YOGURT IN NUTRITION
INITIATIVE FOR SUSTAINABLE AND BALANCED DIETS

Yogurt for Health

The evidence so far

Marking the 10th YINI anniversary

Contents

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Yogurt from Science to Health

Introduction from the YINI Chairs

As we celebrate the 10th anniversary of our ground-breaking initiative, we look back at our achievements so far and embrace the new challenges that lie ahead.

The Yogurt In Nutrition Initiative (YINI) was established in 2013 as a unique collaboration between two international scientific organisations – the American Society for Nutrition (ASN) and the non-profit organisation, Danone Institute International (DII).

The initial goals of the initiative were to summarise our scientific knowledge on the health effects of yogurt, to promote research that addresses gaps in our knowledge, and to share our findings with a broad audience. The activities of the YINI are guided by a Scientific Advisory Board of experts with a passion for advancing our understanding of the links between diet and health.

Inspiring events and promoting lively discussion

Over the past decade, the YINI has organised 10 Global Summits on the health effects of yogurt, held at ASN and International Union of Nutritional Sciences scientific conferences, and an additional 10 major events at other international conferences. The YINI has built a strong portfolio of resources for health professionals, including recordings of conferences and webinars, which are available at **http://www.yogurtinnutrition.com**. Our active digital ecosystem provides news and practical information, and includes social media interfaces such as X **@YogurtNutrition** with over 39,000 followers and Instagram **yogurt_in_nutrition** with over 14,000 followers.

A new mission to meet today's planetary challenges

Since 2019, the YINI has taken on an additional role to address some of the most pressing concerns of our modern world: hunger, food sustainability, and planetary health. It became the Yogurt in Nutrition Initiative for Sustainable and Balanced Diets, with a new mission: "to promote and advance knowledge and practice on healthy sustainable diets and the importance of all food groups to meet nutritional needs across the lifespan, while respecting local food cultures, affordability, and accessibility."

Looking forward at the 10th YINI anniversary

We celebrate the 10th anniversary of the YINI at a time of rapid scientific advancements that are highlighting exciting potential developments for managing health through yogurt as part of a sustainable and balanced diet. We're ready to embrace the scientific challenges that lie ahead. Meanwhile, we are pleased to share our latest evidence-based conclusions so far in this **Yogurt for Health** publication, updated from the first edition that was published on the YINI 5th anniversary.

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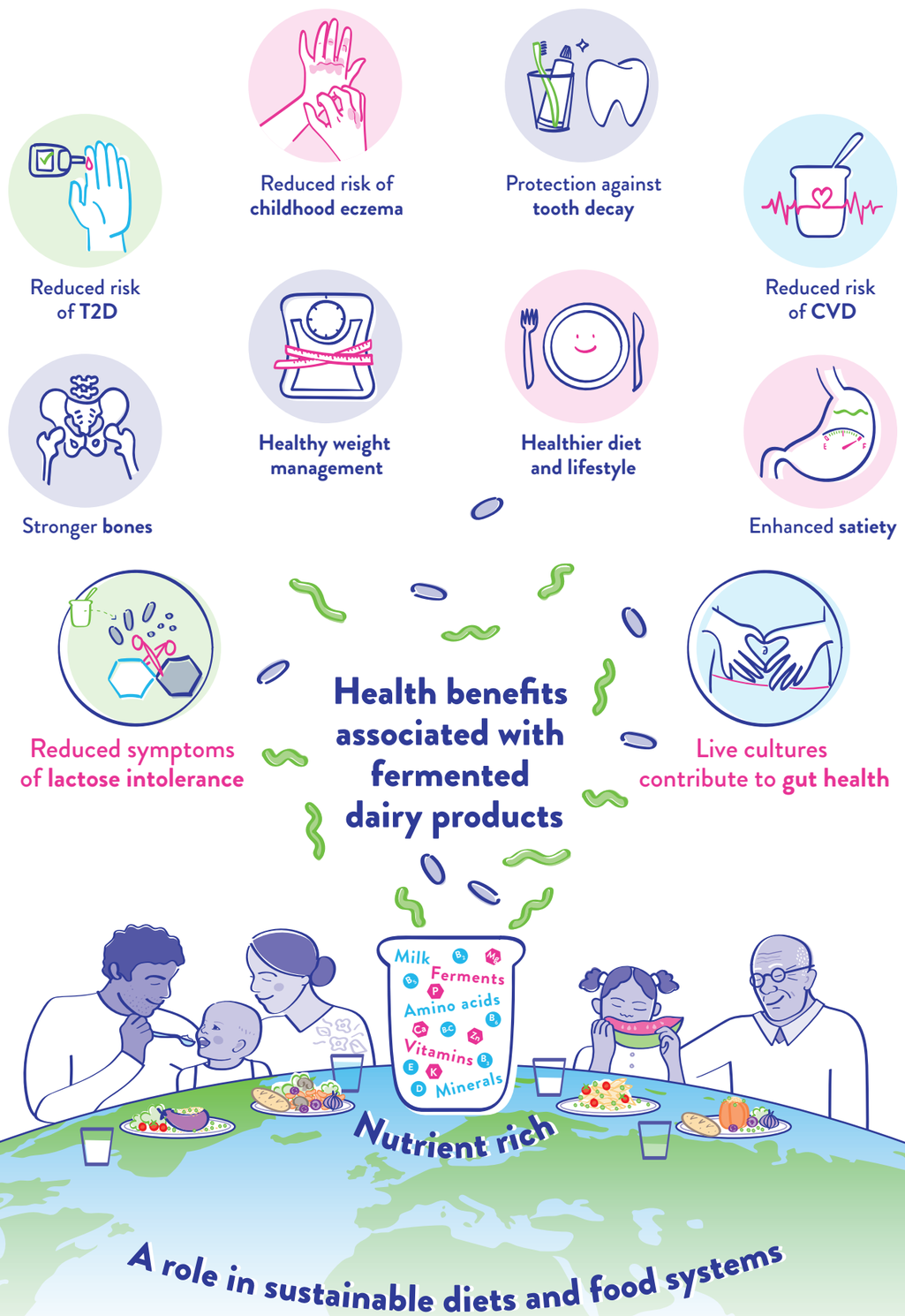
How yogurt can help unite the health of people and planet



Yogurt for Health: a summary

Yogurt is an integral and affordable part of the diet in many cultures around the world. Underpinning the benefits of yogurt consumption are two special characteristics: its high nutrient density and the live bacteria it contains due to the addition of bacteria to achieve fermentation from milk.

Yogurt is a nutrient-rich food recommended in dietary guidelines

Eating yogurt every day can help people reach their recommended intakes of several key nutrients, especially proteins and calcium. Yogurt, along with other dairy products, is therefore recognised in food-based dietary guidelines around the world as a key contributor to nutrient intakes for adults and children (pp. 10–11). Yogurt consumption tends to go hand-in-hand with a healthy lifestyle. A wealth of evidence shows that, compared with non-consumers, people who regularly eat yogurt have better diet quality, a more active lifestyle, drink less alcohol, and are less likely to smoke (pp. 12–13).

Several characteristics of yogurt support its contribution to sustainable diets

Rich in several essential nutrients, yogurt is a valuable contributor to sustainable diets that must be predominantly plant-based yet provide the nutrients required for healthy living. As part of a plant-predominant diet, yogurt would fulfil the four components of a sustainable diet – it can provide an affordable and culturally acceptable source of key nutrients for health, with a smaller environmental footprint than many other animal-based foods (pp. 32–35).

Eating yogurt is associated with some well-established health benefits

Since yogurt is rich in protein, calcium, and other nutrients important for bone health, it has long been associated with the growth of stronger, healthy bones in childhood and a reduced risk of bone fractures in later life (pp. 14–15). The live bacteria in yogurt help to digest lactose, allowing people with lactose maldigestion to enjoy the nutritional benefits of dairy products without suffering ill-effects – a characteristic recognised by the European Food Safety Authority (pp. 16–17). As a fermented food, yogurt may also have a beneficial effect on gut health – modulating the gut microbiota, protecting the intestinal barrier, and potentially helping to prevent a range of gastrointestinal disorders (pp. 18–19).

Increasing evidence supports additional health benefits of eating yogurt

Eating yogurt can increase the feeling of being full, which may help to manage energy intake and support weight reduction in people who are dieting. Recent evidence suggests that yogurt consumption is associated with a reduced risk of being overweight or obese (pp. 20–23). Evidence also points to a cardiometabolic protective effect of yogurt consumption. Large-scale studies show that eating yogurt daily is associated with ~20% reduced risk of Type 2 diabetes (pp. 24–25). Regular yogurt consumption has been linked to a reduced risk of cardiovascular disease – and large population-based studies reveal an association between eating yogurt and a reduced risk of death from cardiovascular disease and all causes (pp. 26–27).

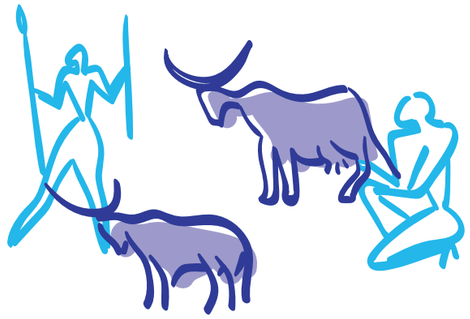
Emerging benefits and future research challenges

Recent advances in our understanding of the effects of yogurt consumption on the oral and gut microbiome have led to the emergence of further potential health benefits. These include protection against childhood eczema and allergies (pp. 28–29) and reduction in the risk of tooth decay and gum disease (pp. 30–31).

More research is needed before we can understand fully all the health impacts of yogurt consumption and the mechanisms behind these effects. Ongoing research should also focus on the role of yogurt in local and regional food systems to shed further light on its contribution, as a nutrient-dense food, to the sustainable diets so essential for our modern world.

The story of yogurt

Part of the human diet for thousands of years



Made by generations of people over thousands of years, yogurt has become an integral part of the diet in many cultures around the world. Only recently have scientists begun to understand the potential health benefits that yogurt may offer, largely thanks to the discovery of lactic acid bacteria.

A way to preserve milk

- The first use of milk products in the human diet can be traced back to the Neolithic period between 10,000 and 5,000 BC, a time when nomadic people were settling down to an agricultural way of life. Simultaneously they were starting to domesticate milk-producing animals such as cows, goats, yaks, buffalo and camels.[1]
- At that time, herdsmen in the Middle East carried milk in bags made of animal gut. Contact with intestinal enzymes may have caused the milk to curdle and sour.[1] This may have led to the realisation that a dairy product could be conserved for a relatively long period.[1]
- Yogurt was well known in the Greek and Roman empires, and it is even mentioned in the Bible.
- The word 'yogurt' is believed to stem from a Turkish word meaning to thicken, coagulate or curdle.

Early associations between yogurt and health

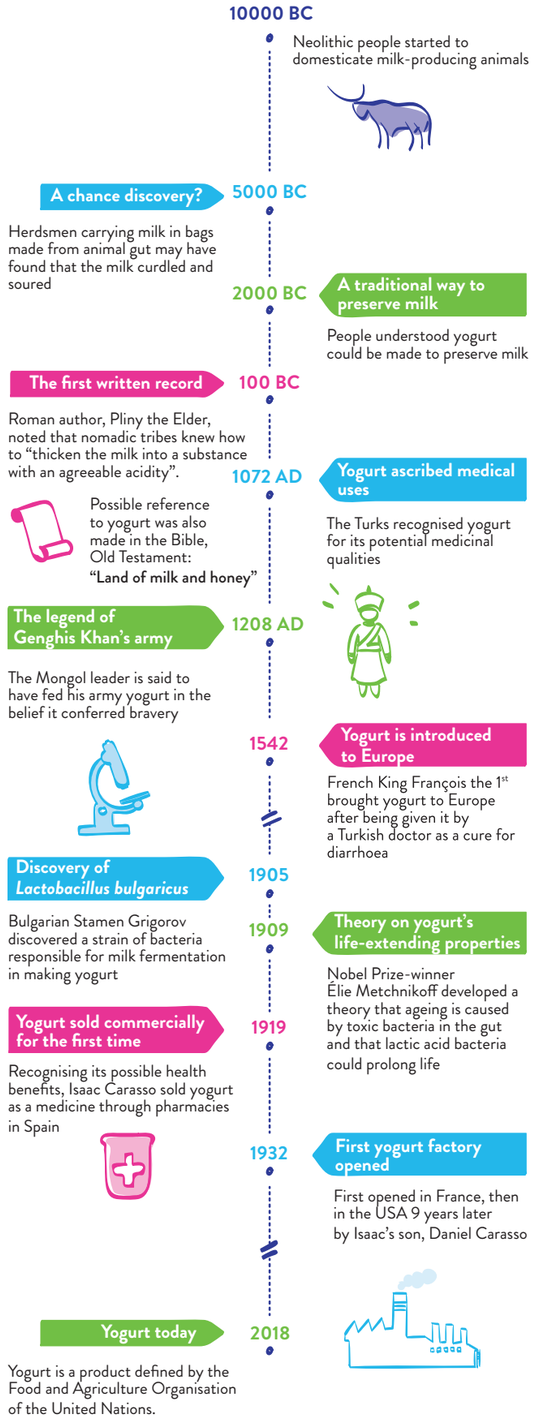
- In the 11th century, the curative properties of yogurt were evaluated for the first time in Turkish literature, suggesting its use in conditions such as diarrhoea and stomach cramps.[1]
- According to legend, 12th century Mongolian ruler Genghis Khan fed his army yogurt, believing it instilled strength and bravery.[1]
- Yogurt was introduced into Western Europe in the 16th century by the King of France, François the 1st, after he was given it by a doctor from Turkey as a treatment for severe diarrhoea.[1]

