup>13</sup>

In the U.S., about 36% of the adult population overall is lactase non-persistent,<sup>14</sup> with lactase non-persistence in 20-30% of white persons of European or Scandinavian decent, 70% of Mexicans and 80% of African Americans.<sup>12</sup> 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.<sup>12</sup>

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%
<b>Asia and Oceania</b>		
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)
<b>Eastern Europe, former Soviet Republics</b>		
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)
<b>Americas</b>		
Brazil	60%	(58, 62)
Canada	59%	(44, 74)
Colombia	80%	(73, 87)
Mexico	48%	(44, 52)
United States	36%	(33, 39)
<b>Middle East/Northern Africa</b>		
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)
<b>Southern, Eastern, Western Africa</b>		
Botswana	88%	(78, 98)
Ethiopia	77%	(75, 79)
Kenya	39%	(34, 43)
Namibia	93%	(89, 96)
Niger	13%	(7, 19)
Tanzania	45%	(41, 49)
<b>Western, Northern, Southern Europe</b>		
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 United States summarized from the Supplementary Appendix to Storhaug et al.<sup>14</sup>



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.<sup>4,12</sup> In the U.S., several surveys demonstrate that self-reported LI (4-12%) is lower than the estimated prevalence of lactase non-persistence (36%).<sup>15-19</sup>

## **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),<sup>3,4</sup> 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.<sup>20</sup> Health professionals recommend objective testing (e.g., the breath hydrogen test) to help ensure proper diagnosis,<sup>20</sup> 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.<sup>21</sup> 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.<sup>3</sup> 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.<sup>22</sup> 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.<sup>20</sup> 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,<sup>20</sup> which are associated with low calcium intake from dairy foods.<sup>23</sup> 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.<sup>24</sup> 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.<sup>25</sup> 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.<sup>26</sup> 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.<sup>27</sup>

### **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.<sup>1,3,24,28</sup> 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.<sup>29</sup> 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.<sup>30</sup> 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.<sup>28</sup> 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.<sup>31</sup> 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.<sup>32</sup> 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.<sup>33</sup> In a 2021 study with Chinese and Malay children, neither LI nor calcium intake were associated with bone health status.<sup>34</sup> In another 2021 cross-sectional study of 300 Malay, Chinese and Indian young adults, LI was not associated with bone health status.<sup>35</sup> 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.<sup>36</sup> This review also observed that there is currently insufficient evidence to establish a relationship between LI and prostate cancer.<sup>36</sup> Similarly, a 2017 cohort study found no association between LI and colorectal cancer.<sup>37</sup>

---

## **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.<sup>1</sup> 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.<sup>38</sup> Consistent with these results, demand for dairy foods in China (driven by milk and yogurt consumption) has consistently grown in recent years,<sup>39</sup> despite that lactose malabsorption is estimated to occur in ~99% of Chinese adults.<sup>12</sup>

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,<sup>40</sup> 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
<i>Dairy Food</i>		
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.<sup>38,41-43</sup> Some preliminary studies are finding other options that may show promise to help reduce LI symptoms, such as probiotic<sup>43-45</sup> and prebiotic consumption.<sup>46-48</sup>

