Dairy Australia

MILK

A NUTRITIOUS POWERHOUSE IN THE AUSTRALIAN DIET

DELIVERING for DAIRY

MILK AT A GLANCE

Milk is part of a **healthy, sustainable diet** because it is:

- ✓ Affordable
- ✓ Nutritious
- ✓ Part of our culture
- ✓ Contributes to local economies

AUSTRALIA'S MEAN MILK INTAKE

148mL[2]

Milk is a staple in Australian households.

97%

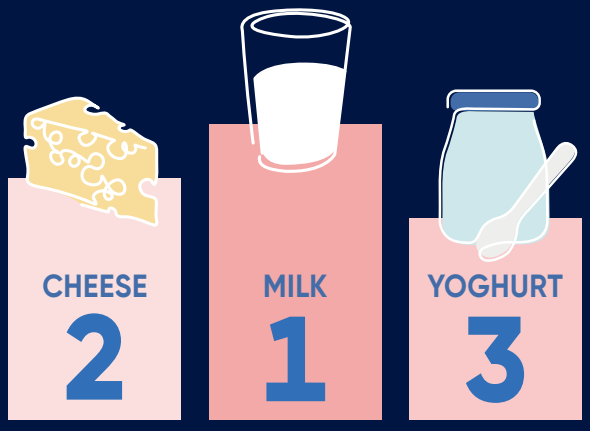
of Australian households purchase milk[1]

Milk has been shown to have **positive health benefits** for **growth and development, bone health, muscle strength, type 2 diabetes, heart health and weight.** Milk can also feature in the diets of those with lactose intolerance.

The Milk Matrix is unique

All types of milk contain essential nutrients such as protein, calcium, magnesium, potassium, phosphorus and zinc, plus vitamins A, B12, riboflavin, niacin and iodine.

Milk is the greatest contributor of calcium in the Australian diet.



Sources of calcium in the Australian Diet

How do Australians consume milk?[3]

68% BEVERAGES

26% IN BREAKFAST CEREALS

23% COMBINED WITH OTHER INGREDIENTS AS PART OF A BEVERAGE

18% CONSUMED ALONE

14% IN CAFE STYLE COFFEE

WHY MILK?

Milk^ is an affordable, convenient, widely consumed food, containing a unique package of nutrients housed within a complex liquid structure. It plays a key role in healthy eating patterns across all life stages and is a key part of many food-based dietary guidelines around the world[4, 5]. The 2013 Australian Dietary Guidelines recommend milk as a Five Food Group food[6]; this is for good reason as consumption is associated with reduced risk of heart disease, stroke, hypertension, type 2 diabetes, metabolic syndrome and colorectal cancer.[7]

A few decades ago, the word 'milk' had a similar meaning for most people. It was a trusted and unquestioned in the Australian diet, with everyone generally consuming the same variety: cow's milk. The last decade has seen an increasing number of beverages marketed as 'milk alternatives', with consumers believing these products are just as nutritious as milk[8]. Consumer attitudes to milk have become more diverse. Concerns around environmental impact and dairy's essentiality in the diet means many are now considering reducing milk consumption[9], with some countries having reduced dairy serves from national dietary guidelines.[10]

In the Australian diet, milk contributes majority of dairy serve providing the greatest amount of calcium[11]. However, nine out of ten Australians are falling short of their recommended intake of the dairy food group[12].

This report summarises the science around plain milk and the important role it plays in a healthy diet.

Dairy Australia is the national services body for the Australian dairy industry. This report, prepared by health professionals at Dairy Australia, aims to bring together the most up-to-date and emerging research around the health benefits of milk. It draws from the latest evidence from around the globe, to help health professionals and policymakers to understand the unique health benefits of milk, and to encourage all Australians to enjoy milk as part of a heathy, sustainable diet.

^ The definition of 'milk' for the purpose of this report refers to cow's milk only.

WHAT IS MILK?

Legally, milk is defined by The Food Standards Code for Australia and New Zealand (FSANZ) as *"the mammary secretion of milking animals, obtained from one or more milkings, for consumption as liquid milk or for further processing, but excludes colostrum."*[13]

Milk has been a staple in the diet for thousands of years; its consumption can be traced back to the 7th century BC, with a definitive role in food production and cultures worldwide[14, 15]. The first people to drink milk regularly were early farmers and pastoralists in western Europe – some of the first humans to live with domesticated animals, including cows. The production of milk provided a source of nourishment for early farmers, and it grew into other products, including cheese and butter[16].