Discovery of lactic acid bacteria

Starter cultures that convert lactose in milk to lactic acid have been used in the inoculation of fresh milk with small quantities of sour milk since long before anything was known about bacteriology. For people living in primitive sanitary conditions, making fermented milk products offered a safe way of preserving dairy because the acidity of these products destroyed pathogens.[2]

- The first observation of bacteria in sour milk was made by Antonie van Leeuwenhoek in about 1675.[2]
- However, it was not until the 20th century that the first glimpse was caught of an explanation for the health benefits associated with yogurt consumption.
- In 1905 a Bulgarian medical student, Stamen Grigorov, described the lactic acid bacteria in yogurt, *Bacillus bulgaricus* – now *Lactobacillus bulgaricus* – which is still used in yogurt nowadays.[1]

Yogurt through the ages



- Four years later, the Nobel Prize-winner Élie Metchnikoff suggested that ageing is caused by toxic bacteria in the gut and that lactic acid could prolong life.[1]
- As the 20th century progressed, yogurt became known for its potential health benefits and it began to be sold commercially, first in pharmacies as a medicine.
- The first yogurt factory was opened in 1932, in France by Daniel Carasso.

"Yogurt is an ancient food and has been part of our diet for thousands of years. It has been valued as a healthy food for much of that time but we're only just beginning to understand how it might be good for us."

- Professor Mauro Fisberg

What is yogurt?

Today, yogurt is described by the United Nations' Food and Agriculture Organisation and the World Health Organization in their Codex Alimentarius as a fermented milk product containing two strains of live bacteria, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*. Both strains must remain active in the final product, with a total of at least 10 million bacteria per gram.[1,3]

Yogurt is a nutrient-rich food

Yogurt contains both micronutrients – vitamins and minerals – and macronutrients, including proteins and fatty acids.

- Yogurt contains high-quality protein, including all nine essential amino acids in the proportions needed for protein synthesis.[4]
- Yogurt is a rich source of calcium, providing up to 20% of daily calcium intake per 116 g or ~4-ounce portion (one average pot).[5]
- Yogurt also provides smaller amounts of many other micronutrients, including potassium, zinc, phosphorus, magnesium, iodine, vitamin A, riboflavin (vitamin B2), vitamin B5, vitamin B12 and in some countries, vitamin D.[6,7]

Yogurt consumption helps meet nutrient intake requirements

Yogurt and other dairy products contribute to key nutrient intakes for adults and children.[6,8,9] That is why most regional and national food-based dietary guidelines recommend the consumption of dairy products – and, when amounts are specified, two or three servings per day are typically recommended.[10-13]

▶ Adults

Many people fall short of meeting recommended intakes of certain nutrients in their diet. Close to 30% of men and 60% of women in the USA do not consume enough calcium and >90% do not consume enough vitamin D.[11] Deficiencies of several nutrients persist in the Middle East, North Africa and Central Asia including calcium, vitamins A, D, B12 and zinc.[13]

Yogurt contributes many of these nutrients. For example, 125 g (~4 ounces) of plain yogurt provides, among other nutrients, 20% of an adult's recommended daily intake of calcium, 21% of riboflavin, 11% of vitamin B12, and 16% of phosphorus.[14,15]

- Data from the USA National Health Nutrition and Examination Survey (NHANES), the Canadian Community Health Survey, and the UK National Diet and Nutrition Survey show that yogurt consumers have higher daily intakes of several key nutrients including riboflavin, vitamin C, folate, vitamin D, potassium, iron, magnesium and calcium **(Figure 1).**[5,16,17]
- Furthermore, regular yogurt eaters are more likely to meet or exceed nutrient recommendations for vitamins and minerals including vitamin A, riboflavin, folate, potassium, calcium, magnesium, zinc and iodine **(Figure 2).**[5,16,18-20]

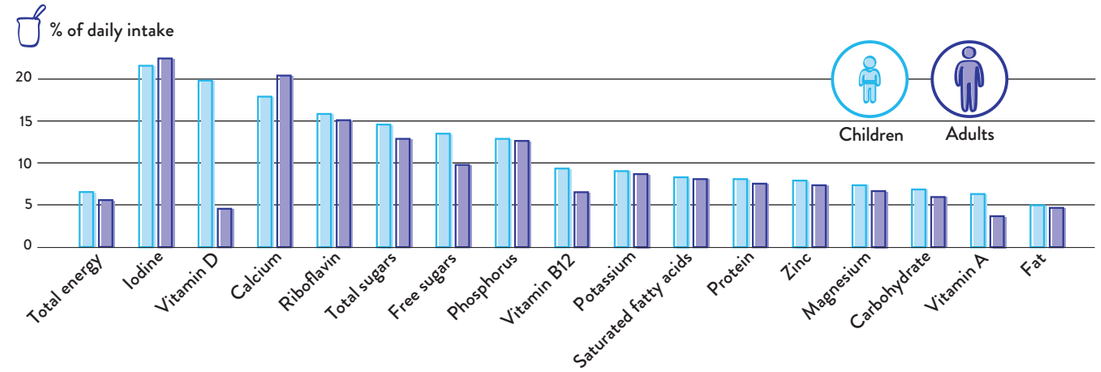
▶ Children

Good diet quality is important for children and adolescents to support growth and development. Teenagers are especially at risk of nutrient shortfall, and vitamin D, calcium, potassium, fibre and iron are of particular concern. Yogurt is a valuable part of a balanced nutrient-rich diet during childhood, contributing a substantial percentage of a child's needs for micronutrients and macronutrients.[8]

"Yogurt is a nutrient-dense food containing a wide range of macro- and micro-nutrients. Eating yogurt every day can help us meet our recommended levels of several key nutrients."

- Professor Frans Kok

Figure 1. Contribution of yogurt to daily energy and nutrient intake



Percentage contribution of yogurt to daily energy and nutrient intake, based on average daily yogurt consumption of 83–96 g (~3 ounces) for children (aged 1.5–18 years) and 115–117 g (~4 ounces) for adults (≥19 years) in the UK, National Diet and Nutrition Survey 2014/15 to 2016/17. Adapted from Zhu Y, et al. J Nutr Sci. 2021;10:e85 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[5]

- Data from the USA NHANES show that increasing dairy food consumption (milk, cheese and yogurt) to meet the recommended level in the USA for adolescents of three servings per day can make up for the shortfall of three nutrients of public health concern – calcium, vitamin D and potassium.[9]
- The UK survey data suggest that adding a 125 g (~4 ounces) pot of low-fat fruit yogurt per day to adolescents' diets would increase mean calcium intake from below to above the Recommended Nutrient Intake.[6]

Yogurt's contribution to total and added sugar intake is relatively low

The World Health Organization recommends limiting the consumption of non-milk extrinsic sugars – which include those added to food by manufacturers or by consumers – to a maximum of 10% energy intake.[21,22] However, many people in Western societies are exceeding this threshold.

Concerns that sweetened yogurt contributes to these excess sugar intakes are not supported by the scientific data. In the USA, a NHANES analysis found that flavoured yogurt contributes about 1% of added sugars to the diets of adults. This compared with 28.1% from soft drinks.[23]

Added sugar intake increases throughout childhood and amounts to 15% of total daily energy intake among adolescents.[11] While more than 50% of total sugars and 66% of added sugars in children's diets come from sweet products such as cakes, sweets and sugary drinks, yogurt accounts for only 1–8% of total sugars and 4–9% of added sugar in children's diets in Europe.[24]

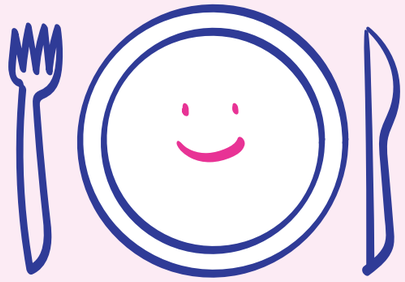
Figure 2. Nutrient inadequacy in yogurt consumers *versus* non-consumers

	n = 24,322	*n* = 1676	*n* = 37,598	*n* = 2200
	% population below Estimated Average Requirement (EAR)			
Calcium (mg)	48.6 ± 0.7	**15.4 ± 1.9***	48.3 ± 0.6	**20.7 ± 1.7***
Iron (mg)	2.18 ± 0.13	1.57 ± 0.47	5.01 ± 0.12	5.51 ± 0.61
Magnesium (mg)	37.0 ± 0.6	**14.2 ± 1.0***	58.0 ± 0.7	**32.6 ± 1.5***
Vitamin A, RAE (µg)	26.2 ± 0.9	**7.58 ± 1.60***	48.1 ± 0.8	**29.5 ± 2.1***
Thiamin (mg)	1.34 ± 0.20	**0.56 ± 0.27***	7.04 ± 0.41	5.47 ± 1.20
Folate, DFE (µg)	3.82 ± 0.43	**0.82 ± 0.52***	12.3 ± 0.5	9.34 ± 1.57
Vitamin B_6 (mg)	2.18 ± 0.32	1.25 ± 0.51	12.9 ± 0.6	10.9 ± 1.4
Vitamin B_{12} (mg)	0.86 ± 0.15	**0.11 ± 0.08***	4.35 ± 0.33	**0.76 ± 0.40***
Vitamin C (mg)	19.2 ± 0.9	**9.39 ± 1.87***	45.1 ± 0.8	**34.8 ± 1.8***
Vitamin D (µg)	91.1 ± 0.5	86.4 ± 2.0	95.4 ± 0.3	93.2 ± 1.5

Consumer
Non-consumer

*Statistically significant difference between yogurt consumers and non-consumers. A lower % population below the estimated average requirement (EAR) for nutrient intake among yogurt consumers means better nutritional adequacy *versus* non-consumers. Adapted from Cifelli CJ, et al. Nutrients. 2020;12:3435 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[16]

Eating yogurt is associated with healthier diet and lifestyle



Regular yogurt consumers of all ages tend to eat and live healthily. They are less likely to eat unhealthy foods, or smoke or drink alcohol to excess, and are more likely to exercise regularly than people who don't.[25-30]

Regular yogurt consumers tend to choose healthy diets

Yogurt consumption is associated with better diet quality, measured using validated indices of healthy eating, among both children and adults in the USA, Canada and Europe.[5,16,17,31-35] Regular yogurt consumers are less likely to consume unhealthy food and more likely to stick to dietary guidelines than non-consumers.