## 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.<sup>49</sup>

## 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.



## References

- <sup>1</sup> U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary guidelines for Americans, 2020-2025. 9th Edition. Accessed January 18, 2022. <https://www.dietaryguidelines.gov/>.
- <sup>2</sup> Hess JM, Cifelli CJ, Agarwal S, Fulgoni VL. Comparing the cost of essential nutrients from different food sources in the American diet using NHANES 2011-2014. *Nutrition Journal*. 2019;18(1):1-10. doi:10.1186/S12937-019-0496-5/TABLES/8.
- <sup>3</sup> Suchy FJ, Brannon PM, Carpenter TO, et al. NIH consensus development conference statement: Lactose intolerance and health. *Annals of Internal Medicine*. 2010;152(12):792-796. doi:10.7326/0003-4819-152-12-201006150-00248.
- <sup>4</sup> Misselwitz B, Butter M, Verbeke K, Fox MR. Update on lactose malabsorption and intolerance: Pathogenesis, diagnosis and clinical management. *Gut*. 2019;68(11):2080-2091. doi:10.1136/GUTJNL-2019-318404.
- <sup>5</sup> Lenfestey MW, Neu J. Gastrointestinal development: Implications for management of preterm and term infants. *Gastroenterology Clinics of North America*. 2018;47(4):773-791. doi:10.1016/J.GTC.2018.07.005.
- <sup>6</sup> Romero-Velarde E, Delgado-Franco D, García-Gutiérrez M, et al. The importance of lactose in the human diet: Outcomes of a Mexican consensus meeting. *Nutrients*. 2019;11(11). doi:10.3390/NU11112737.
- <sup>7</sup> Wang Y, Harvey CB, Hollox EJ, et al. The genetically programmed down-regulation of lactase in children. *Gastroenterology*. 1998;114(6):1230-1236. doi:10.1016/S0016-5085(98)70429-9.
- <sup>8</sup> Kuchay RAH. New insights into the molecular basis of lactase non-persistence/persistence: A brief review. *Drug Discoveries & Therapeutics*. 2020;14(1):1-7. doi:10.5582/DDT.2019.01079.
- <sup>9</sup> di Rienzo T, D'Angelo G, D'Aversa F, et al. Lactose intolerance: From diagnosis to correct management. *European Review for Medical and Pharmacological Sciences*. 2013;17 Suppl 2:18-25.
- <sup>10</sup> Misselwitz B, Pohl D, Frühauf H, Fried M, Vavricka SR, Fox M. Lactose malabsorption and intolerance: Pathogenesis, diagnosis and treatment. *United European Gastroenterology Journal*. 2013;1(3):151. doi:10.1177/2050640613484463.
- <sup>11</sup> The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Definition & Facts for Lactose Intolerance. 2018. Accessed February 2, 2022. <https://www.niddk.nih.gov/health-information/digestive-diseases/lactose-intolerance/definition-facts>.
- <sup>12</sup> Bayless TM, Brown E, Paige DM. Lactase non-persistence and lactose intolerance. *Current Gastroenterology Reports*. 2017;19(5). doi:10.1007/S11894-017-0558-9.
- <sup>13</sup> Harvey L, Ludwig T, Hou AQ, et al. Prevalence, cause and diagnosis of lactose intolerance in children aged 1-5 years: A systematic review of 1995-2015 literature. *Asia Pacific Journal of Clinical Nutrition*. 2018;27(1):29-46. doi:10.6133/APJCN.022017.05.
- <sup>14</sup> Storhaug CL, Fosse SK, Fadnes LT. Country, regional, and global estimates for lactose malabsorption in adults: A systematic review and meta-analysis. *The Lancet Gastroenterology & hepatology*. 2017;2(10):738-746. doi:10.1016/S2468-1253(17)30154-1.
- <sup>15</sup> Kantar Worldpanel. Kantar Worldpanel online consumer survey, data through Dec 31 2019.; 2019.
- <sup>16</sup> Health Focus International. Global Trend Study, USA: Shoppers' journey towards living & eating healthier.; 2018.
- <sup>17</sup> The NPD Group. The NPD Group: Profiles and dairy consumption habits among individuals who are lactose intolerant.; 2008.
- <sup>18</sup> The NPD Group. Dairy Management Inc. (DMI) Lactose intolerance messaging research.; 2010.
- <sup>19</sup> Nicklas TA, Qu H, Hughes SO, Wagner SE, Foushee HR, Shewchuk RM. Prevalence of self-reported lactose intolerance in a multiethnic sample of adults. *Nutrition Today*. 2009;44(5):222-227. doi:10.1097/NT.0B013E3181B9CAA6.
- <sup>20</sup> Bailey RK, Fileti CP, Keith J, Tropez-Sims S, Price W, Allison-Otley SD. Lactose intolerance and health disparities among African Americans and Hispanic Americans: An updated consensus statement. *Journal of the National Medical Association*. 2013;105(2):112-127. doi:10.1016/S0027-9684(15)30113-9.
- <sup>21</sup> Heyman MB, Committee on Nutrition. Lactose intolerance in infants, children, and adolescents. *Pediatrics*. 2006;118(3):1279-1286. doi:10.1542/PEDS.2006-1721.
- <sup>22</sup> Nicklas TA, Qu H, Hughes SO, et al. Self-perceived lactose intolerance results in lower intakes of calcium and dairy foods and is associated with hypertension and diabetes in adults. *The American Journal of Clinical Nutrition*. 2011;94(1):191-198. doi:10.3945/AJCN.110.009860.
- <sup>23</sup> Jarvis JK, Miller GD. Overcoming the barrier of lactose intolerance to reduce health disparities. *Journal of the National Medical Association*. 2002;94(2):55. doi:10.13016/akm5-uc2y.
- <sup>24</sup> Rozenberg S, Body JJ, Bruyère O, et al. Effects of dairy products consumption on health: Benefits and beliefs--A commentary from the Belgian Bone Club and the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases. *Calcified Tissue International*. 2016;98(1):1-17. doi:10.1007/S00223-015-0062-X.
- <sup>25</sup> Jones BL, Oljira T, Liebert A, et al. Diversity of lactase persistence in African milk drinkers. *Human Genetics*. 2015;134(8):917-925. doi:10.1007/S00439-015-1573-2.
- <sup>26</sup> Chin EL, Huang L, Bouzid YY, et al. Association of lactase persistence genotypes (rs4988235) and ethnicity with dairy intake in a healthy U.S. population. *Nutrients*. 2019;11(8). doi:10.3390/NU11081860.
- <sup>27</sup> Dewiastry E, Setiati S, Agustina R, et al. Prevalence of lactose intolerance and nutrients intake in an older population regarded as lactase non-persistent. *Clinical Nutrition ESPEN*. 2021;43:317-321. doi:10.1016/J.CLNESP.2021.03.033.
- <sup>28</sup> Hodges JK, Cao S, Cladis DP, Weaver CM. Lactose intolerance and bone health: The challenge of ensuring adequate calcium intake. *Nutrients*. 2019, Vol 11, Page 718. 2019;11(4):718. doi:10.3390/NU11040718.
- <sup>29</sup> Hilliard CB. High osteoporosis risk among East Africans linked to lactase persistence genotype. *BoneKEY Reports*. 2016;5:803. doi:10.1038/BONEKEY.2016.30.
- <sup>30</sup> Treister-Goltzman Y, Friger M, Peleg R. Does primary lactase deficiency reduce bone mineral density in postmenopausal women? A systematic review and meta-analysis. *Osteoporosis International*. 2018 29:11. 2018;29(11):2399-2407. doi:10.1007/S00198-018-4635-1.