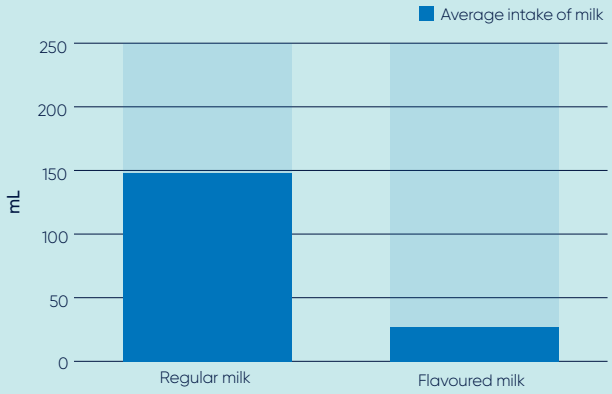
In 1891 there were almost one million dairy cows in Australia. Today the dairy industry is the fourth largest rural industry in Australia and is a key sector of the agricultural economy and local communities.

What's a serve of milk?

The 2013 Australian Dietary Guidelines[17] define a serve of milk as:

- Fresh regular or reduced fat milk
- UHT
- Reconstituted powdered milk
- Buttermilk
- Evaporated milk

Nine out of 10 Australians are not consuming enough dairy foods, and intake of milk is well below the recommended serve sizes[18]. The most recent national health survey found the average intake across all population groups was just 148mL of plain milk (0.6 of a dairy serve) and 27mL of flavoured milk (0.1 of a dairy serve)[19]. This is below the recommended daily intake of dairy foods, which ranges from two-and-a-half to four serves per day.[20]



Milk in dietary guidelines around the world

A review of dietary guidelines in the Food and Agriculture Organization of the United Nations (FAO) database shows that nearly all of them advise consumption of milk or milk products (with varying amounts and types of dairy)[21, 22]. This is reflective of the overwhelming scientific evidence that milk is an important component of a healthy dietary pattern and associated with positive health outcomes.

As an affordable, concentrated source of macro and micronutrients, milk can play a particularly important role in human nutrition in developing countries, where diets may lack diversity and consumption of other foods may be limited[23].

The recently revised American Dietary Guidelines have retained dairy foods as a separate, distinct food group in recognition of the health and nutrition benefits to people of all ages. The guidelines recommend three serves per day for most Americans, with a focus on low fat and reduced fat dairy foods[24]. Other dietary recommendations such as the updated Australian Heart Foundation position statement on dairy foods in a heart healthy diet recommend reduced fat dairy foods only for people who have high cholesterol or heart disease. Their advice for the general population recommends enjoying regular fat, unflavoured dairy foods every day as part of a healthy diet[25].

Conversely, the current Canadian Dietary Guidelines and the Danish Dietary Guidelines suggest a reduction in dairy serves compared to previous versions, with a strong focus on consumption of plant-based foods. Similarly, The EAT-Lancet Commission 'Diets for a Better Future: Rebooting and Reimagining Healthy and Sustainable Food Systems in the G20' report recommends no more than 250g of dairy be consumed each day for environmental reasons[26]. This contradicts the stance taken by the majority of countries reporting in the FAO dietary guidelines database - nearly all of whom advise consumption of milk and/or dairy foods; their recommendations are based on the overwhelming scientific evidence that dairy is an essential driver of health and essential nutrition, an important component of a healthy dietary pattern and associated with positive health outcomes.

Milk in dietary guidelines in Australia

The Australian Dietary Guidelines state that the key to eating well is to enjoy a variety of nutritious foods from each of the five food groups every day. One of the five food groups is dairy, which includes milk, yoghurt and cheese. A wide range of milk products are available in Australia, including dried, evaporated or UHT (long life). As such, these milk products, including all reduced fat or full cream varieties, plain and flavoured and powered milk are all recommended.

Milk consumption in Australia

Ninety-five percent of Australian households report purchasing milk in any given week[27]. According to insights from the Australian Health Survey, the majority (68%) of milk consumed in Australia is in beverages, followed by 26% added to breakfast cereals, 23% combined with other ingredients as part of a beverage (e.g. milk added to tea), 18% consumed alone and 14% in café style coffee[28].