▶ Adults

- Compared with those who eat little or no yogurt, people who eat yogurt frequently have a better diet quality **(Figure 1)**,[16] and tend to follow dietary guidelines more closely.[6,26]
- Yogurt consumers score more highly on the Healthy Eating Index (HEI) than non-consumers, which could be partly explained by a significant increase in fruit, grain and dairy consumption.[36]
- Yogurt consumers are more likely to have a diet with more fruits, vegetables, nuts, legumes, fish and seafood, and fewer fast foods such as French fries and fried foods, processed and red meats, pizza, snacks, soft drinks and alcohol.[27]
- People who frequently consume yogurt have higher nutrient intakes than those who do not often eat yogurt even when yogurt is not a source of these nutrients.[6,26] Hence frequent yogurt consumers (at least one serving per day) have been found to have higher intakes of folic acid, copper, manganese and iron.[26]
- Both in children and in adults (in Spain and the USA), swapping high-calorie, nutrient-poor snacks for full fat yogurt with fruit could help boost key nutrients and improve dietary quality without contributing to dietary excess and obesity.[37,38]

▶ Children

- Young children who regularly consume yogurt have a better diet quality and the overall nutrient content of their diets is higher than those who don't.[33,39,40]
- The diets of children who eat yogurt regularly are better overall than non-consumers – they consume more fruit, whole grains and total dairy **(Figure 1)**,[16,41] and fewer fatty foods.[7]

Yogurt consumption is a marker of a healthier lifestyle

Numerous studies suggest yogurt consumption is also a signature of a healthy lifestyle **(Figure 2)**.[6,19,25,27,41-43]

Compared with people who do not eat yogurt, those who do consume yogurt:

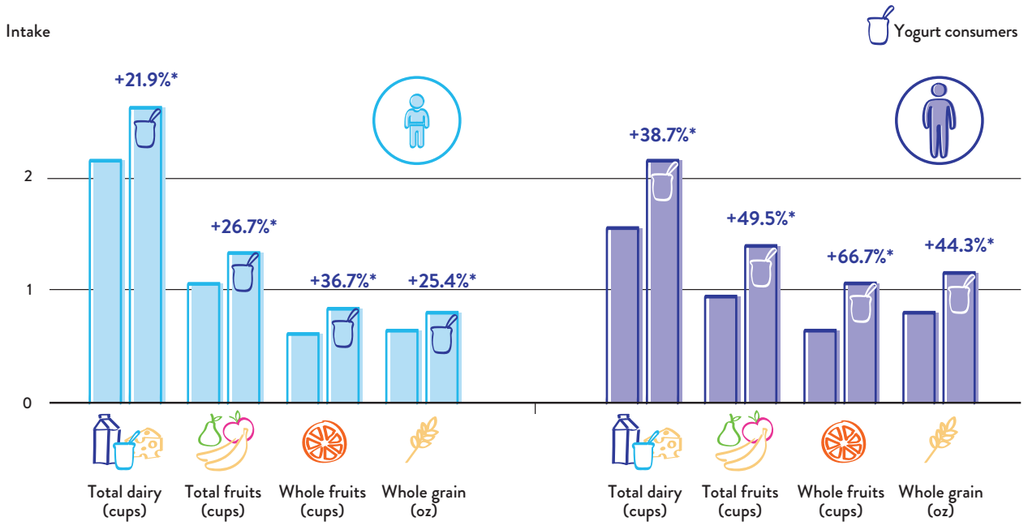
- are generally healthier and leaner. They also tend to be more highly educated and of higher socio-economic status.[28,43]
- show healthier non-nutritional behaviour: they are less likely to smoke,[25,28-30,41] tend to drink less alcohol and are more likely to be physically active in their leisure time than non-consumers.[29,34]
- tend to have a better health-related quality of life and mental health.[44]

Children who regularly consume milk and yogurt are more likely than those who don't to engage in healthy lifestyle behaviours with more physical activity and less sitting in front of a screen.[32]

"Yogurt consumption is a signature of healthy living. Compared with non-consumers, people who regularly eat yogurt tend to have better diet quality, have a more active lifestyle, drink less alcohol, and are less likely to smoke."

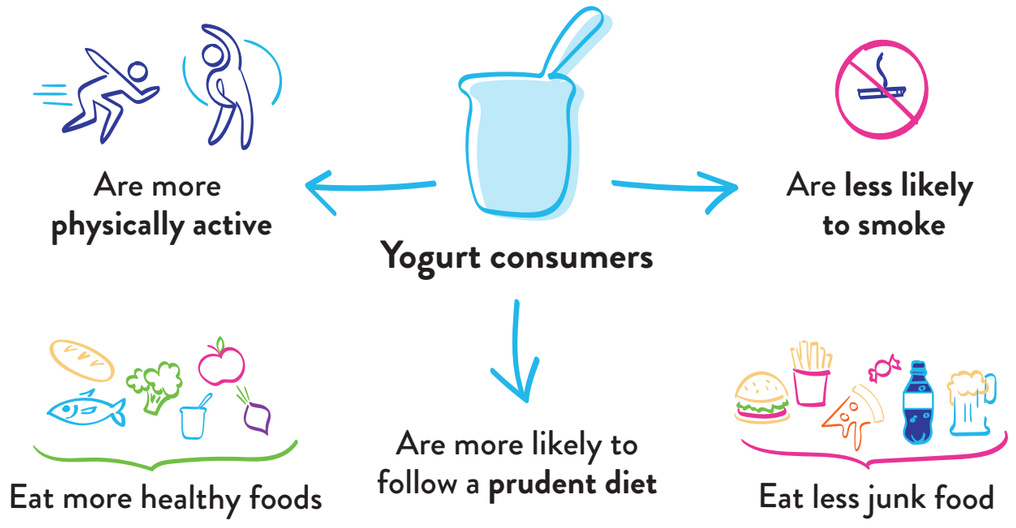
- Professor Angelo Tremblay

Figure 1. Diet quality among children and adults who are yogurt consumers versus non-consumers



*Statistically significant difference between yogurt consumers and non-consumers. Adapted from Cifelli CJ, et al. Nutrients. 2020;12:3435 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[16]

Figure 2. Yogurt consumption is linked to a healthier diet and lifestyle [25-30,32,34]



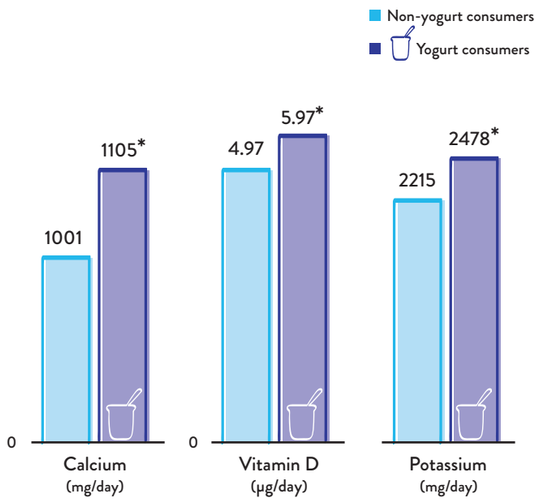
Yogurt consumption is associated with stronger bones and reduced fracture risk

Yogurt (as part of the dairy product group) is recommended in many dietary guidelines because of its nutrient content essential for bone health.

Yogurt is rich in elements essential for bone health

Dairy products including yogurt are rich in protein and several micronutrients important for bone health – phosphorus, potassium, vitamin D (when fortified) and most notably calcium **(Figure 1)**.[7,45-48]

Figure 1. Yogurt consumption increases children's intake of vital micronutrients for bone health



*Statistically significant difference between yogurt consumers and non-consumers. Adapted from Keast DR, et al. Nutrients.2015;7:1577–93 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[7]

In addition, yogurts containing live bacteria and those with added prebiotics – food ingredients that promote the growth or activity of beneficial microorganisms – may benefit bone health by modifying the gut microbiota and increasing calcium absorption.[49]

Yogurt is linked to healthy growth of bones during childhood and adolescence

- In a study in China, adding one serving of yogurt to the usual diet of preschool children for 5 days each week over 9 months promoted growth (height and weight gain) and significantly increased bone mineral density compared with children not receiving yogurt supplementation.[50]
- Consumption of fermented dairy products, such as yogurt, is associated with improved bone health, particularly bone mineral density, in children and teenagers.[49,51,52]

"For most age groups, it is difficult to meet the nutrient requirements for healthy bones without three servings of dairy products each day."

- Professor Connie Weaver

Yogurt is associated with stronger bones and better physical function in older people

Increasing yogurt consumption could be a convenient way of improving the nutritional status and health of older adults, including their bone health.[53]

The association between yogurt consumption and bone health was investigated in a study of people aged over 60 years. Results showed:

- Women who frequently ate yogurt (more than one serving per day) had stronger bones than those who rarely or never ate yogurt (less than one serving per week).[54] Total hip and femoral neck bone mineral density was 3.1–3.9% higher among frequent yogurt consumers.
- In men, vertebral bone mineral density was 4.1% higher in low-yogurt consumers compared with non-consumers. High-yogurt consumers were found to have 12.9% higher mean vitamin D concentrations than low-/non-consumers. A potential protective effect on bone was supported by changes in levels of the bone biomarker TRAP 5b (tartrate-resistant acid phosphatase 5b), a direct marker of osteoclasts – bone cells involved in the maintenance and repair of bone.[54]
- Compared with low-/non-consumers, women who often ate yogurt had better scores for daily living activities and physical self-maintenance.[54]

Yogurt may reduce the risk of hip fracture

Available evidence suggests that yogurt is associated with a lower risk of hip fracture in older adults.[55]

- Improving calcium and protein intakes with dairy foods (milk, yogurt and cheese) reduces the risk of all bone fractures occurring in older care residents by one-third.[56]
- A meta-analysis reported that a higher intake of yogurt was associated with a 25% reduction in hip fracture risk when compared with low intake.[57]
- A study in middle-aged and elderly Swedish women showed that low intake of fermented milk products (yogurt and soured milk) was associated with high rates of hip fracture.[58]
- Hip fracture rates were lowest among women with a high intake of fermented milk products in combination with a high intake of fruit and vegetables.[58]

Yogurt could reduce the risk of osteoporosis

In people over the age of 60 years, statistical modelling of yogurt intake and bone health predicted that each increase of one serving per week of yogurt intake was associated with a 39% lower risk of osteoporosis in women and a 52% lower risk in men.[54]

Encouraging older people to eat yogurt more often, particularly vitamin D- and calcium-fortified yogurt, may be a valuable public health strategy to stave off osteoporosis.[54,59-61]

Yogurt is recommended as part of a healthy diet

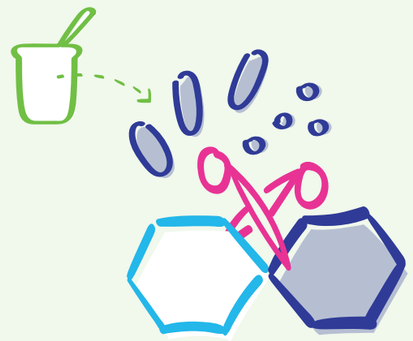
Many international advisory boards recommend the consumption of dairy products in amounts equivalent to 400–500 mL (~14–17 fluid ounces) milk per day.[62] By consuming three servings of dairy products per day, the recommended daily intakes of nutrients essential for good bone health may be readily achieved.[11,48]

Several countries include yogurt (as part of dairy products) in their dietary guidelines.[63] These include, among others, the USA, Canada, Japan, the UK, Australia, Switzerland, Sweden, and Portugal.

"Yogurt is rich in protein, calcium, and several micronutrients important for bone health at all ages but particularly during childhood growth phases, and in later life to maintain stronger bones and physical function, and to reduce risk of falls and fractures."

- Professor René Rizzoli

Yogurt improves lactose digestion and reduces symptoms of lactose intolerance



Live yogurt cultures have properties that improve digestion of lactose.[64-66]

Lactose maldigestion is common in adults

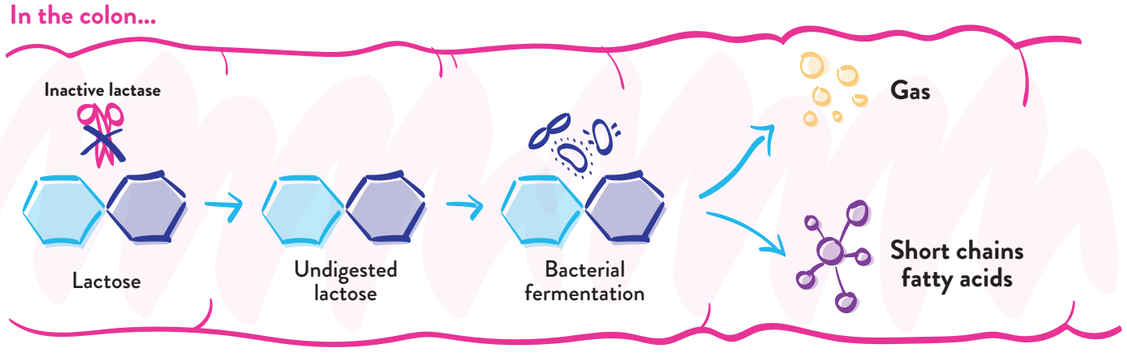
Lactose is a natural sugar found in milk and other dairy products. It can be broken down in the small intestine by the enzyme lactase into glucose and galactose, two simpler sugars that are readily absorbed into the bloodstream.[64]

- After weaning, our ability to digest lactose declines because we produce less lactase.[67,68] Difficulty in digesting lactose due to this normal reduction in lactase production/activity is known as lactose maldigestion.[68]
- Undigested lactose reaching the colon is broken down by the resident microbiota, resulting in the production of short-chain fatty acids (SCFAs) and gases **(Figure 1)**.[68] In most people, this maldigestion produces no noticeable symptoms.
- When lactose maldigestion gives rise to symptoms such as bloating, cramps, diarrhoea, and flatulence, this is called lactose intolerance.[67,68]
- Self-diagnosis of lactose intolerance is common, but it is often incorrect and in fact very few people have confirmed clinical lactose intolerance.[45,69]

People with lactose intolerance may eat moderate amounts of dairy products without experiencing significant symptoms

Dairy products are widely recognised as an important part of a healthy diet as they are a source of several nutrients (see pp. 10-11). Dairy products are particularly important for providing calcium, for which it is difficult to achieve the recommended daily intake from a dairy-free diet without supplements.[45]

Figure 1. Lactose maldigestion: a difficulty in digesting lactose[68]



It is therefore important that dairy products are part of everyone's diet, including people with lactose maldigestion or intolerance.