- <sup>31</sup> Hamilton NK, Ojo O, Adegboye ARA. The effect of self-reported lactose intolerance and dairy consumption on bone mineral density among American hip arthroplasty patients: A cross-sectional study. *International Journal of Environmental Research and Public Health*. 2020;17(19):1-17. doi:10.3390/IJERPH17197182.
- <sup>32</sup> Klemm P, Dischereit G, Lange U. Adult lactose intolerance, calcium intake, bone metabolism and bone density in German-Turkish immigrants. *Journal of Bone and Mineral Metabolism*. 2020;38(3):378-384. doi:10.1007/S00774-019-01070-4.
- <sup>33</sup> Lee Y, Savaiano DA, McCabe GP, et al. Behavioral intervention in adolescents improves bone mass, yet lactose maldigestion is a barrier. *Nutrients*. 2018, Vol 10, Page 421. 2018;10(4):421. doi:10.3390/NU10040421.
- <sup>34</sup> Makbul IAA, Daud NM, Yahya NFS, Aziz NA. Prevalence of lactose intolerance and malabsorption among children of two ethnic groups from the urban areas of Malaysia and its relation to calcium intake and bone health status. *Archives of Osteoporosis*. 2021;17(1). doi:10.1007/S11657-021-01053-X.
- <sup>35</sup> Yahya NFS, Daud NM, Makbul IAA, Aziz QASA. Association of calcium intake, lactose intolerance and physical activity with bone health assessed via quantitative ultrasound among young adults of a Malaysian university. *Archives of Osteoporosis*. 2021;16(1). doi:10.1007/S11657-020-00874-6.
- <sup>36</sup> Amiri M, Diekmann L, von Köckritz-Blickwede M, Naim HY. The diverse forms of lactose intolerance and the putative linkage to several cancers. *Nutrients*. 2015, Vol 7, Pages 7209-7230. 2015;7(9):7209-7230. doi:10.3390/NU7095332.
- <sup>37</sup> Gençdal G, Salman E, Özütemiz Ö, Akarca US. Association of LCT-13910 C/T polymorphism and colorectal cancer. *Annals of Coloproctology*. 2017;33(5):169-172. doi:10.3393/AC.2017.33.5.169.
- <sup>38</sup> Shaukat A, Levitt MD, Taylor BC, et al. Systematic review: Effective management strategies for lactose intolerance. *Annals of Internal Medicine*. 2010;152(12):797-803. doi:10.7326/0003-4819-152-12-201006150-00241.
- <sup>39</sup> Inouye A. Peoples Republic of China, Dairy and Products Semi-Annual, Higher Profits Support Increased Fluid Milk Production. USDA GAIN Report, 2019. Report Number CH19042.
- <sup>40</sup> IRI. MULO+C (Multi-Outlets + c-Stores); Based on 4 Weeks Ending 11-3-2019. 2019.
- <sup>41</sup> Agostoni C, Bresson JL, Fairweather-Tait S, et al. Scientific Opinion on the substantiation of health claims related to live yoghurt cultures and improved lactose digestion (ID 1143, 2976) pursuant to Article 13(1) of Regulation (EC) No 1924/2006. *EFSA Journal*. 2010;8(10):1763. doi:10.2903/J.EFSA.2010.1763.
- <sup>42</sup> Savaiano DA. Lactose digestion from yogurt: Mechanism and relevance. *The American Journal of Clinical Nutrition*. 2014;99(5 Suppl). doi:10.3945/AJCN.113.073023.
- <sup>43</sup> Fassio F, Facioni MS, Guagnini F. Lactose maldigestion, malabsorption, and intolerance: A comprehensive review with a focus on current management and future perspectives. *Nutrients*. 2018;10(11). doi:10.3390/NU10111599.
- <sup>44</sup> Staudacher H. Probiotics for lactose intolerance and irritable bowel syndrome. *British Journal of Community Nursing*. 2015;Suppl Nutrition:S13-S14. doi:10.12968/BJCN.2015.20.SUP6A.S12.
- <sup>45</sup> Vitellio P, Celano G, Bonfrate L, Gobbetti M, Portincasa P, de Angelis M. Effects of *Bifidobacterium longum* and *Lactobacillus rhamnosus* on gut microbiota in patients with lactose intolerance and persisting functional gastrointestinal symptoms: A randomised, double-blind, cross-over study. *Nutrients*. 2019;11(4):886. doi:10.3390/NU11040886.
- <sup>46</sup> Azcarate-Peril MA, Ritter AJ, Savaiano D, et al. Impact of short-chain galactooligosaccharides on the gut microbiome of lactose-intolerant individuals. *Proceedings of the National Academy of Sciences of the United States of America*. 2017;114(3):E367-E375. doi:10.1073/PNAS.1606722113/-/DCSUPPLEMENTAL.
- <sup>47</sup> Chey W, Sandborn W, Ritter AJ, Foyt H, Azcarate-Peril MA, Savaiano DA. Galacto-oligosaccharide RP-G28 improves multiple clinical outcomes in lactose-intolerant patients. *Nutrients*. 2020;12(4):1058. doi:10.3390/NU12041058.
- <sup>48</sup> Azcarate-Peril MA, Roach J, Marsh A, et al. A double-blind, 377-subject randomized study identifies *Ruminococcus*, *Coprococcus*, *Christensenella*, and *Collinsella* as long-term potential key players in the modulation of the gut microbiome of lactose intolerant individuals by galacto-oligosaccharides. *Gut Microbes*. 2021;13(1):1957536. doi:10.1080/19490976.2021.1957536/SUPPL\_FILE/KGMI\_A\_1957536\_SM7339.ZIP
- <sup>49</sup> Harju M, Kallioinen H, Tossavainen O. Lactose hydrolysis and other conversions in dairy products: Technological aspects. *International Dairy Journal*. 2012;22(2):104-109. doi:10.1016/J.IDAIRYJ.2011.09.011.



# Science Summary

## Dairy Foods Help Nourish Infants and Toddlers



### Overview



Leading pediatric and health organizations recognize the benefits of milk and dairy foods in the early years after birth. Exclusive breastfeeding is recommended for at least the first 6 months followed by breastfeeding along with a variety of nutrient-dense complementary foods from all food groups, including dairy (i.e., cheese, yogurt), to support early growth and build a life-long foundation for healthy eating. Food allergies, including dairy milk allergy, are rare and typically develop in the first 2 years after birth, then decline through childhood. Pediatric

and health organizations recommend introducing potentially allergenic foods, including dairy foods, during the complementary feeding period. After the first birthday, whole dairy milk is recommended as the primary beverage, and water may be given to help quench thirst. As part of a healthy diet for 1-2 year-olds, the 2020 Dietary Guidelines for Americans (DGA) recommends 1  $\frac{2}{3}$  to 2 cup equivalents of dairy foods (whole milk, yogurt, cheese) depending on daily calorie needs. In this age group, milk and dairy foods contribute more than 25% of daily energy consumed and about 40% of protein and vitamin A, 77% of vitamin D, 64% of calcium, 31% of magnesium, one-third or more of potassium and zinc – and less than 18% of daily sodium intake. For toddlers with confirmed dairy milk allergy, lactose intolerance or parental preference to avoid dairy foods, the only acceptable plant-based alternative to dairy milk is unsweetened fortified soy beverage. Other plant-based beverages lack or fall short of key nutrients found in dairy milk and have been linked to nutrient deficiencies and metabolic imbalances. Leading pediatric and health organizations recognize the benefits of dairy milk and foods for early childhood.