Per capita, consumption of drinking milk is currently estimated at 94 litres each year. This marks a small decline over recent years: however, consumption remains high compared to other developed countries. This is possibly thanks to the expansion of the 'coffee culture' in Australia and growth in flavoured milk products.

In 2019/20 sales of UHT milk increased strongly following the initial COVID-19 outbreak as consumers stockpiled products at home in fear that they might run out of milk. Despite this surge in demand for UHT products, fresh milk remains the most popular variety amongst Australian consumers[29].

The share of fresh white full cream milk, as a percentage of the total fresh white milk market, has increased, and sale volumes of modified milk (e.g. skim) have declined. While white (unflavoured) milk still accounts for most of drinking milk sold, flavoured milk has also grown in importance[25].

Milk production in Australia

Approximately one third (29%) of Australia's milk is turned into drinking milk. The remainder is turned into cheese (39%), skim milk powder or butter (22%), whole milk powder (4%) and other uses (6%)[25].

Fresh plain milk is minimally processed. As the composition of milk produced changes through the course of a season, most milk is standardised to ensure a consistent taste and nutritional profile year-round. Milk must be legally pasteurised for safety reasons; as well as destroying harmful bacteria and micro-organisms, pasteurisation also extends the shelf life, with minimal impact on the nutrient content[30]. Milk generally undergoes further processing in the form of homogenisation, which disperses the fat equally throughout the milk, rather than allowing it to separate at the top (although varieties of non-homogenised milk are now more widely available).

Australian milk varieties

All types of milk are classified as 'Five Food Group foods' according to the Australian Dietary Guidelines[31]. Key milk varieties available in Australia are described below:

Milk type	Description
Regular-fat/full-cream/whole	Minimum 3.2% fat and 3% protein. 250 kJ/100mL[32].
Reduced-fat/lite	At least 25% less fat than full cream milk, or approximately 2% fat. 197kJ/100mL[33]. The cream removed during modification can be bottled as a standalone product or is manufactured into butter and other dairy products.
Skim	Maximum of 0.15% of fat and a minimum of 3% protein. 154kJ/100mL[28]
Ultra-Heat Treated (UHT)/ long life	Heated to 140°C for two seconds and then packaged aseptically which destroys any harmful bacteria and micro-organisms. This also extends the shelf life as a pantry staple outside the refrigerator.
A2	Contains only A2 protein. Milk contains several proteins including beta casein, which can be present in two forms: A1 and A2. Whether milk contains A2 protein or a mixture of A1 and A2, they are both safe to drink, contain the same essential nutrients, provide a range of health benefits and are recommended for good health in the Australian Dietary Guidelines[30].
Evaporated	Produced by gently heating milk to evaporate the water and concentrating the milk solids to 20-28%. After the milk is concentrated, the milk is then canned and sterilised to destroy bacteria and enzymes to increase shelf life, which is useful where no refrigeration is available. This process also makes the natural lactose sugar caramelise, which provides a unique colour and flavour[34, 35]. Evaporated milk is often used as a healthier alternative to cream, as well as commonly used to bake sweet dishes as acid can be added without the milk curdling.
Powdered/dried	Made by removing the water from fresh milk through spray drying, reducing the moisture level to just 3%. The nutrients remain the same after spray drying, however are much more concentrated in the powdered form. Powdered milk can be reconstituted to fresh milk with the addition of water[30].
Buttermilk	Made by adding lactic acid bacteria to milk, which ferments it. The bacteria turns lactose into lactic acid, which lowers the pH. The acid curdles the protein in the milk, making it slightly thick with a tangy flavour. Buttermilk is commonly used as an ingredient in pancakes, waffles, muffins, and cakes as the acidity. The acidity activates the baking soda in recipes and acts as a raising agent.
Fortified milk	Any type of milk that has been modified for an additional functional benefit. For example, some milks in Australia have added protein, vitamin D or calcium.
Fermented milk	Made by adding micro-organisms to milk, which results in coagulation and a reduction in pH[36]. Yoghurt is the most common example of fermented milk, where the fermentation has been carried out with lactic acid producing micro-organisms

Regular vs reduced fat milk – which is better for health?

Reduced-fat milk has traditionally been recommended over regular-fat varieties due to its lower energy and saturated fat content, which in the past has been thought to limit the risk of excessive energy intake, weight gain, and potential detrimental health effects such as cardiovascular disease[37]. Current dietary guidelines in the United States, the United Kingdom, and other countries recommend that adults and children over the age of two years consume predominantly reduced fat, rather than regular fat milk[38–41].