People with lactose intolerance or lactose maldigestion can generally tolerate up to 12 g (~0.4 ounces) of lactose (equivalent to about one glass of milk or 240 g/~8 ounces of natural yogurt), particularly when consumed as part of a meal, with no or minor symptoms.[67,70]

There is some evidence that a daily intake of 24 g (~0.8 ounces) of lactose can be tolerated if it is distributed throughout the day and consumed with other foods.[67,70]

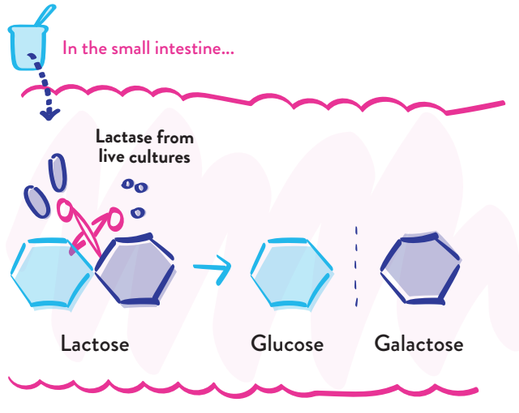
Since dairy products vary in the amount of lactose they contain, the amount of lactose ingested depends upon the type and quantity of dairy products consumed. In particular, a reduced level of lactose is found in yogurt containing the two active bacterial cultures *L. delbrueckii* subsp. *bulgaricus* and *S. thermophilus*.[45]

Yogurt may improve lactose digestion

The live bacteria *L. delbrueckii* subsp. b*ulgaricus* and *S. thermophilus* produce lactase which breaks down some of the lactose in yogurt **(Figure 2)**.[45,64,65]

- The bacteria survive their passage through the gut and the bacterial lactase helps further with digestion of lactose in the small intestine.[71]
- Unlike milk, yogurt's semi-solid state benefits lactose digestion by slowing transit through the gut.[65,72]

Figure 2. Bacteria in yogurt aid lactose digestion[64]



"Yogurt consumption is recommended by health authorities as part of a healthy balanced diet, even for people with lactose maldigestion or intolerance. In fact, yogurt containing live active cultures may improve lactose digestion and reduce symptoms of intolerance in people with lactose maldigestion."

- Professor Bob Hutkins

Several studies show that yogurt with live active cultures may significantly enhance lactose digestion and reduce symptoms of intolerance in people with lactose maldigestion.[52,73-76]

Yogurt is recommended by health authorities for people with lactose maldigestion

The European Food Safety Authority (EFSA) has approved the claim that yogurt improves digestion of lactose.[66]

- The EFSA's conclusions were based on 13 studies showing that consumption of live cultures in yogurt improved digestion of lactose in yogurt among people with lactose maldigestion.[66]
- To qualify for this claim, yogurt must contain at least 10^8 CFU live starter bacteria (*L. bulgaricus* and *S. thermophilus*) per gram of yogurt, and therefore fresh yogurt is best. Ultra-high temperature (UHT) yogurt or yogurt labelled 'long-life' has been heat-treated and this process kills the beneficial bacteria.

Several medical organisations recommend that people with lactose maldigestion – including those with lactose intolerance – consume yogurt as part of a balanced diet.[64-66,71,72]

"The live bacteria in yogurt survive passage through the gut. The lactase they produce breaks down some of the lactose in yogurt and this allows people suffering from lactose maldigestion/ intolerance to gain the nutritional benefits of yogurt and of other dairy products as well."

- Professor Naïma Lahbabi-Amrani

Yogurt with live cultures may contribute to gut health

Habitual yogurt consumption modifies the composition and function of the gut microbiota in a way that may lead to health benefits.[77-79]

Diet can influence the diversity of the gut microbiota, which is important for health

The gut microbiota plays an important role in digestion.[80] It may also be essential for the normal development and functioning of the immune and nervous systems.[81]

- Maintaining the healthy diversity of the gut microbiota is important in preventing disease.[80]
- Researchers have proposed that there is a gut microbiota 'signature' that could promote intestinal inflammation and subsequent systemic low-grade inflammation, a condition that predisposes to Type 2 diabetes (T2D) and obesity.[82]

"As a fermented food containing millions of live bacteria, yogurt may have a beneficial effect on gut health, increasing gut microbiota richness and robustness, protecting the intestinal barrier, and preventing a range of gastrointestinal disorders."

- Dr Joël Doré

The composition of the gut microbiota is influenced by our diet, among other factors.[82] Moreover, in fermented foods such as yogurt, the products of fermentation and particularly the bacteria involved in the fermentation process, can provide additional properties to the food beyond basic nutrition.[81,83]

Hence, fermented foods such as yogurt are arousing research interest as potentially having benefits beyond an extended shelf life and improved texture and flavour.[81,83]

Yogurt can deliver millions of live bacteria to the gut and may beneficially alter the gut microbiota

Yogurt with live cultures contains millions of bacteria **(Figure 1)** and eating yogurt daily could potentially increase the number of bacteria in the diet by up to 10,000-fold.[81]

- While probiotic bacteria are unlikely to have long-lasting effects on the gut microbiota,[81] consuming yogurt with live cultures on a regular basis will at least temporarily bolster the live bacteria in the gut,[36] most commonly the yogurt starters *Streptococcus thermophilus* and *Bifidobacterium animalis* subsp. *lactis*.[36,84-88]
- In addition, prebiotics may be added to yogurt (often in the form of fruit) and these may stimulate the proliferation of beneficial bacteria in the gut.[37]
- Daily yogurt consumption appears to boost the numbers of *Lactobacilli* in the gut and is associated with a slight increase in microbial diversity over a 42-day period.[77]

As well as beneficially altering the composition of the gut microbiota, probiotic bacteria – live microorganisms intended to have health benefits when consumed – in yogurt may alter the function of the existing resident bacteria by affecting the production of SCFAs;[81] these have beneficial effects on energy metabolism.[89]

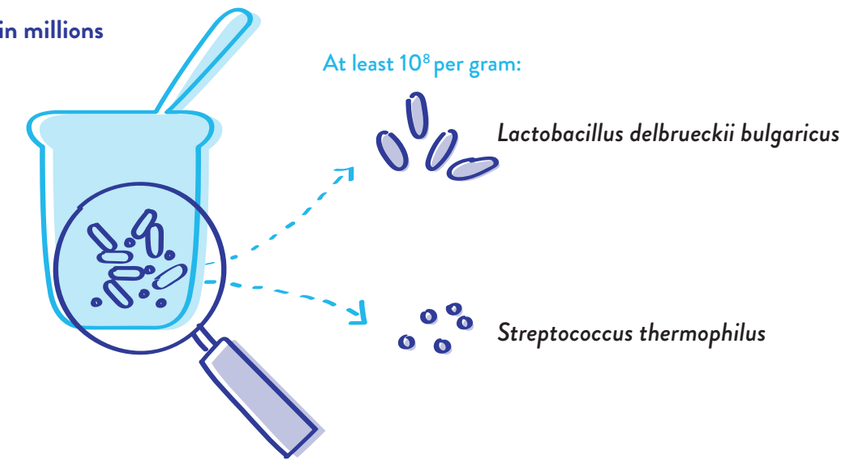
Yogurt may help to protect the intestinal barrier

Animal studies have suggested that a peptide derived from the milk protein found in yogurt, β-casein, increases the production of mucin, an essential component of the mucus layer that lines and protects the intestine.[90,91]

"Modulation of the gut microbiota through yogurt consumption may prove to help in treating and preventing irritable bowel syndrome, infectious diarrhoea, and allergy gastroenteritis. Studies are needed to explore these potential benefits."

- Professor Olivier Goulet

Figure 1. Yogurt can contain millions of live bacteria[3]



"Yogurt is an important part of nutrition and dietary guidelines as it offers both a great nutrient density and also live bacteria to contribute to gut health."

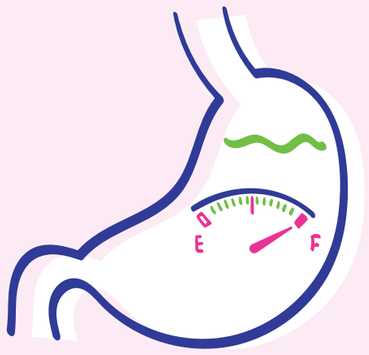
- Professor Seppo Salminen

Yogurt may protect against gastrointestinal disease

Research suggests that yogurt might play a role in the prevention and treatment of gastrointestinal disorders.

- For children with mild to moderate persistent diarrhoea, a yogurt-based diet may be recommended as it has been shown to reduce stool output and the duration of diarrhoea.[78]
- Modulation of the gut microbiota by yogurt, particularly yogurt containing *Lactobacillus* and *Bifidobacterium*, might be of value in the prevention or treatment of gastrointestinal diseases such as irritable bowel syndrome, infectious diarrhoea and allergy gastroenteritis.[52,79,92]
- Yogurt is frequently used in many countries for the nutritional management of acute gastroenteritis, although data on this approach are limited and large randomised controlled trials are needed to provide evidence to support it.[93]

Yogurt can enhance satiety and may help to manage energy intake



Consuming yogurt can increase satiety – the feeling of being full – which in turn may help reduce energy/food intake.[94-97]

Yogurt consumption reduces the feeling of hunger more than other dairy products

Greater appetite suppression is seen with yogurt than other dairy products:

- Hunger was 8% lower when participants consumed yogurt as a mid-morning snack than when they ate a portion of cheese matched for energy content and volume.[94]
- In one study, hunger was 10% lower after a yogurt snack than after a matched serving of milk and 8% lower compared with a matched portion of cheese.[94]
- In another study, appetite and subsequent energy intake were reduced most after yogurt and cheese **(Figure 1)**, but only yogurt reduced appetite more than milk in young adults (aged 20–30 years).[98]
- In a study of children (aged 9–14 years), Greek yogurt and cheese snacks reduced average appetite compared with a low-fat milk snack.[99]
- However, similar appetite suppression and subsequent food intake were obtained after consumption of Greek yogurt or a cultured coconut-based product for breakfast.[100]

Low-fat yogurts increase feelings of fullness more than fruit-based drinks

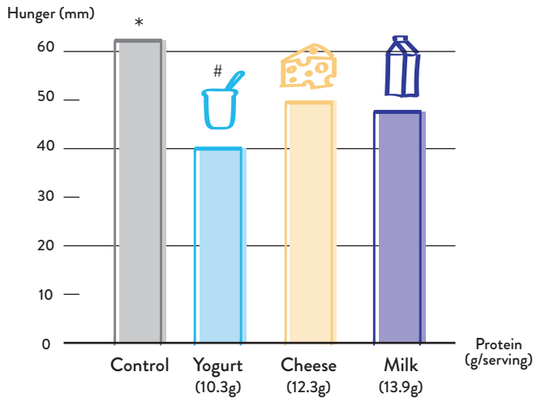
Higher satiety ratings were seen following consumption of low-fat yogurts in a study comparing them with fruit drinks containing the same amounts of calories.[95]

"Yogurt is a high protein, low energy density food associated with greater appetite suppression than other dairy foods. This may help to regulate energy intake when it is eaten as a snack."

- Dr Anestis Dougkas

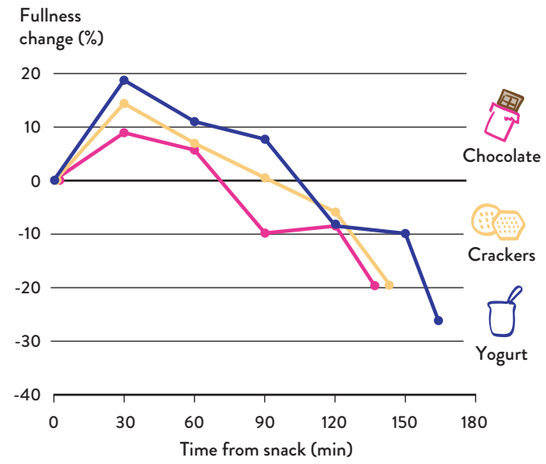
Yogurt containing peach – whether eaten with a spoon or in drinkable form – was more satiating than a peach-flavoured dairy drink and a peach juice drink: both the yogurts were associated with less hunger and higher fullness ratings.[95]

Figure 1. Hunger rating 45 minutes after dairy snacks



*Significantly different from the other snacks tested; #Significantly different from milk and cheese. Protein content is for the following serving sizes: 410 g of milk, 278 g of yogurt + water to complete the volume, 49 g of cheese + water to complete the volume. Hunger was measured using subjective visual analogue scale. Adapted with permission from Dougkas A, et al. Br J Nutr. 2012;108:2274–85.[94]

Figure 2. Fullness after snack consumption until dinner request



Perceived fullness was assessed from time of eating a snack until requesting dinner in 20 healthy women. Adapted from Ortinau LC, et al. Nutr J. 2014;13:97 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[97]

How might yogurt exert its satiating effect?

Several factors may account for the satiating properties of yogurt, including nutrient content and effects on appetite-regulating hormones.