### Leading pediatric and health organizations recognize the benefits of milk and dairy foods in the early years after birth

Guidance from leading pediatric and health organizations for infant and toddler feeding practices is grounded in decades of research assessing nutritional requirements for healthy growth, cultural influences on eating patterns and key developmental milestones.<sup>1-3</sup> Exclusive breastfeeding is universally recommended,<sup>1, 2, 4-8</sup> including most recently by the 2020 Dietary Guidelines for Americans (DGA),<sup>9</sup> for at least the first 6 months after birth followed by breastfeeding along with complementary foods, including yogurt and cheese, over the next 6 months. An iron-



fortified infant formula is the only acceptable alternative for breastmilk from birth to 12 months.<sup>2, 7</sup> The American Academy of Pediatrics (AAP)<sup>7</sup> and others<sup>2, 10</sup> further state that when mutually desired by mother and child, breastfeeding may continue beyond 12 months.

Beginning at about 6 months of age, parents are encouraged to offer a wide variety of nutrient-dense complementary foods from all food groups, including the dairy group (i.e., plain, unsweetened whole milk yogurt, cheese), to help support infant growth and to begin to build a foundation for healthy eating.<sup>2, 3, 5, 9, 11</sup> In the United States (U.S.), breastmilk, infant formulas and baby foods are the top three sources of energy intake by 6-12 month old infants and together account for 74% of daily calories; table foods and other beverages make up the remaining 26%.<sup>12</sup> Health professional organizations in the U.S. concur that the transition from breastmilk and/or infant formula to regular dairy milk should not occur before the first birthday<sup>2, 9, 13</sup> because of increased risk for intestinal bleeding.<sup>2, 14</sup> About a third (34%) of 6-12 month old infants in the U.S., however, are given fluid dairy milk too early.<sup>3</sup>

The 2020 DGA recommends, as part of a healthy diet, 1-2 year-olds consume 1  $\frac{2}{3}$  to 2 cup equivalents (eq) of dairy foods (whole milk, yogurt, cheese) depending on daily calorie needs (~700-1000 kcal/d).<sup>9</sup> Whole dairy milk is recommended as the primary beverage for most toddlers by four leading health organizations comprising a 2019 expert panel: the AAP, Academy of Nutrition and Dietetics, American Academy of Pediatric Dentistry and the American Heart Association.<sup>2, 10</sup> In addition to whole dairy milk being an important source of energy and key nutrients for growth, a systematic review and meta-analysis of 20 cross-sectional and 8 prospective cohort studies of 1-18 year-old children showed that consumption of whole dairy milk (3.25% fat) compared with lower fat milks (0.1-2% fat) was associated with a lower likelihood of overweight or obesity.<sup>15</sup> Consumption of water, but not other beverages, also is encouraged to help quench thirst and meet fluid requirements.<sup>2, 9-11</sup>

## **Dairy's unique nutrient package provides key nutrients for healthy growth and development**

The nutritional adequacy of the diet of infants and toddlers, environmental influences and the child's genetic background all play important roles in healthy growth and development.<sup>16, 17</sup> Inadequate or excess amounts of energy, individual nutrients and/or nutrient combinations can affect the development of organs, including the brain,<sup>17</sup> bone<sup>18</sup> and gastrointestinal system<sup>19</sup> and can have lasting consequences.<sup>16, 20</sup> Consistent with the 2020 DGA recommendation that a variety of foods from all food groups be offered starting at about 6 months of age<sup>9</sup>, most 6 to 12 month old infants consume fruits (84%), vegetables (79%) and grains (89%); about half (47%) in this age group consume protein foods; and 19% and 11% consume cheese and yogurt, respectively.<sup>3</sup>

Beginning at 1 year of age, dairy milk replaces breastmilk and/or infant formula as the main beverage for toddlers and young children. Nearly all (96%) toddlers consume dairy milk, 66% consume cheese, and 22% consume yogurt<sup>3</sup> with average consumption of 2.5 cup eq/d of dairy foods (milk, 2.1 cup eq; cheese, 0.4 cup eq; yogurt, 0.1 cup eq).<sup>9</sup> Milk, cheese and yogurt are important sources of energy and nutrients for toddlers (12-24 months), together contributing more than 25% of daily energy, about 40% of protein and vitamin A, 77% of vitamin D, 64% of calcium, 31% of magnesium, one-third or more of potassium and zinc<sup>12</sup> – and less than 18% of daily sodium.<sup>21</sup> Milk alone is the number 1 food source of energy, protein, calcium, vitamin D, potassium, vitamin A, magnesium and zinc for this age group.<sup>12</sup> Although consumption of macronutrients and most micronutrients is generally adequate from birth to 2 years of age



in the U.S.,<sup>22, 23</sup> nutrient gaps exist for iron between 6 and 12 months and for vitamin D, vitamin E, potassium and fiber between 12 and 24 months of age.<sup>9, 23</sup> In addition, toddlers overconsume sodium<sup>9, 22, 23</sup> and added sugars.<sup>9</sup>

## Yogurt and cheese as complementary foods help establish healthy eating habits

Infants begin to learn how to eat when first offered complementary foods.<sup>24-26</sup> Preferences for specific foods also are learned, and offering a variety of nutrient-dense foods can help establish healthy eating habits that extend at least into early adulthood.<sup>24</sup> The overall goal in shaping an infant's eating behavior is to match their consumption to their energy and nutrient needs for healthy growth and development.<sup>25, 26</sup> Offering foods with a variety of flavors and textures can help with early acceptance of healthy foods across all food groups.<sup>2</sup> Yogurt and cheeses, for example, provide unique sensory experiences (e.g., texture, taste, flavors) that can contribute to healthy eating habits. Plain, unsweetened yogurt alone or with fruits and/or vegetables is a nutritionally sound approach for a sour/tangy taste experience, and cheese comes in a variety of textures ranging from soft and solid to lumpy (e.g., cottage cheese). Portion sizes vary and depend in part on when 6-12 month-old infants are developmentally ready to accept the individual dairy foods.<sup>27, 28</sup> The Child and Adult Care Food Program (CACFP) meal pattern guidance for this age group states that up to 2 ounces of cheese, up to 4 ounces of cottage cheese and/or up to 4 ounces of yogurt may be offered at breakfast, lunch and/or supper.<sup>27</sup> It has been proposed that with repeated exposure to a new food, infants associate its sensory properties to its energy density and at least to some extent learn to modulate amounts eaten.<sup>24</sup>