The current Australian Dietary Guidelines (ADGs) recommend consumption of 'milk, cheese, yoghurt and/or alternatives, mostly reduced fat'. However, many health organisations often interpret this recommendation to mean consumption of reduced fat only. The term 'mostly' is defined in the ADGs to mean at least 50% of varieties[42] and comes from a dietary modelling and kilojoule perspective, as opposed to health benefits associated with consuming a specific type of dairy foods.

Both regular and reduced-fat dairy have the same package of essential nutrients, meaning for many, their choice of dairy can be based on personal preference.

Since the release of the 2013 ADGs, a growing body of evidence, including nine systematic reviews and/or meta-analyses[43–51] and 17 cohort studies published since 2009[52–67] indicate that dairy food consumption, regardless of fat content, is not linked to higher risk of cardiovascular disease or stroke, (and in some cases, is linked to lower risk[68–70]) or weight gain.

After reviewing the body of evidence, the Australian Heart Foundation updated their position statement on dairy foods and heart healthy eating and have removed their restriction on regular fat dairy foods for the general population, concluding that ***"There is not enough evidence to recommend fat modification (i.e. full fat over reduced fat products, or reduced fat over full fat products) for the general population"***[71].

Dairy fat has the most complex profile of all the fats, containing more than 400 different fatty acids (e.g. short, medium and long-chained fatty acids). Just as not all types of carbohydrate have the same impact on health, not all types of saturated fat are associated with the same health effects.

Dairy fat appears to act differently on lipid metabolism compared to other dietary sources of saturated fat[72], with the structure of the Dairy Matrix also playing a key role.

Putting milk's saturated fat in context

The proportion of fat in milk is displayed in the infographic below in comparison to a number of other significant sources of saturated fat in the Australian diet. Milk contains an amazing package of important nutrients that would be missed from the diet should it be removed. Instead, it is recommended to reduce discretionary food consumption, including cakes, muffins, desserts, pastries, sweet biscuits and sausages that together supply 16.1% of Australians saturated fat intake[73].

Product	Proportion of saturated fat (%) in the Australian diet
Mixed dishes where cereal is the major ingredient (e.g. pizza, sandwiches, burgers, taco/tortilla dishes, pasta/noodle dishes, rice-based dishes)	9.9
Cheese	7.2
Cakes, muffins and desserts	4.9
Unprocessed beef, sheep, pork	4.8
Pastries	4.6
Milk products	4.0
Sweet biscuits	3.4
Butter	3.3
Sausages	3.2
Poultry and feathered game	2.3

DISCOVER THE DAIRY MATRIX

Traditionally, nutrition research and dietary advice has focused on the relationship between single nutrients (such as saturated fat, sodium, protein or calcium) and their effect on health. However, it is becoming increasingly recognised that we do not eat nutrients in isolation, rather we eat whole foods as part of varied diets and dietary patterns[74, 75].

Whole foods have a physically and nutritionally complex structure that has an influence on the digestion of the food and the absorption of nutrients[76]. The concept of the Food Matrix offers a more holistic view and recognises that the health effects of a food are much more complex than that of a single nutrient (or even a few nutrients). Rather, they are a function of both its structure and nutrient content, and how these interact together. As nutrition science evolves, we are learning more about the food matrix effect and its importance on our health. For more information on the Dairy Matrix click the QR code.

A closer look at the Milk Matrix

The Dairy Matrix is one of the best researched examples of the Food Matrix effect. While milk seems simple, the complex structure of the Milk Matrix means milk is so much more than a source of calcium.

Milk is an example of a liquid food matrix, composed mostly of water (87%), with a smaller solid component (13%). The solid component of milk contains highly bioavailable proteins, carbohydrate (in the form of lactose), complex fatty acids, essential vitamins and minerals and bioactive components.

At the macroscopic level, milk is an oil-in-water emulsion formed by small milk fat globules dispersed in a serum phase. At the microscopic level, the casein micelles, globular proteins, and lipoprotein particles are in suspension within a solution rich in lactose, soluble proteins, minerals, vitamins and other minor components.