- The high protein content of yogurt could partly account for the higher satiety effect of yogurt seen in these findings.[96]
- Protein 'preloading' – in which small amounts of protein are eaten at a set time before a meal – enhances satiety and reduces appetite by slowing stomach emptying and direct communication with the brain's appetite-regulation centre.[101]
- Other factors that may influence the satiating effects of yogurt include its energy density, the way it is consumed (with a spoon or drunk), and its rate of passage through the digestive tract. The potential effects of fermentation may also play a role.[94]
- Yogurt may influence appetite-regulating hormone release in the gut.[98]
- Yogurt consumed before a meal stimulates metabolic responses leading to reduced pre-meal appetite, later food intake, and post-meal glycaemia.[98]

High-protein yogurt could be a healthy replacement for high energy-dense snacks

Consuming yogurt as a high-protein, less energy dense snack instead of high-fat snack foods may improve appetite control and satiety and reduce subsequent energy intake.

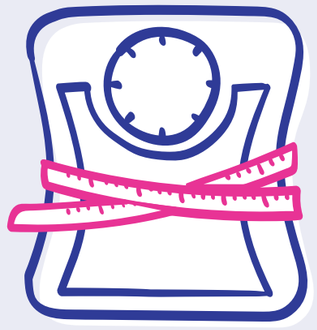
- Women participating in a study were less hungry after consuming a mid-afternoon snack of high protein yogurt than after consuming high-fat crackers or chocolate matched for energy content **(Figure 2)**.[97]
- Despite having the same energy content as the high-fat snacks, yogurt delayed the participants' desire to eat the next meal by around 30 minutes.[97]
- Moreover, the women consumed around 100 fewer calories in a subsequent meal after consuming yogurt than after eating crackers or chocolate.[97]

Among healthy young men, a yogurt drink taken as a mid-afternoon snack induced a greater feeling of fullness in the hour before a meal than a chocolate bar of the same energy content.[96]

"Yogurt, thanks to the presence of high-quality amino acid pattern, promotes satiety and reduces energy intake.[102] Increased acidity during fermentation positively affects calcium absorption; increased calcium bioavailability plays an important role, especially in low-calcium consumers, in the control of blood glucose and energy metabolism."

- Professor Michele Sculati

Eating yogurt is associated with healthy weight management



Yogurt consumption is associated with reduced body mass index (BMI), reduced body weight or weight gain, thinner waist and reduced body fat.[52,103-106]

Yogurt is linked to reduced risk of overweight and obesity and smaller waist circumference

▶ Adults

Yogurt may be classified as a protective food against long-term weight gain,[107] as demonstrated in numerous studies:

- A recent meta-analysis including 32,330 individuals (11,947 overweight/obesity cases) across five studies conducted in the USA, Spain and Korea found a 13% reduction in risk of overweight/obesity for every 50 g (~2 ounce) increase in daily yogurt consumption.[106]

- Eating more yogurt was associated with less weight gain per 4-year period among 120,877 healthy non-obese adults in the USA followed for 12–20 years. For each additional serving of yogurt per day there were 372 g (~13 ounces) less weight gain over 4 years **(Figure 1)**.[108]

- In the USA Framingham Heart Study Offspring Cohort, predominantly overweight people who ate three or more servings of yogurt per week gained about 55% less weight over a year than those who ate less than one serving per week.[109] When it came to waist size, high-yogurt consumers gained 20% less circumference than low-yogurt consumers.

- Data from the USA NHANES (1999–2014) study revealed a reduced prevalence of obesity in adults associated with consumption of yogurt or a probiotic supplement.[110]

- A large Spanish cohort study in non-overweight adults found that people who ate seven or more servings of yogurt per week had a 20% lower risk of overweight or obesity after 6 years when compared with low-yogurt consumers (up to two servings per week).[111,112]

- In a Canadian study, yogurt consumption was associated with lower body weight, waist-to-hip ratio and waist circumference, and tended to be associated with a lower BMI when compared with no yogurt consumption – benefits which were sustained over 6 years of follow up.[27,113]

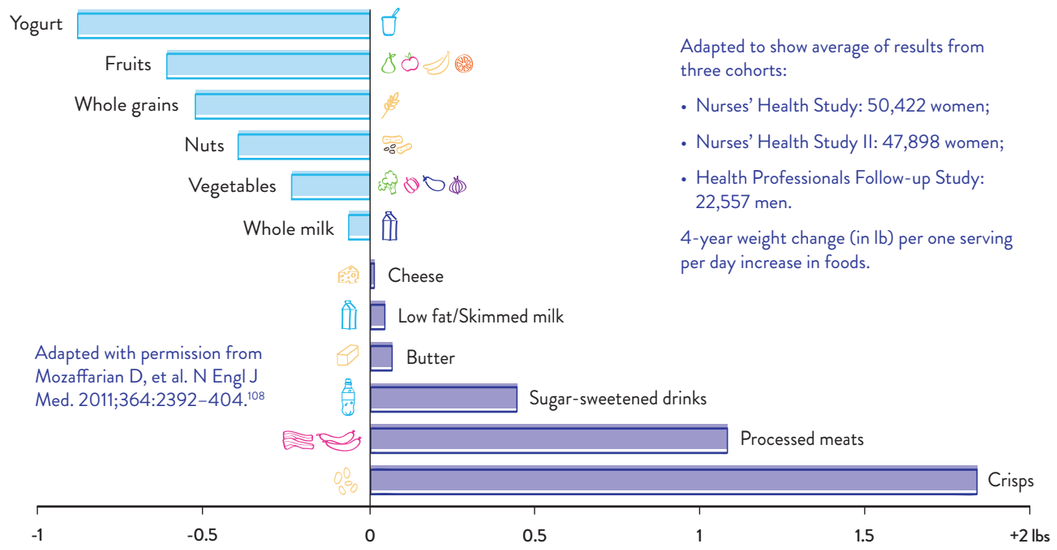
- In a UK study, increasing consumption of fermented dairy products (low-fat yogurt or cheese) was associated with a smaller increase in body weight among 15,612 adults followed for 3.7 years.[114]

- Higher consumption of low-fat yogurt (>3 servings/week) was associated with less visceral and intermuscular fat and smaller waist circumference among women.[115]

"Increasing yogurt consumption is proportionally associated with lower body weight and reduced weight gain over several years. Daily yogurt consumption is also linked to other indicators of healthy body composition including lower body fat and smaller waist circumference, both in adults and in children."

- Professor Barbara Rolls

Figure 1. Weight change associated with increased consumption of yogurt or other foods



▶ Children

Results from the USA NHANES (2005–2008) study of children aged 8–18 years and the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study showed that yogurt consumption was associated with less body fat compared with non-consumption.[7,116] Among overweight or obese adolescent girls, increased dairy consumption (4 servings/day of milk, low-fat yogurt, cheese) was associated with improved body composition in the absence of weight loss.[117]

Yogurt may support body weight reduction when dieting

- Some evidence exists to suggest that including yogurt in an energy-controlled diet leads to greater weight loss.[118,119]

- A 3-month trial in 34 obese people found that those who included three servings of fat-free yogurt daily as part of an energy-restricted diet lost 22% more body weight and 61% more body fat than those not eating yogurt.[120]

- Consumption of yogurt fortified with calcium, protein and probiotics within a low energy diet *versus* a low energy diet without yogurt or with plain yogurt led to greater improvement in BMI, waist circumference, body fat percentage and reduction in body fat mass among obese people over 8–10 weeks.[121,122]

How might yogurt influence body weight and body fat?

Several theories have been put forward.

- Yogurt consumption increases the feeling of fullness and decreases the feeling of hunger (see pp. 20-21).

- Yogurt consumers tend to choose healthy diets and healthier lifestyles compared with non-consumers (see pp. 12-13).

- Live bacteria in yogurt may beneficially alter the gut microbiota and influence weight, although the mechanism for this is as yet unclear.[8,119,123]

- Calcium in yogurt may affect body fat by reducing its absorption from the intestine,[124] increasing breakdown of fats,[125] and causing less fat to be stored in fat cells.[125,126]

- Yogurt naturally contains B vitamins and fortification of yogurt with complementary B vitamins may contribute to body weight management through modification of energy-yielding metabolism;[125] this has been shown to aid weight loss among overweight and obese people.[127]

- Obesity is accompanied by chronic, low-grade inflammation in various tissues.[128] A Brazilian population-based study suggested that increasing yogurt consumption may protect against inflammation.[129]

Yogurt consumption is associated with reduced risk of Type 2 diabetes and metabolic syndrome

Multiple meta-analyses have reported a consistent association between yogurt consumption and reduced risk of Type 2 diabetes (T2D) **(Figure 1)**.[130-133]

The association between yogurt consumption and reduced risk of T2D is seen across populations and age groups

▶ Adults

- The inverse association between yogurt consumption and T2D risk has been shown in populations in North America,[131] across Europe[134-136] the UK, Australia and Japan.[106]
- A recent meta-analysis of 14 studies from the USA, UK, Netherlands, Spain, Australia and Japan that included 483,090 individuals (32,896 T2D cases) found a 7% reduction in risk of T2D for every 50 g (~2 ounce) increase in daily yogurt consumption.[106]
- Analysis of dietary habits of 192,352 adults in the USA included in three large prospective cohort studies showed that increasing yogurt consumption by >0.5 servings/day was associated with an 11% lower T2D risk over 4 years.[137,138]
- Chen et al. reported that frequent yogurt intake was consistently and inversely associated with T2D risk in young, middle-aged and elderly adults.[131]
- A study of young Canadian people of mean age 20 years concluded that eating yogurt may protect against insulin resistance among those at risk of obesity, independent of lifestyle factors.[139]

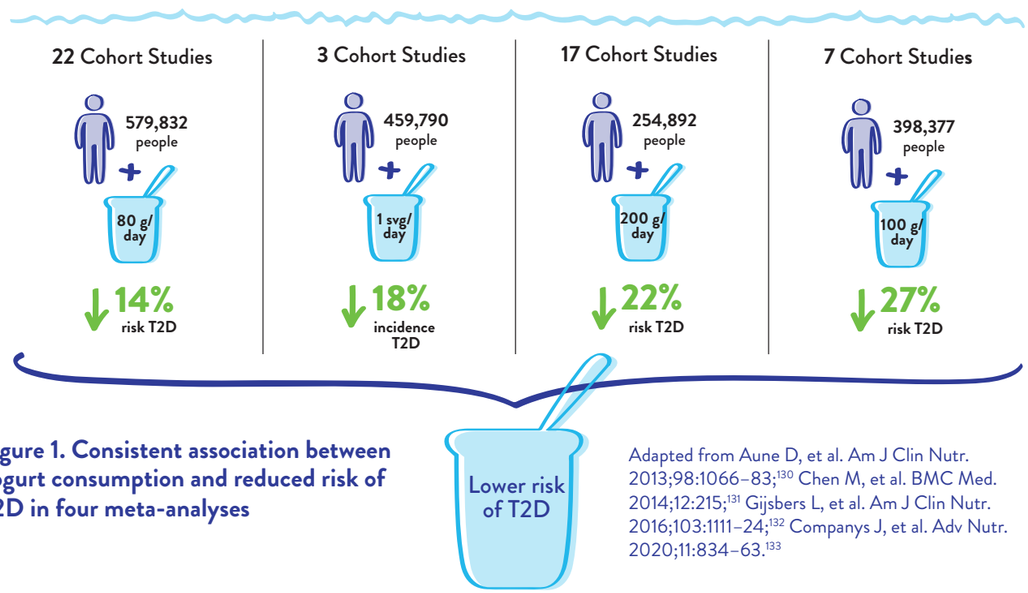


Figure 1. Consistent association between yogurt consumption and reduced risk of T2D in four meta-analyses

Adapted from Aune D, et al. Am J Clin Nutr. 2013;98:1066–83;[130] Chen M, et al. BMC Med. 2014;12:215;[131] Gijsbers L, et al. Am J Clin Nutr. 2016;103:1111–24;[132] Companys J, et al. Adv Nutr. 2020;11:834–63.[133]

▶ Children

- Among children and teenagers aged 2–18 years in the USA, those who ate at least one serving of yogurt per week had a healthier insulin profile, suggesting a reduced risk for T2D, compared with those who ate yogurt less frequently.[41]
- Yogurt eaten by children as a snack has been associated with benefits to metabolic regulation compared with a carbohydrate snack, particularly for blood glucose regulation and insulin response.[140]

Yogurt is associated with reduced risk of pre-diabetes

Studies among large Dutch population cohorts have identified a lower risk of pre-diabetes with increased consumption of fermented dairy products and specifically yogurt.[35,141,142]

- Higher intake of high-fat yogurt was associated with reduced pre-diabetes and insulin resistance risk over 11 years of follow up.[35]

The association with T2D may be specific to the type of dairy product

- Analysis of three large prospective cohort studies involving 192,352 people over 4 years found that replacing dairy products that have a high-fat content, such as cheese, with lower fat dairy, such as yogurt or reduced-fat milk, was associated with a lower risk of T2D.[137]
- A Danish study showed that yogurt eaten in place of low- or whole-fat milk was associated with a lower rate of T2D during a median follow-up of 15.3 years in people aged 50–64 years at baseline (11–17% reduction per serving per day substituted).[143]

Replacing carbohydrate-based snacks with yogurt is also associated with reduced risk of T2D

- In an elderly Spanish population at high cardiovascular risk followed up for a median of 4.1 years, replacing one serving per day of carbohydrate-based snacks with a daily serving of yogurt was associated with a reduced risk of T2D.[134]
- Similarly, a UK study found that substituting yogurt in place of potato-based snacks was associated with a 47% reduced risk of T2D in people aged 40–79 years who were followed up for 11 years.[135]

"Strong evidence shows that regular yogurt consumption is associated with reduced risk of Type 2 diabetes, prevention of metabolic syndrome and improved cardiovascular risk profile in the general population."