Although health professional guidance states that complementary foods should be introduced starting at 6 months of age,<sup>2, 9</sup> about half (47%) of U.S. infants are first offered complementary foods between 4 and 6 months of age.<sup>3</sup> The 2020 Dietary Guidelines Advisory Committee (DGAC) report, however, concluded that introducing complementary foods at 4-5 months of age does not offer long-term advantages or disadvantages with regard to the select developmental indicators examined: growth, size, body composition, overweight or obesity; iron status; or risk of developing food allergy, atopic dermatitis/eczema, or asthma during childhood.<sup>3</sup> Even though offering complementary foods before 4 months of age is not recommended,<sup>3, 11</sup> a third (32%) of U.S. infants are introduced to complementary foods before the age of 4 months.<sup>3, 9, 29</sup>

## Experts support early introduction of potentially allergenic foods, including dairy

While food allergies typically develop in the first 2 years after birth,<sup>30</sup> they are rare and impact 6-8% at 1 year of age,<sup>30</sup> and are immune system reactions to specific proteins in foods, not the food as a whole. Immunogenic responses involve mainly the skin, respiratory system and digestive system<sup>2, 31</sup> and may be IgE-mediated or non-IgE-mediated.<sup>32-34</sup> Symptoms range from mild to severe and can be immediate (within hours) or delayed (days to weeks after exposure).<sup>31, 32</sup> When digestive symptoms are present, differential diagnostics may be needed to distinguish from other causes such as lactose intolerance, which is a sensitivity to lactose (a disaccharide) and not an allergy.<sup>32, 33</sup> While any food can elicit an allergic response, nine types of foods account for the vast majority of food allergies: peanuts, eggs, milk and dairy, tree nuts, soy, wheat, fish, shellfish and sesame.<sup>35, 36</sup> Some allergies, including dairy milk and egg allergy, peak at around 1 to 2 years of age and then fall progressively through childhood.<sup>37</sup> Dairy milk allergy in the U.S is reported to affect about 1.5% of infants (<12 m), 4.3% of toddlers at 2 years of age and 1.1% of 11-13 year-old children.<sup>37</sup> Health professional guidance is widely available in the U.S.<sup>32, 34</sup> and globally<sup>31, 38, 39</sup> to help physicians



diagnose dairy milk allergy, manage symptoms in infants and children and help ensure proper nutrition for healthy growth and development.

Pediatric and health organization recommendations about when to introduce potentially allergenic foods, including dairy foods, have shifted in recent years – from delaying introduction until after the first birthday to introducing these foods during the complementary feeding period.<sup>3, 9, 32, 34</sup> Most recently, a 2019 Nutrition Evidence Systematic Review, which was conducted as part of the USDA and the Department of Health and Human Services Pregnancy and Birth to 24 Months project, concluded that moderate evidence suggests no relationship between the age of complementary food introduction and risk of developing food allergy, atopic dermatitis/eczema or childhood asthma.<sup>40</sup> This review informed the 2020 DGAC scientific report, which concurred with these findings<sup>3</sup> and led the 2020 DGA to recommend introducing infants to potentially allergenic foods, including yogurt and cheese, beginning at around 6 months of age.<sup>9</sup>

In the 2019 Systematic Review, yogurt and cheese were included among the other complementary foods examined, however, fluid dairy milk (in the form of dairy milk-based infant formulas and regular dairy milk) was not.<sup>40</sup> The majority (81%) of infants in the U.S. are fed infant formula, including dairy milk-based formulas and/or regular milk in the first year after birth.<sup>41</sup> Among these infants, 69% are fed dairy milk formula, 5% are fed gentle/lactose-reduced infant formulas, 12% are fed soy-based infant formulas, 6% are fed specialty formulas and 13% are fed regular milk (e.g., dairy milk, flavored milks, soy beverage). While fluid dairy milk did not meet the predetermined definition of complementary foods for the systematic review, it was noted that future work should include systematic review of studies that examined fluid dairy milk consumption during the first year of life in relation to allergy-relevant health outcomes.<sup>40</sup>

### **Yogurt consumption by infants and toddlers – evidence for gut health benefits**

A 2019 systematic review of seven randomized,<sup>42-48</sup> one observational<sup>49</sup> and two prospective cohort<sup>50, 51</sup> studies found that consumption of yogurt by healthy infants and toddlers and those with infectious diarrhea was linked to gut health benefits.<sup>52</sup> Collectively, these studies examined effects of yogurt consumption on a broad range of interrelated outcomes that included duration of diarrhea, intestinal colonization and later risk of atopic disease. Yogurt consumption by infants and toddlers was shown to have beneficial effects on recovery from infectious diarrhea<sup>43-45, 47</sup> and on intestinal microbial composition,<sup>46, 49</sup> which included increased colonization with lactobacilli and bifidobacteria.<sup>49</sup> The two prospective cohort studies further showed that yogurt consumption by infants (<12 m of age) was associated with reduced risk of atopic dermatitis after the first birthday,<sup>50, 51</sup> and in one of these studies, with a positive effect on food sensitivity.<sup>51</sup> Conclusions about these benefits, however, are constrained due to the small number of studies, diverse endpoints examined, cultural influences across studies (i.e., developed/under-developed regions across the globe) and study population differences (e.g., healthy; acute/persistent diarrhea, malnutrition and/or hospitalization). More research clearly is needed to advance our understanding of the rapid and complex changes in intestinal microbiota and concurrent maturation of the immune system when new foods, including dairy foods, are added to the diet of infants and toddlers.<sup>53-55</sup> As noted in a 2021 review by a leading expert in gut microbiology, “Although current data is often fragmentary and observational, it can be concluded that the nutrition that a child receives in early life is likely to impinge not only on the development of the microbiota at that time, but also on the subsequent lifelong, functional relationships between the microbiota and the human host.”<sup>54</sup>