The nutritional and functional complexity in the Milk Matrix is exemplified by milk fat, a complex natural fat, which has over 400 different fatty acids, each with different physiological properties[77, 78]. Components of the membrane which encloses the fat droplets in milk (known as the milk fat globule membrane (MFGM)) also have functional effects, and may play a protective role in preventing cardiovascular disease[79, 80] reducing inflammation[81, 82,] and gut health[83].

Milk proteins are among the highest-quality proteins, due to their high proportion of essential amino acids and excellent bioavailability. Caseins compose about 80% of the total milk proteins, existing as large colloidal aggregates known as casein micelles. Due to its unique colloidal structure, the casein micelle facilitates efficient transport and delivery of proteins and minerals to the body[84, 85].

The physical matrix of milk can be transformed via fermentation, heat, and other ripening processes – creating other foods such as yoghurt (semi-solid or gel-like in structure) and cheese (solid in structure). These distinctions are important as different dairy foods possess their own unique physical and nutritional matrices, which impacts the functional properties of each unique dairy food.

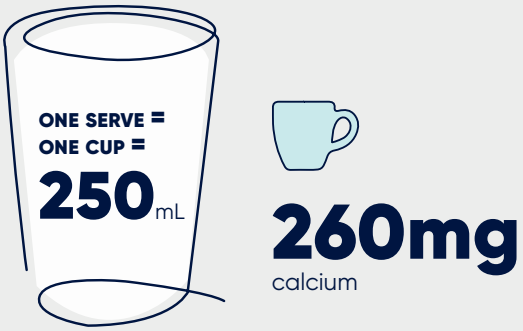
The role of the Milk Matrix in culinary nutrition

Milk is commonly used in cooking and baking, featuring in many traditional sweet and savoury recipes from cakes and desserts to curries and soups. The carbohydrate, protein and fat in milk provides unique functional attributes. For example, the casein proteins in milk can form gels when acidified or when certain enzymes (rennet) are added, playing a critical role in cooking. Milk proteins can also adhere to the surfaces of oil droplets or air bubbles, which is vital in the formation of emulsified products. The ability of milk fat globules to be both liquid at high temperatures and partially solidify when cooled to refrigerator temperatures, is critical in cooking techniques such as churning ice cream.

NUTRITION COMPOSITION

Milk provides a source of energy, macronutrients, essential vitamins and minerals. The most recent Australian nutrition survey found that cow's milk contributed approximately 20% calcium, 8.7% phosphorous, 17.3% iodine, 5.2% of vitamin A, 4.6% vitamin B6 and 17.5% vitamin B12 to the average Australian adult diet[86].

Few other widely available foods naturally contain as much bioavailable calcium. While it is sometimes assumed that supplementation with the same amount of calcium from different food sources has comparable effects on bone health, it is increasingly recognised that the effects of milk on health extend beyond the benefits of the individual nutrients they contain. Rather, the unique combination of nutrients and bioactive factors, and how they interact with each other in the dairy matrix, combine to produce the overall effect on health.



CALCIUM ALTERNATIVES IN THE AUSTRALIAN DIET

Amount required to consume the equivalent amount of calcium as a serve of milk, plus calcium bioavailability

Bioavailable calcium absorbed
Sources 16, 19. All figures are approximate

Figure 1 Macronutrient and calcium composition of Australian milk varieties per 250mL serve[87]

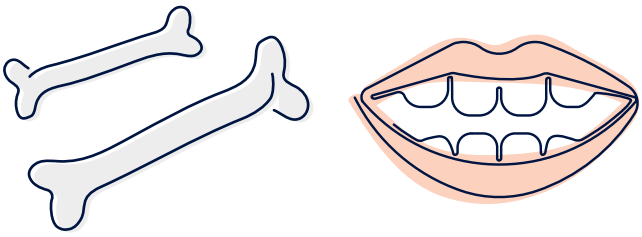
Milk type	Energy (kj)	Protein (g)	Fat (g)	Saturated Fat (g)	Carbohydrate (g)	Total Sugar (g)	Sodium (mg)	Calcium (mg)
Fresh, regular fat	703	8.5	8.5	5.5	15	15	88	260
Fresh, regular fat A2	703	8.5	8.5	5.5	15	15	88	260
Fresh, reduced fat	478	9	3	2.1	12.5	12.5	90	310
Fresh, skim	355	9	0.3	0.2	12	12	123	295
Powdered, regular fat*	760	9	9.8	6.5	15.3	15.3	118	308
Evaporated (canned), full fat	738	9.5	10.1	6.5	12.4	12.4	120	319
Buttermilk	625	10.5	5.0	3.2	13.5	13.5	143	358