- Professor André Marette

Yogurt may reduce the risk of metabolic syndrome

Several studies report a beneficial effect associated with yogurt consumption on prevention of metabolic syndrome (MetS) and improved cardiometabolic risk profile in the general population.[52,88,125] In a meta-analysis of prospective cohort studies, yogurt intake was associated with a 20% reduction in risk of MetS development.[133]

How might yogurt reduce T2D risk?

Several mechanisms may explain the association between yogurt consumption and reduced T2D risk.

- People who eat yogurt are less likely than those who don't eat yogurt to have unhealthy lifestyles that are linked to increased risk of T2D.[43,144]
- Yogurt is a low glycaemic index food, suggesting that it does not cause a spike in blood glucose levels after a meal.[145]
- Yogurt consumers have lower plasma insulin and C-peptide concentrations in response to oral glucose, and exhibit a better metabolic profile compared with non-consumers.[113]
- Live bacteria in yogurt can improve the composition of the gut microbiota and this may help reduce inflammation, which is linked to T2D.[82,88,146]
- The risk of T2D has been shown to decrease by 7% for each 10 µg increase in dietary vitamin K2. Whole-fat yogurt contains up to 28 µg of vitamin K2 per 100 g (~4 ounce) serving.[148]

Increased yogurt consumption might reduce healthcare costs

Researchers analysing UK data have predicted that if the adult population increased the amount of yogurt they ate by one serving per day, they could generate savings to the National Health Service of £140 million over 5 years through reductions in the incidence of T2D.[149]

Eating yogurt is associated with reduced risk of cardiovascular disease

Dairy products such as yogurt have consistently been linked with either neutral or beneficial effects on risk of cardiovascular disease (CVD), a finding highlighted by multiple literature reviews and a meta-analysis.[52,150-153]

Yogurt may reduce the risk of high blood pressure

Among adults included in the USA NHANES (1999–2014) survey, the prevalence of hypertension was 20% lower for those that consumed yogurt, compared with non-consumers, and blood pressure levels were significantly lower.[110]

Another study of adults in the USA found that greater intakes of dairy, low-fat/fat-free dairy, low-fat/skimmed milk and yogurt were associated with a lower risk of developing high blood pressure per year.[154]

Eating one extra serving of yogurt per week was related to a 6% lower risk of developing high blood pressure.[154]

Yogurt may reduce risk of CVD

Yogurt consumption is associated with lower CVD risk:

- A meta-analysis of 10 cohort studies from the USA, Sweden, The Netherlands, Finland, Australia and the UK, including 385,122 participants found a 17% decreased risk of CVD with fermented dairy food intake. Sub-group analysis found that yogurt consumption was associated with a 22% fall in CVD risk.[155]
- A study of 7,679 Australian women found that high yogurt intake (>70 g or ~2 ounces/day) was associated with 16% lower CVD risk over 15 years compared with no intake.[156]
- Among a Greek population (N=3042), a 20–30% lower CVD risk over 10 years was found per 200 g or ~7 ounces/day yogurt consumption, with the greater effect seen in women.[157]
- A French study of 104,805 adults from the NutriNet-Santé cohort (2009–2019) found no association between overall dairy intake and CVD risk over 5 years but did find that eating at least 160 g or ~6 ounces/day of fermented dairy (yogurt and cheese) was associated with 19% lower risk of cerebrovascular disease compared with intakes of less than 57 g/day (~2 ounces/day).[158]

▶ In people with high blood pressure:

- Consuming two or more servings of yogurt per week, especially when part of a healthy diet, was associated with a reduced risk of heart attack or stroke compared with eating less than one serving per month.[159]
- Among those eating two or more servings of yogurt per week, women had a 17% lower CVD risk and men had a 21% lower risk compared with those who ate less than one serving per month.[159]

▶ Children and teenagers could benefit too

- In European adolescents, consumption of milk and yogurt was inversely associated with being overweight and positively associated with cardiorespiratory fitness.[116,160]
- Dairy consumption was inversely associated with CVD risk score in European girls aged 12.5–17.5 years.[160]

Yogurt may reduce mortality risk

Yogurt consumption is associated with reduced risk of all-cause and CVD mortality across population-based studies.[161] A meta-analysis of 17 cohort studies of 896,871 participants, with 75,791 deaths, found:[161]

- the highest intake of yogurt was associated with a 7% lower risk of death from all causes and 11% lower risk of death from CVD than the lowest intake;
- each additional serving of yogurt per day (244 g or ~8 ounces) was associated with a 7% reduced risk of all-cause mortality and 14% reduced risk of CVD mortality.

While the association between yogurt consumption and all-cause mortality has met with mixed results from large cohort studies in the past,[152,162] more recent studies show an association with reduced risk of mortality.

- A meta-analysis of 235,676 participants in eight cohort studies found that yogurt intake of at least 200 g/day (~7 ounces/day) was associated with 12% lower all-cause mortality and 13% lower risk of CVD mortality compared with lower yogurt intake.[163]
- In the Prospective Urban Rural Epidemiology (PURE) study (2003–2018) of 136,384 people aged 35–70 years from 21 countries in five continents, higher intake of yogurt (>1 serving/day) was associated with a 14% lower risk of death or major cardiovascular event, 17% lower risk of total mortality and 10% lower risk of major CVD compared with no intake.[164]
- A large population survey of adults (N=32,625) in the USA NHANES (1999–2014) study found a 17% reduced risk for all-cause mortality with yogurt intake over 8 years. The health benefits of yogurt were more pronounced among women, people aged ≥60 years, and non-Hispanic Black people.[165]
- A Japanese population study (N=14,264) showed a 28–30% reduction in mortality over 9 years with increasing yogurt intake among people aged 40–74 years **(Figure 1)**.[166]

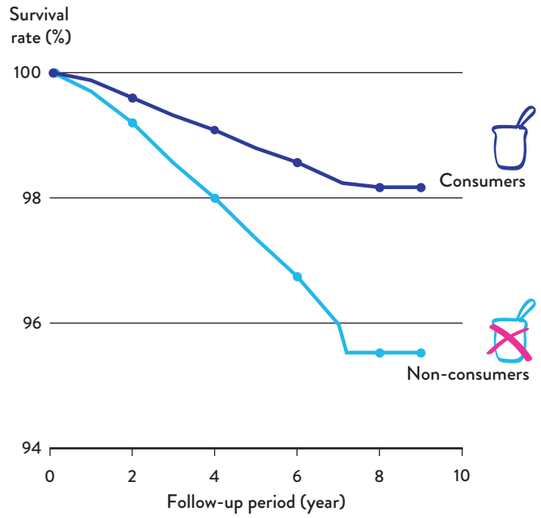
How might yogurt reduce CVD risk?

Blood pressure modulation following the consumption of yogurt may be linked to an association with improved lipid profiles,[167] reduced BMI, or the ability to produce anti-hypertensive peptides that inhibit angiotensin-converting enzyme, which plays a crucial role in blood pressure regulation.[20,110]

The association between yogurt consumption and reduced risk of CVD may be due to the protective properties of some components.[151-153]

- Yogurt and other dairy products are rich in micronutrients and proteins, some of which have been shown to lower blood pressure.[151,154]
- Low-grade inflammation underlies the pathology of CVD, and some saturated fatty acids found in dairy products (e.g., lauric acid) may have anti-inflammatory effects.[153]
- Calcium, potassium and magnesium found in yogurt have been linked to a reduced risk of stroke.[152]
- The dairy matrix may contribute to the beneficial effects of yogurt and other dairy products and determine the fat bioavailability.[151]
- Fermented milk products such as probiotic-containing yogurts have a high antioxidant potential,[79] and could play a part in healthy and active ageing.[53]

Figure 1. Yogurt consumption is associated with improved survival rate



Survival rate shows the association between yogurt intake and total mortality, defined as death from any cause over a 9-year follow-up period, in 14,264 Japanese subjects aged 40–74 years. Adapted from Nakanishi A, et al. BMC Nutrition. 2021;7:33 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[166]

"Yogurt consumption is associated with reduced risk of cardiovascular disease – and large population-based studies reveal a link between yogurt consumption and reduced risk of death from cardiovascular and all causes."

- Professor Luis Moreno

Yogurt consumption is associated with a reduced risk of childhood eczema and allergies

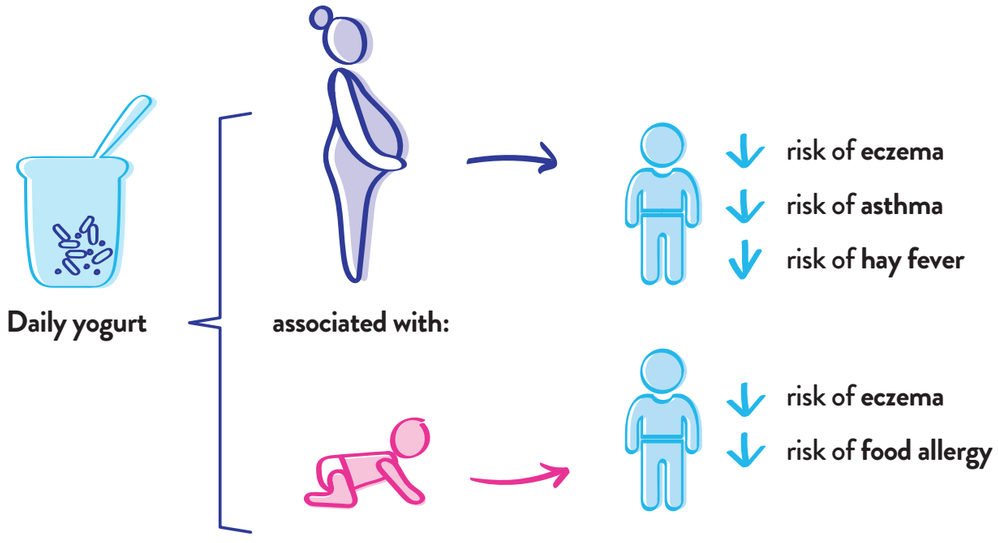
Eating yogurt during pregnancy or infancy is associated with changes to the immune system that may help protect against childhood eczema and food or respiratory allergies **(Figure 1)**.[92,168-173]

Infants whose mothers eat yogurt during pregnancy have a reduced risk of eczema and respiratory allergies

Eating yogurt frequently during pregnancy is associated with a reduced risk of offspring developing eczema and respiratory allergies during infancy, according to evidence from observational studies:[168-170]

- A study from Japan showed that infants had a reduced risk of eczema and asthma at the age of 2 years if their mothers consumed dairy products including milk, yogurt, and cheese, during pregnancy.[168]
- In a Turkish study, eating yogurt daily during pregnancy was associated with a 78% lower risk of infants developing eczema by the age of 2 years, compared with eating yogurt less frequently.[169]
- In the USA, a study showed that eating yogurt daily during pregnancy was associated with a lower risk of infants developing eczema, asthma, or hay fever by the age of 4 years, compared with eating yogurt less frequently.[170]

Figure 1. Association between regular yogurt consumption and risk of childhood eczema and allergies



"Growing evidence suggests that infants who regularly eat yogurt, or whose mothers frequently ate yogurt while pregnant, have a reduced risk of developing childhood eczema and allergies. This may be due in part to the allergy-protective effects of the bacteria commonly found in fermented dairy foods."