## Plant-based milk alternatives are not recommended for toddlers and young children

Most toddlers and young children tolerate dairy milk.<sup>14</sup> Among the many plant-based milk alternatives available today, unsweetened fortified soy-based beverage is the only one acceptable milk alternative for the approximately 4% of toddlers with dairy milk allergy.<sup>9, 10, 14</sup> Although often labeled as “milk” (e.g., rice milk, almond milk, etc.), many plant-based milk alternatives lack or fall short of key nutrients found in dairy milk.<sup>10, 14</sup> A 2020 position paper by the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) states that “without adequate compensation for nutrients not supplied in such a product, [plant-based “milk”] can place a young child at risk.”<sup>14</sup> In addition to the potential for inadequate consumption of energy, protein and select micronutrients, adverse effects on growth, nutritional status and health indicators including protein-energy malnutrition and metabolic and electrolyte disorders have been found.<sup>14</sup>

The energy and nutrient content of plant-based beverages is highly variable.<sup>14</sup> In addition, most have a lower protein content than dairy milk per serving and lower protein quality. The NASPGHAN position paper estimated that an 8-ounce serving of soy- or pea-based milk-alternative provides about 60% of the protein-equivalent found in an 8-ounce serving of dairy milk, and for oat-, rice- and almond- based milk alternatives, dairy milk protein-equivalents are even lower at around 36%, 8% and 2%, respectively.<sup>14</sup> Although the protein quality of these milk alternatives can be improved by adding limiting amino acids, this often leads to unpleasant flavor and aroma profiles. Sweeteners can be and are added to improve the taste (as high as 17 g per serving),<sup>14</sup> however, consumption of sweetened beverages, including sweetened forms of plant-based milk alternatives, by toddlers and young children is not recommended.<sup>9, 10, 14</sup> Parents are encouraged to consult with their health care provider when considering a plant-based milk alternative to dairy milk for a toddler or young child with allergies or lactose intolerance, or if parental preference is to avoid dairy products.<sup>10, 14</sup> Leading pediatric and health organizations agree that unsweetened dairy milk should be the main beverage for all other toddlers (12-24 m) and young children<sup>2, 9, 10, 14</sup> along with water to quench thirst and, if necessary, fortified soy beverage as the alternative to dairy milk.<sup>2, 9, 10</sup>

## References

- <sup>1</sup> National Academies of Sciences, Engineering and Medicine 2020. Feeding Infants and Children from Birth to 24 Months: Summarizing Existing Guidance. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25747>.
- <sup>2</sup> Perez-Escamilla R, Segura-Perez S, Lott M. On behalf of the RWJF HER Expert Panel on Best Practices for Promoting Healthy Nutrition, Feeding Patterns and Weight Status for Infants and Toddlers from Birth to 24 Months. Feeding Guidelines for Infants and Young Toddlers: A Responsive Parenting Approach. Durham, NC: Available at <http://healthyeatingresearch.org>, 2017.
- <sup>3</sup> Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.
- <sup>4</sup> American Heart Association. Dietary Recommendations for Healthy Children, <https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/nutrition-basics/dietary-recommendations-for-healthy-children>. 2018. Accessed December 1, 2021.
- <sup>5</sup> World Health Organization. Infant and Young Child Feeding. <https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding>. 2018. Accessed December 3, 2021.
- <sup>6</sup> American Academy of Family Physicians, Breastfeeding, Family Physicians Supporting (Position Paper). Available at: <https://www.aafp.org/about/policies/all/breastfeeding-position-paper.html> Accessed November 30, 2021.
- <sup>7</sup> American Academy of Pediatrics Committee on Nutrition. Breastfeeding. Edition ed. In: Kleinman RE, Greer FR, eds. Pediatric Nutrition 8th Edition. Itasca, IL: American Academy of Pediatrics, 2020:45-78.
- <sup>8</sup> World Health Organization. Exclusive breastfeeding for six months best for babies everywhere. [https://www.who.int/mediacentre/news/statements/2011/breastfeeding\\_20110115/en/](https://www.who.int/mediacentre/news/statements/2011/breastfeeding_20110115/en/) 2011. Accessed December 3, 2021.
- <sup>9</sup> U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020-2025. 9th Edition. December 2020. Available at <https://dietaryguidelines.gov/>.
- <sup>10</sup> Lott M, Callahan EH, Welker Duffy E, Story M, Daniels S. Healthy beverage consumption in early childhood: Recommendations from key national health and nutrition organizations. consensus statement. In: Healthy Eating Research, ed. Available at <http://healthyeatingresearch.org> 2019.