**reconstituted with water*

Figure 2 Micronutrient composition of Australian regular fat, reduced fat and flavoured milk per 250mL serve[88]

Milk type	Energy (kj)	Protein (g)	Fat (g)	Saturated Fat (g)	Carbohydrate (g)	Total Sugar (g)	Sodium (mg)	Calcium (mg)
Fresh, regular fat	703	8.5	8.5	5.5	15	15	88	260
Fresh, regular fat A2	703	8.5	8.5	5.5	15	15	88	260
Fresh, reduced fat	478	9	3	2.1	12.5	12.5	90	310

HEALTH BENEFITS OF MILK



Bone and dental health

The majority of food-based dietary guidelines around the world recognise the multifaceted role dairy foods play in contributing key nutrients for bone and dental health [89–91]. **Milk is the biggest supplier of calcium, phosphorus and potassium in the Australian diet – essential nutrients needed for good bone health and strong teeth[92]**. Milk also offers a valuable supply of highly absorbable protein and zinc, key nutrients that synergistically contribute to bone tissue and collagen synthesis[93]. Milk is a superior choice for dental health compared to soy beverages; a study comparing the effects of soy beverages and milk found that milk provides a significantly greater degree of remineralisation compared to soy alternatives[94]. Further to this, enamel mineral content of teeth after consumption of milk and soy beverages found that soy alternatives resulted in demineralisation of tooth enamel whereas milk resulted in remineralisation[95].

The requirements for calcium, phosphorus and potassium are increased during critical stages of life. Around 50% of adult bone mass is acquired during the adolescent years and just a 10% increase in peak bone mass could reduce the risk of fracture by 50% in women after menopause.

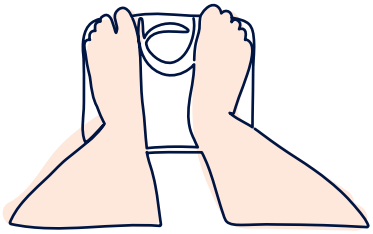
Adolescence is a critical time for building bones that need to last a lifetime, while in the period following menopause, women begin to lose bone mass rapidly, increasing risk of osteoporosis. In Australia, eight out of 10 adolescents do not consume enough milk or other dairy foods[96]. Research has shown that consuming dairy foods is associated with greater bone mineral content and density in adolescents[97].

In the elderly population, diminishing bone density can lead to elevated risks of osteoporosis and subsequent fractures[98, 99]. Menopausal women, in particular, experience hormone-related changes that accelerate bone loss[100, 101]. This is of particular concern for Australian women over the age of 75 who do not eat enough dairy foods[102], with one in four suffering from osteoporosis[103]. Research from the University of Melbourne and Austin Health has linked increased dairy food consumption (including milk and skim milk powder) with reduced risk of falls and fractures in aged care residents; an 11% reduction in the risk of falls, 33% reduction in the risk of all fractures in aged-care residents[104].

Diet quality and nutrient density

Milk intake is a marker for dietary quality because of its nutrient contribution; milk is an excellent source of several essential nutrients such as high-quality protein, minerals calcium, phosphorus, potassium and iodine, and vitamins B2 and B12, as well as many natural bioactive components (e.g. specific fatty acids and peptides). The proteins naturally found in milk are unmatched in quality and offer benefits across life stages such as strengthening bone density and assisting in muscle maintenance for healthy aging.

Along with being the biggest source of calcium, milk is also the biggest source of vitamin B12, iodine, riboflavin (vitamin B2), phosphorus and potassium in the Australian diet[105]. Observational and dietary modelling studies have shown milk consumption to be a reliable indicator of dietary quality across multiple age groups, with consumers more likely to meet their requirements of protein, essential minerals and vitamins A, B2, B6 and B12 [106–110].