- Professor Sharon Donovan

Infants who regularly eat yogurt have a reduced risk of childhood eczema and food allergies

Introducing yogurt to infants during their first year of life is associated with a reduced risk of developing eczema and food allergies later in life, according to evidence from observational studies:[92,171-173]

- In a Japanese study, eating yogurt before the age of 12 months was associated with a 30% lower risk of developing eczema and a 47% lower risk of developing food sensitivity by the age of 5 years, compared with eating no yogurt.[171]
- In a European study, introducing yogurt before the age of 12 months was associated with a 59% lower risk of developing eczema by the age of 4 years, compared with no introduction.[172]
- A further New Zealand study involved infants predisposed to allergy as their parents had a history of allergy. It found that introducing yogurt in the first year of life was associated with significant reductions in eczema and food allergy at 12 months old.[173]

The risk of developing eczema and food allergies also appears to be associated with frequency of yogurt consumption during infancy:[171,173]

- In one study, infants who ate yogurt daily had a lower risk of developing both eczema and food sensitivity than those who ate yogurt less frequently.[171]
- In another study, infants who ate yogurt daily or 2–6 times a week were significantly less likely to develop eczema than those who ate yogurt less than once a month.[173]

The possible allergy-protective effects of yogurt may be due to the strains of bacteria it contains

- A comparison of foods introduced in the first year of life found the protective effect against developing eczema associated with yogurt was greater than that associated with other dairy products.[172]
- A series of randomised controlled trials showed that a *Lactobacillus rhamnosus* probiotic supplement, given daily to infants from birth for 2 years, was associated with protection against eczema and food allergy assessed up to 11 years old.[173,174]
- Another interventional study found that eating yogurt containing added *Lactococcus lactis* probiotic strains daily for 8 weeks reduced the severity of existing eczema in children aged 2–15 years.[175]
- A large observational study found that consumption of milk containing added *Lactobacillus* and *Bifidobacterium* probiotic strains by mothers during pregnancy and their infants was associated with a reduced risk of eczema at 18 months of age.[176]

Protection against allergies may be achieved through the gut microbiome

Experts suggest that consumption of fermented dairy products during pregnancy or early infancy may protect against allergies in early childhood by increasing infant gut microbiome diversity and function; this helps to supress allergic responses:[169,170]

- Maternal diet may affect the infant microbiome and allergy outcomes either directly or indirectly via the maternal microbiome.[170]
- Research has reported that higher yogurt intake can increase the diversity of the gut microbiome in children and adults, and this can influence the development of the immune system to protect against allerigies.[170]

Eating yogurt may help protect against tooth decay and gum disease

Research suggests that eating yogurt can modify the mouth's microbiome and is associated with improved oral health, helping to protect against tooth decay and gum disease – the main causes of tooth loss.

Regular yogurt consumption may reduce the risk of tooth decay and inflammatory gum disease

- Adults who eat yogurt every day have a lower risk of tooth loss resulting from gum disease, compared with those who don't eat any yogurt.[177]
- Eating yogurt daily has also been associated with a reduced risk of tooth decay among children and teenagers, compared with not eating yogurt.[178]

Several studies have shown that daily consumption of dairy products, including yogurt, is associated with improved oral health compared with less frequent consumption:[179-181]

- One study showed that adults who ate or drank more than six servings of dairy food (including milk and yogurt) per week had a 24% lower prevalence of gum disease than those who didn't consume any dairy food. This difference was reduced to just 9% for infrequent consumption of dairy food (one serving per week or less).[179]
- Authors of one study recommended daily consumption of yogurt to improve oral health after they found that adults who ate yogurt daily were 76% less likely to have gum disease than those who ate yogurt less than once a week.[180]
- Another study reported greater oral health improvements in children who drank *Lactobacillus* probiotic milk every day, compared with three times a week – these benefits remained for at least 6 months after discontinuation.[181]

Dairy products have several protective effects against tooth decay

According to evidence from both interventional and observational studies, consuming dairy products may be associated with a reduced risk of tooth decay due to several different protective effects:[182,183]

- Lactose in milk has lower potential for causing tooth decay than other dietary sugars as it is not fermented to acidic products in the mouth.[182,183]
- Calcium and phosphate in milk help prevent the decay of tooth enamel and may even support remineralisation of tooth enamel.[182]
- The proteins and fats in milk may also reduce the ability of plaque to stick to tooth enamel and produce acids.[182]

It is likely that the protective potential of plain unsweetened yogurt is similar to that of milk.[182]

The probiotic content of some yogurts may add to their oral health benefits

Several randomised controlled trials have demonstrated that yogurts containing added *Bifidobacterium* or *Lactobacillus* probiotic cultures are effective antibacterial agents against plaque-causing *Streptococcus mutans* bacteria **(Figure 1)**:[184-187]

"Eating yogurt every day may contribute to improved oral health by modifying the mouth's microbiome, reducing the risk of developing tooth decay and gum disease in both adults and children."

- Professor Sharon Donovan

- Such probiotic yogurts were shown to reduce levels of *Streptococcus mutans* bacteria in the saliva and dental plaque of both adults and children.[184-187]
- In one study, probiotic yogurt also increased salivary pH, reducing the acidity of saliva by diminishing the acid production ability of *Streptococcus mutans*.[184]
- Laboratory cultures have also shown that *Lactobacillus* probiotic yogurt can inhibit the growth and adhesion of *Streptococcus mutans* bacteria.[188]

Randomised controlled trials have shown that eating yogurt containing added *Bifidobacterium* or *Lactobacillus* probiotic cultures is associated with reductions in several markers of gum inflammation **(Figure 1)**:[189-191]

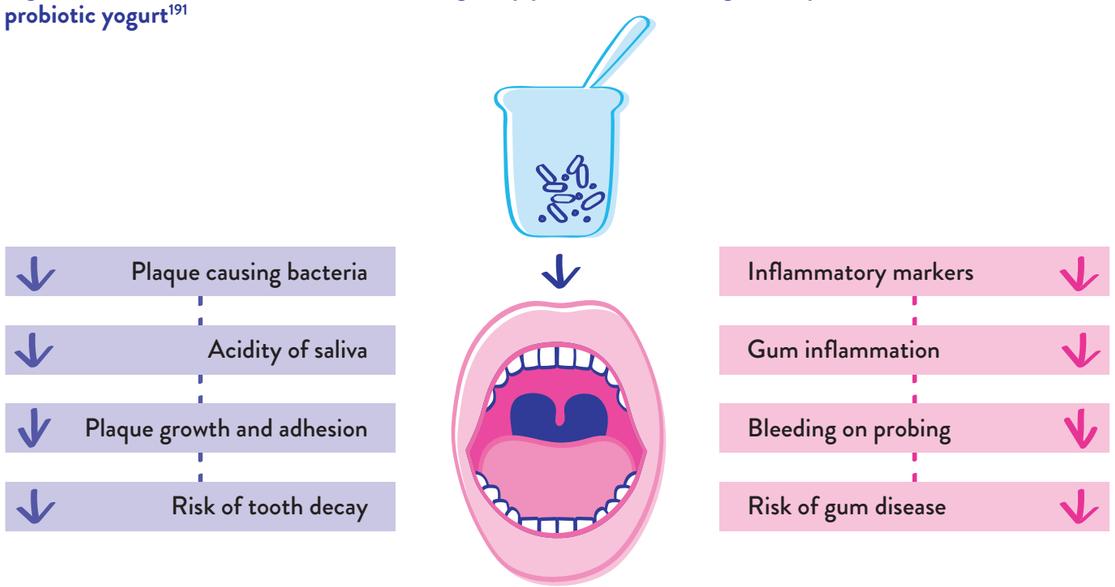
- People who ate probiotic-containing yogurts experienced greater reductions in plaque formation, gum inflammation, probing depth, bleeding on probing, and inflammatory fluids or markers, compared with those who ate non-probiotic-containing yogurt.[189,190]

These oral health benefits may be achieved through modifying the oral microbiome

Studies in adults and children suggest that consumption of dairy products containing added probiotics, including yogurt containing added *Bifidobacterium* or *Lactobacillus* probiotic strains, may help prevent tooth decay through modification of the oral microbiome.[192]

- Evidence suggests that these benefits are achieved due to the ability of the live bacteria in probiotic-containing dairy products to modify the composition of the mouth's microbiome, and so reduce the decay-causing bacteria that can lead to oral disease.[177,191-194]
- The characteristics of individual dairy products may also have an important role – the lactic acid bacteria starter cultures used to make fermented dairy products, such as yogurt, may also help to reduce tooth decay-causing bacteria.[191,194]

Figure 1. Benefits to oral health of consuming dairy products containing added probiotics, such as probiotic yogurt[191]



Yogurt can be a part of sustainable diets and food systems

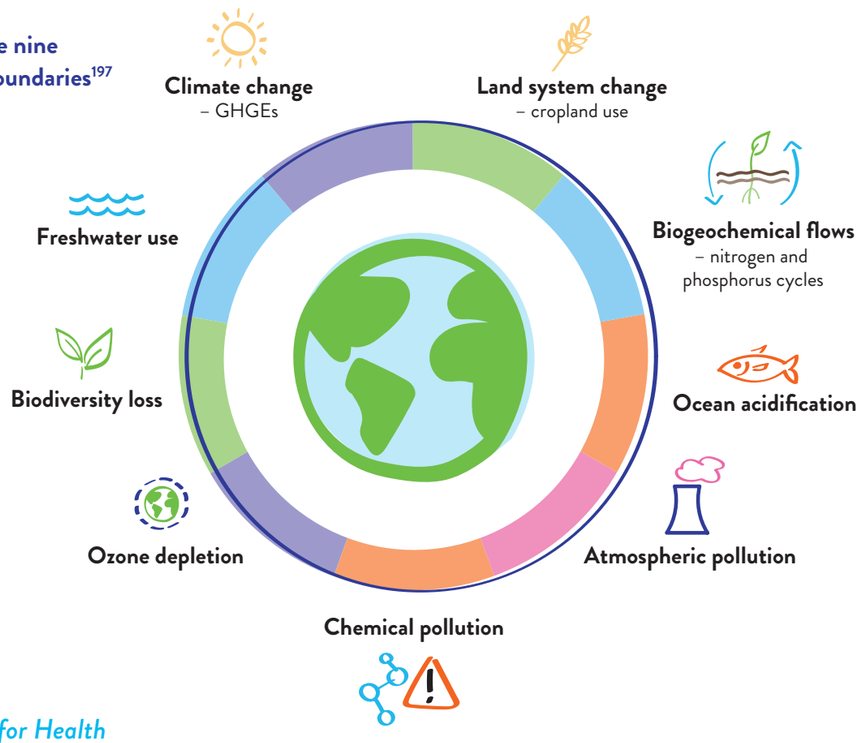
Sustainable diets aim to balance planetary and human health; they are defined as nutrient-rich, affordable, accessible, and culturally acceptable, as well as having a relatively low environmental impact.[195]

To ensure a diet is sustainable, the entire food system – including production, processing, distribution, consumption, and disposal – must be considered.[195] Within this context, scientific models show that dairy products, including yogurt, may have a role to play in sustainable diets and food systems.[46]

The characteristics of food systems should allow human impact to stay within planetary boundaries. These boundaries represent the systems that are crucial for regulating and maintaining the stability of our planet. Together, they define global limits within which humanity should operate to ensure a stable and resilient environment.[196] Local, regional, and global food systems should operate within these planetary boundaries to produce foods that contribute to sustainable diets worldwide **(Figure 1)**.[196]

Today's food systems are one of the biggest reasons why we exceed planetary boundaries, responsible for up to 35% of greenhouse gas emissions (GHGEs), 48% of cropland use, and 70% of freshwater use, with high impacts on forests and loss of biodiversity.[195,196]

Figure 1. The nine planetary boundaries[197]



The 2019 report of the EAT-*Lancet* Commission,[196] along with recent global events such as United Nations (UN) Climate Change Conferences and Food Systems Summits, have all called for a switch to diets that are made up of foods produced through sustainable food systems – which incorporate environmental improvements in food production, processing and distribution and reduced food loss and waste.[195,196]

Sustainable diets must balance health, environmental, social, and economic impacts

However, a sustainable diet is more than just a dietary pattern with a low environmental impact. A sustainable diet represents an acceptable compromise between health, environmental, social, and economic factors, described by the UN's Food and Agriculture Organization (FAO) and the World Health Organization (WHO) **(Figure 2)**:[195]

Scientists have demonstrated that the best balance between these dimensions of a sustainable diet can be achieved by adopting varied, plant-based diets, such as flexitarian, planetarian, or territorial diets:[196,198,199]

- Flexitarian and planetarian diets – designed to be healthy for both people and planet – combine a large number of plant-based foods with low levels of red meat and moderate amounts of poultry, fish, eggs, and dairy.[196,198]
- Territorial diets, such as the Mediterranean diet, are region-specific flexitarian diets composed mainly of seasonal, locally sourced foods.[198,199]

"Dairy foods, including yogurt, play a key role in sustainable flexitarian diets. They provide an affordable source of high-quality protein, are definitely the lowest cost source of calcium and other bone-building nutrients, and have a much lower carbon cost than meat."