- <sup>11</sup> American Academy of Pediatrics Committee on Nutrition. Complementary Feeding. Edition ed. In: Kleinman RE, Greer FR, eds. *Pediatric Nutrition*, 8th Edition. Itasca, IL: American Academy of Pediatrics, 2020.
- <sup>12</sup> Grimes CA, Szymlek-Gay EA, Campbell KJ, Nicklas TA. Food sources of total energy and nutrients among U.S. Infants and Toddlers: National Health and Nutrition Examination Survey 2005-2012. *Nutrients* 2015;7(8):6797-836. doi: 10.3390/nu7085310.
- <sup>13</sup> American Academy of Pediatrics Committee on Nutrition. Formula Feeding of Term Infants. Edition ed. In: Kleinman RE, Greer FR, eds. *Pediatric Nutrition* 8th Edition. Itasca, IL: American Academy of Pediatrics, 2020:79-112.
- <sup>14</sup> Merritt RJ, Fleet SE, Fifi A, Jump C, Schwartz S, Sentongo T, Duro D, Rudolph J, Turner J, Nutrition NCo. North American Society for Pediatric Gastroenterology, Hepatology and Nutrition Position Paper: Plant-based milks. *J Pediatr Gastroenterol Nutr* 2020;71(2):276-81. doi: 10.1097/MPG.0000000000002799.
- <sup>15</sup> Vanderhout SM, Aglipay M, Torabi N, Jüni P, da Costa BR, Birken CS, O'Connor DL, Thorpe KE, Maguire JL. Whole milk compared with reduced-fat milk and childhood overweight: a systematic review and meta-analysis. *Am J Clin Nutr* 2020;111(2):266-79. doi: 10.1093/ajcn/nqz276.
- <sup>16</sup> Agostoni C. The right infant nutrition: do nutrition and growth matter in the 6 to 24 month period? *Journal of Pediatric and Neonatal Individualized Medicine (JPNIM)* 2014;3(2):e030229. doi: 10.7363/030229.
- <sup>17</sup> Schwarzenberg SJ, Georgieff MK. Advocacy for improving nutrition in the first 1000 days to support childhood development and adult health. *Pediatrics* 2018;141(2):e20173716. doi: 10.1542/peds.2017-3716.
- <sup>18</sup> Specker B. Nutrition influences bone development from infancy through toddler years. *Journal of Nutrition* 2004;134(3):691S-5S. doi: 10.1093/jn/134.3.691S.
- <sup>19</sup> Ratsika A, Codagnone MC, O'Mahony S, Stanton C, Cryan JF. Priming for life: early life nutrition and the microbiota-gut-brain axis. *Nutrients* 2021;13(2). doi: 10.3390/nu13020423.
- <sup>20</sup> Uauy R, Kain J, Mericq V, Rojas J, Corvalán C. Nutrition, child growth and chronic disease prevention. *Ann Med* 2008;40(1):11-20. doi: 10.1080/07853890701704683.
- <sup>21</sup> Maalouf J, Cogswell ME, Yuan K, Martin C, Gunn JP, Pehrsson P, Merritt R, Bowman B. Top sources of dietary sodium from birth to age 24 mo, United States, 2003-2010. *Am J Clin Nutr* 2015;101(5):1021-8. doi: 10.3945/ajcn.114.099770.
- <sup>22</sup> Ahluwalia N. Nutrition monitoring of children aged birth to 24 months (B-24): Data collection and findings from the NHANES. *Advances in Nutrition* 2020;11(1):113-27. doi: 10.1093/advances/nmz077.
- <sup>23</sup> Eldridge AL, Catellier DJ, Hampton JC, Dwyer JT, Bailey RL. Trends in mean nutrient intakes of US infants, toddlers and young children from 3 Feeding Infants and Toddlers Studies (FITS). *Journal of Nutrition* 2019;149(7):1230-7. doi: 10.1093/jn/nxz054.
- <sup>24</sup> Nicklaus S. The role of dietary experience in the development of eating behavior during the first years of life. *Ann Nutr Metab* 2017;70(3):241-5. doi: 10.1159/000465532.
- <sup>25</sup> Murray R. Influences on the Initial Dietary Pattern Among Children From Birth to 24 Months. *Nutr Today* 2017;52(2):s25-s9. doi: 10.1097/NT.0000000000000195.
- <sup>26</sup> Birch LL, Doub AE. Learning to eat: birth to age 2 y. *Am J Clin Nutr* 2014;99(3):723s-8s. doi: 10.3945/ajcn.113.069047.
- <sup>27</sup> Feeding Infants in the Child and Adult Care Food Program. United States Department of Agriculture. Food and Nutrition Service. July 2021: 1-200. [https://fns-prod.azureedge.net/sites/default/files/resource-files/FI\\_FullGuide\\_2021.pdf](https://fns-prod.azureedge.net/sites/default/files/resource-files/FI_FullGuide_2021.pdf) Accessed February 3, 2022.
- <sup>28</sup> Child and Adult Care Food Program: Meal Pattern Revisions Related to the Healthy, Hunger-Free Kids Act of 2010. Final Rule. Department of Agriculture, Food and Nutrition Service. Federal Register 2016;81(79):24348-75. <https://www.govinfo.gov/content/pkg/FR-2016-04-25/pdf/2016-09412.pdf> Accessed February 3, 2022.
- <sup>29</sup> Bailey RL, Stang JS, Davis TA, Naimi TS, Schneeman BO, Dewey KG, Donovan SM, Novotny R, Kleinman RE, Taveras EM, et al. Dietary and Complementary Feeding Practices of US Infants, 6 to 12 Months: A Narrative Review of the Federal Nutrition Monitoring Data. *Journal of the Academy of Nutrition and Dietetics* 2021. doi: 10.1016/j.jand.2021.10.017.
- <sup>30</sup> Iweala OI, Choudhary SK, Commins SP. Food Allergy. *Curr Gastroenterol Rep* 2018;20(5):17-. doi: 10.1007/s11894-018-0624-y.
- <sup>31</sup> Fiocchi A, Brozek J, Schünemann H, Bahna SL, von Berg A, Beyer K, Bozzola M, Bradsher J, Compalati E, Ebisawa M, et al. World Allergy Organization (WAO) Diagnosis and Rationale for Action against Dairy milk Allergy (DRACMA) Guidelines. *Pediatr Allergy Immunol* 2010;21 Suppl 21:1-125. doi: 10.1111/j.1399-3038.2010.01068.x.
- <sup>32</sup> Boyce JA, Assa'ad A, Burks AW, Jones SM, Sampson HA, Wood RA, Plaut M, Cooper SF, Fenton MJ, Arshad SH, et al. Guidelines for the diagnosis and management of food allergy in the United States: report of the NIAID-sponsored expert panel. *J Allergy Clin Immunol* 2010;126(6 Suppl):S1-S58. doi: 10.1016/j.jaci.2010.10.007.
- <sup>33</sup> Flom JD, Sicherer SH. Epidemiology of dairy milk allergy. *Nutrients* 2019;11(5). doi: 10.3390/nu11051051.
- <sup>34</sup> Greer FR, Sicherer SH, Burks AW. The effects of early nutritional interventions on the development of atopic disease in infants and children: The role of maternal dietary restriction, breastfeeding, hydrolyzed formulas and timing of introduction of allergenic complementary foods. *Pediatrics* 2019;143(4). doi: 10.1542/peds.2019-0281.
- <sup>35</sup> Food Allergies. US Food & Drug Administration <https://www.fda.gov/food/food-labeling-nutrition/food-allergies> 2021. Accessed January 31, 2022.
- <sup>36</sup> Food Allergy Essentials. Common Allergens. Food Allergy Research and Education <https://www.foodallergy.org/living-food-allergies/food-allergy-essentials/common-allergens> 2022. Accessed January 31, 2022.
- <sup>37</sup> Gupta RS, Warren CM, Smith BM, Blumenstock JA, Jiang J, Davis MM, Nadeau KC. The public health impact of parent-reported childhood food allergies in the United States. *Pediatrics* 2018;142(6):e20181235. doi: 10.1542/peds.2018-1235.
- <sup>38</sup> Fiocchi A, Dahda L, Dupont C, Campoy C, Fierro V, Nieto A. Dairy milk allergy: towards an update of DRACMA guidelines. *World Allergy Organ J* 2016;9(1):35. doi: 10.1186/s40413-016-0125-0.