- Professor Adam Drewnowski

Dairy products can be part of sustainable diets

Scientists use dietary models to predict how individual food changes will affect the overall nutritional quality and environmental impact of a particular diet. Several diet-modelling studies have found that dairy products can be part of theoretical sustainable diets in adults with a Western-style diet.[200-204] For such adults, the dietary changes that most effectively reduce environmental impact while remaining consistent with dietary guidelines for health are:

1. To eat fewer calories overall
2. To eat less meat especially red and processed meats
3. To introduce pulses, legumes, nuts, and seeds
4. To eat more fruits, vegetables, and wholegrains.[200-204]

Within this framework, maintaining nutrient-dense dairy foods as part of a sustainable diet can help individuals to satisfy their nutritional needs while consuming less meat and more plant-based foods.[200-205] Fortified plant-based dairy-like products may also play a role in sustainable diets alongside dairy products.[206]

- In a diet modelled to reduce dietary carbon footprint by 30% while improving nutritional intakes and staying as close as possible to the diet of French adults, eating fortified plant-based dairy-like products – such as calcium-enriched soya drinks and yogurt-alternatives – alongside traditional dairy products helped to improve diet sustainability, especially in women with low energy intakes.[201]

Recent public health guidance for sustainable diets includes a role for dairy products

The role of dairy products – including yogurt – as part of a plant-based, low-meat flexitarian diet is supported by global, regional, and local recommendations for sustainable diets:[195,196,207-209]

- A moderate dairy intake of around 250 g (~9 ounces) per day that respects nutritional recommendations can form part of a sustainable diet, according to global recommendations published by FAO/WHO and the EAT-*Lancet* Commission.[195,196]
- Modelling studies in regions including France, Nordic countries, and the UK have adapted a global flexitarian diet, including the role of dairy products, to be consistent with local dietary guidelines, cultural considerations, and food systems.[207-209]

Continued ▶

The role of dairy products as part of a flexitarian diet may vary depending on location, due to geographic differences in methods of production, local patterns of consumption, and population-specific nutritional needs.[198,210,211]

Several characteristics of yogurt support its contribution to sustainable diets and food systems

1) Health and nutrition: Yogurt is a nutrient-rich food with health benefits

Eating yogurt daily is an effective way of meeting nutritional requirements with a balanced energy intake – yogurt contains high-quality proteins and essential nutrients including calcium, potassium, magnesium, iron, zinc, and numerous vitamins (see pp.10–11).[7,200,204,205,212]

Yogurt also contains lactic acid bacteria, which have been shown to benefit gut health and digestion.[76] Eating yogurt has been associated with a variety of additional health benefits, including improvements in weight management and reductions in risk of Type 2 diabetes, metabolic syndrome, and cardiovascular disease (see pp. 24–27).[76]

2) Environment: Yogurt has a smaller footprint than some other animal foods

Within the range of animal-based foods, scientists recommend eating less meat – especially beef – to achieve the greatest environmental and health benefits.[213,214] One study found that reducing the consumption of red meat has an environmental benefit around five times greater than reducing the consumption of dairy products, when considering GHGEs, land use, water footprint, and soil pollution.[214]

The environmental footprint of individual foods should be weighed against the nutrient content they provide. Life-cycle assessments show large differences in both nutrient density and environmental impact among foods. In such analyses, yogurt scores above average for nutrient density and slightly below average for climate impact **(Figure 3)**.[215]

▶ Carbon footprint (GHGEs)

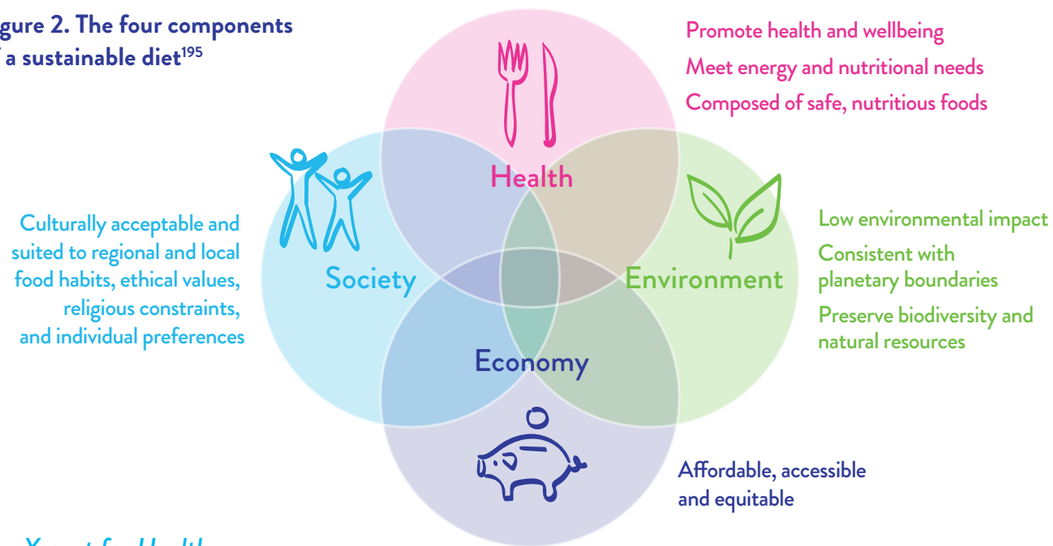
Greenhouse gasses are released at every stage of the food production and consumption cycle – from farming and agricultural practices to packaging, transport and storage in the supermarket and the home, as well as during waste management.[195] Beef and lamb consumption generates around ten times the GHGEs per serving as pork, poultry, and dairy products, which have around ten times the GHGEs of plant-based foods, such as grains, fruits, and vegetables.[216]

- Some studies have found that yogurt compares favourably with many other animal foods in terms of GHGEs for the level of nutrition it provides.[217,218] These studies estimated that yogurt production has a smaller carbon footprint than that of red meat, poultry, and cheese production, similar to that of milk.[217,218]

▶ Water footprint, land use, and biodiversity

Animal-sourced foods generally have a higher impact on land and water use than plant-based foods, with particularly large impacts for the production of red meat.[216] Some studies have found that yogurt production might have a relatively lower impact on biodiversity loss, land use and fresh water use, compared with other animal products such as cheese and meat.[217,218]

Figure 2. The four components of a sustainable diet[195]

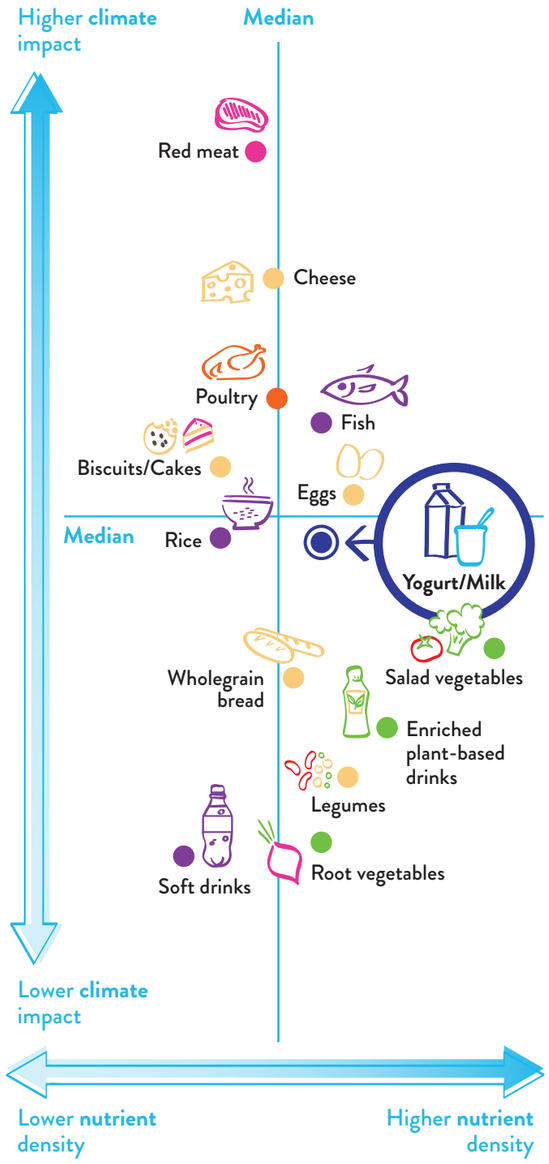


▶ Regenerative dairy farming practices

Scientists estimate that current land and water use for farming is 52–60% above the targets set for limiting biodiversity loss and freshwater withdrawals.[216] Recent improvements in the production and processing of dairy products have helped strengthen their role in sustainable food systems and may help to address this imbalance.[219,220] Regenerative farming practices improve land use and farming techniques to help enhance soil health and biodiversity, reduce water use and food loss, increase carbon storage and reduce GHGEs, reducing the impact of dairy products on the environment.[221]

- Studies show that regenerative dairy farming practices can compensate for up to 28% of GHGEs through soil carbon sequestration.[222] Improvements to livestock management through feeding changes, selective breeding, and manure management can also help to reduce methane emissions from dairy herds by up to 15–20%.[220]

Figure 3. Nutrient density and the climate impact of foods



Adapted from Strid A, et al. Sustainability. 2021;13:3621 under creative commons license CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).[215]

3) Society: Yogurt is part of local cultures in many regions

Dietary choices are often driven by the customs, religion, and culture of specific countries and regions.[46] Fermented dairy products such as yogurt can be found in many geographies worldwide and are already staple foods in many cultures, with different types including:[223,224]

- Amasi and Maas (Africa)
- Dahi and Lassi (Bangladesh, India and Pakistan)
- Chal and Kumia (Central Asia)
- Kefir, Smetana, and Ayran (Europe)
- Labneh, Laban, and Kushk (Middle East)
- Yogurt and Curd (Worldwide)

4) Economy: Yogurt can be affordable and contribute to local economic welfare

Food profiling studies show that yogurt is an affordable source of high-quality proteins and other essential nutrients in many countries and is one of the most affordable sources of calcium.[46] When comparing the costs of different foods per calorie, dairy products including yogurt cost less than meat, poultry, and fish, and are more comparable with the per-calorie cost for beans and eggs.[46]

The affordability of dairy products enables a variety of uses and their incorporation into various dietary patterns and food traditions in different countries and cultures.[46] The production of fermented foods, such as yogurt, is a natural and simple process that provides access to safe and healthy food, creates demand for local produce, and provides employment and income opportunities.[225] Fermentation can also be a good way of producing more sustainable food sources by reducing agricultural and food processing wastage.[226]

Summary of evidence and key conclusions

Scientific statement	Key conclusions	Level of evidence
Yogurt is a nutrient-rich food	Yogurt is a nutrient-dense food containing a wide range of macro- and micro-nutrients	+++
	Eating yogurt daily can help meet nutrient intake requirements in adults and children	+++
Eating yogurt is associated with healthier diet and lifestyle	Regular yogurt consumers of all ages tend to choose healthier diets and more active lifestyles than those who don't regularly eat yogurt	+++
Yogurt consumption is associated with stronger bones and reduced fracture risk	Yogurt consumption is linked to healthy growth of bones during childhood and adolescence	+++
	Eating yogurt is associated with improved bone strength and physical function in older people	+++
Yogurt improves lactose digestion and reduces symptoms of lactose intolerance	Live yogurt cultures can improve lactose digestion and reduce symptoms of intolerance in people with lactose maldigestion	+++
	Health authorities recommend yogurt as part of a healthy balanced diet for people with lactose maldigestion	+++
Yogurt with live cultures may contribute to gut health	Yogurt can deliver millions of live bacteria to the gut and may beneficially alter the gut microbiota	+++
	Yogurt may benefit gut health, protecting the intestinal barrier and may prevent a range of gastrointestinal disorders	++
Yogurt can enhance satiety and may help to manage energy intake	Eating yogurt reduces the feeling of hunger, which may help to regulate energy intake	++
Eating yogurt is associated with healthy weight management	Yogurt consumption is associated with a reduced risk of being overweight and obese	++
	Eating yogurt may support body weight reduction in people who are dieting	++
Yogurt consumption is associated with reduced risk of Type 2 diabetes and metabolic syndrome	Regular yogurt consumption is associated with a reduced risk of T2D across different populations and age groups	+++
	Eating yogurt may help to prevent metabolic syndrome and improve cardiometabolic risk	++
Eating yogurt is associated with reduced risk of cardiovascular disease	Yogurt consumption is associated with beneficial effects on cardiovascular health	++
	Eating yogurt is associated with a reduced risk of death from cardiovascular disease and all causes	+
Yogurt consumption is associated with a reduced risk of childhood eczema and allergies	Regular yogurt consumption during infancy is associated with reduced risk of childhood eczema and food allergies	+
	Eating yogurt during pregnancy may help protect infants against childhood eczema and respiratory allergies	+
Eating yogurt may help protect against tooth decay and gum disease	Eating yogurt is associated with a reduced risk of tooth decay and gum disease in adults and children	+
	Regular yogurt consumption may contribute to improved oral health by modifying the mouth's microbiome	+
Yogurt can be a part of sustainable diets and food systems	Dairy foods including yogurt may play a role in plant-rich, low-meat sustainable diets and food systems	+
	Yogurt can provide an affordable source of essential nutrients with a smaller environmental footprint than many other animal products	+++

Level of evidence: +++ **Established** ++ **Increasing** + **Emerging**

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