- <sup>39</sup> Koletzko S, Niggemann B, Arato A, Dias JA, Heuschkel R, Husby S, Mearin ML, Papadopoulou A, Ruemmele FM, Staiano A, et al. Diagnostic approach and management of cow's-milk protein allergy in infants and children: ESPGHAN GI Committee practical guidelines. *J Pediatr Gastroenterol Nutr* 2012;55(2):221-9. doi: 10.1097/MPG.0b013e31825c9482.
- <sup>40</sup> Obbagy JE, English LK, Wong YP, Butte NF, Dewey KG, Fleischer DM, Fox MK, Greer FR, Krebs NF, Scanlon KS, et al. Complementary feeding and food allergy, atopic dermatitis/eczema, asthma and allergic rhinitis: a systematic review. *Am J Clin Nutr* 2019;109(Suppl\_7):890s-934s. doi: 10.1093/ajcn/nqy220.
- <sup>41</sup> Rossen LM, Simon AE, Herrick KA. Types of infant formulas consumed in the United States. *Clinical pediatrics* 2016;55(3):278-85. doi: 10.1177/0009922815591881.
- <sup>42</sup> Bhatnagar S, Singh KD, Sazawal S, Saxena SK, Bhan MK. Efficacy of milk versus yogurt offered as part of a mixed diet in acute noncholera diarrhea among malnourished children. *J Pediatr* 1998;132(6):999-1003. doi: 10.1016/s0022-3476(98)70398-1.
- <sup>43</sup> Boudraa G, Touhami M, Pochart P, Soltana R, Mary JY, Desjeux JF. Effect of feeding yogurt versus milk in children with persistent diarrhea. *J Pediatr Gastroenterol Nutr* 1990;11(4):509-12. doi: 10.1097/00005176-199011000-00011.
- <sup>44</sup> Dewit O, Boudraa G, Touhami M, Desjeux JF. Breath hydrogen test and stool characteristics after ingestion of milk and yogurt in malnourished children with chronic diarrhoea and lactase deficiency. *J Trop Pediatr* 1987;33(4):177-80. doi: 10.1093/tropej/33.4.177.
- <sup>45</sup> Eren M, Dinleyici EC, Vandenplas Y. Clinical efficacy comparison of *Saccharomyces boulardii* and yogurt fluid in acute non-bloody diarrhea in children: a randomized, controlled, open label study. *Am J Trop Med Hyg* 2010;82(3):488-91. doi: 10.4269/ajtmh.2010.09-0529.
- <sup>46</sup> Guerin-Danan C, Chabanet C, Pedone C, Popot F, Vaissade P, Bouley C, Szylit O, Andrieux C. Milk fermented with yogurt cultures and *Lactobacillus casei* compared with yogurt and gelled milk: influence on intestinal microflora in healthy infants. *Am J Clin Nutr* 1998;67(1):111-7. doi: 10.1093/ajcn/67.1.111.
- <sup>47</sup> Pashapour N, Iou SG. Evaluation of yogurt effect on acute diarrhea in 6-24-month-old hospitalized infants. *Turk J Pediatr* 2006;48(2):115-8.
- <sup>48</sup> Pedone CA, Bernabeu AO, Postaire ER, Bouley CF, Reinert P. The effect of supplementation with milk fermented by *Lactobacillus casei* (strain DN-114 001) on acute diarrhoea in children attending day care centres. *Int J Clin Pract* 1999;53(3):179-84.
- <sup>49</sup> Martino DJ, Currie H, Taylor A, Conway P, Prescott SL. Relationship between early intestinal colonization, mucosal immunoglobulin A production and systemic immune development. *Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology* 2008;38(1):69-78. doi: 10.1111/j.1365-2222.2007.02856.x.
- <sup>50</sup> Roduit C, Frei R, Loss G, Büchele G, Weber J, Depner M, Loeliger S, Dalphin ML, Rojonen M, Hyvärinen A, et al. Development of atopic dermatitis according to age of onset and association with early-life exposures. *J Allergy Clin Immunol* 2012;130(1):130-6.e5. doi: 10.1016/j.jaci.2012.02.043.
- <sup>51</sup> Shoda T, Futamura M, Yang L, Narita M, Saito H, Ohya Y. Yogurt consumption in infancy is inversely associated with atopic dermatitis and food sensitization at 5 years of age: A hospital-based birth cohort study. *J Dermatol Sci* 2017;86(2):90-6. doi: 10.1016/j.jdermsci.2017.01.006.
- <sup>52</sup> Donovan SM, Rao G. Health benefits of yogurt among infants and toddlers aged 4 to 24 months: a systematic review. *Nutr Rev* 2019;77(7):478-86. doi: 10.1093/nutrit/nuz009.
- <sup>53</sup> Dogra SK, Cheong KC, Wang D, Sakwinska O, Colombo Mottaz S, Sprenger N. Nurturing the early life gut microbiome and immune maturation for long term health. *Microorganisms* 2021;9(10). doi: 10.3390/microorganisms9102110.
- <sup>54</sup> Tannock Gerald W. Building robust assemblages of bacteria in the human gut in early life. *Applied and Environmental Microbiology* 2021;0(ja):AEM.01449-21. doi: 10.1128/AEM.01449-21.
- <sup>55</sup> Fragkou PC, Karaviti D, Zemlin M, Skevaki C. Impact of early life nutrition on children's immune system and noncommunicable diseases through its effects on the bacterial microbiome, virome and mycobiome. *Front Immunol* 2021;12(806). doi: 10.3389/fimmu.2021.644269.





[USDairy.com](http://USDairy.com)