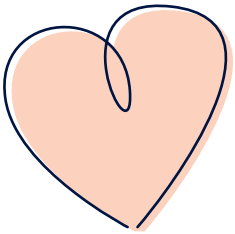


Healthy weight

In developing the 2013 Australian Dietary Guidelines, the National Health and Medical Research Council found no evidence to show a link between eating dairy foods and weight gain or risk of obesity in adults. Studies published since the release of the 2013 Australian Dietary Guidelines continue to show a neutral effect of dairy foods on weight. In addition, two recent research studies found that including at least three serves of dairy foods, such as milk, in an everyday diet was not linked to weight gain compared to individuals eating less than 1-2 serves of dairy foods per day[111, 112]. In fact, dairy foods, such as milk, may have modest benefits in facilitating weight loss in short-term or energy-restricted diets[113].

Similar findings have been shown in children and adolescents. Research found that milk and other dairy foods are consistently found to be not associated, or inversely associated, with obesity and indicators of adiposity in children[114].

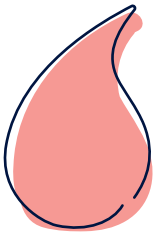
There are a number of factors that may explain the beneficial effects of milk for weight-loss; milk has a low Glycaemic Index, together with a high protein content that may assist satiety[115]. In addition, dairy calcium may be beneficial for weight loss because a high calcium intake can reduce lipogenesis and stimulate lipolysis, as well as reduce the amount of dietary fat absorbed by the body[116, 117].



Heart health and cardiovascular disease

Twenty-five percent of Australian deaths are attributed to cardiovascular disease, making it Australia's most costly disease[118]. The Australian Dietary Guidelines recognise the importance of including milk in the diet to protect against heart disease, stroke and reduce blood pressure, as do the 2020 American Dietary Guidelines[119, 120].

Research indicates that consuming dairy foods, including milk, is not associated with higher risk for cardiovascular disease and may be associated with a reduced risk[121, 122]. In addition, three research studies published from 2016-18 determined that total dairy intake was associated with a 20% reduced risk of stroke mortality[123], an 8% lower risk of stroke[124] and no evidence for an increased or decreased risk of adverse cardiovascular incidents or all-cause mortality with milk consumption[125].



Diabetes

A number of meta-analyses of prospective cohort studies have concluded that higher milk consumption is associated with a reduced risk of type 2 diabetes[126–129].

Both reduced fat and regular fat milk may play a beneficial role in preventing type 2 diabetes and emerging evidence suggests that regular fat milk may be especially protective in those who have pre-diabetes[130, 131].

There are several plausible biological mechanisms through which milk products may play a role in reducing the risk of developing type 2 diabetes[132–134] whey protein in milk may reduce postprandial plasma glucose concentration in type 2 diabetics[135], as well as promote insulin sensitivity, improve glucose tolerance and lipid profile, and also help weight control[136–139]. Calcium, as well as magnesium, may reduce the risk of type 2 diabetes through their role in modulating insulin resistance, pancreatic beta-cell function, and inflammation[140, 141].

Sports nutrition and muscle health

There are a number of studies supporting the benefits of dairy, especially milk, for exercise performance and recovery of muscle function[142]. Chocolate milk specifically, has been found to be as effective at promoting glycogen resynthesis as traditional sports beverages[143]. As for promoting rehydration, it is indicated that chocolate milk is not only effective for exercise-induced dehydration, but is also superior to sports drinks due to lower total urine output during recovery[144]. The ability of milk to effectively act as a rehydration beverage likely relates to its high water content (~85%) and composition of electrolytes, namely potassium and sodium, which are lost through sweating.

Protein from milk has been shown to have beneficial body composition effects in men and women. Male weightlifters who drank skim milk after a workout built approximately twice as much muscle as those who drank soy beverages [145, 146], while women who drank 500mL of skim milk an hour after resistance exercise gained more muscle and lost more fat than those who had a sugar-based energy drink. In addition, milk is a cost-effective beverage option compared to sports drinks, and is a better choice for dental health, as it is less acidic[147].

Childhood growth and development

There is a wealth of research to support the importance of milk for children of all ages[148–154]. Dairy nutrients play a critical role in healthy growth and development and the consumption of dairy foods during childhood is linked to increased bone density in adulthood[155].

In the United States, the Feeding Infants and Toddlers Study (FITS) and the National Health and Nutrition Examination Study (NHANES) have documented the key role that milk plays in the diets of toddlers for both macro- and micronutrients[156]. Studies from multiple European countries have similarly documented the important role of milk in the diets of young children[157–160].

Consumption of milk is also associated with greater height growth in children[161, 162]. Research found that girls who drank >3 servings per day of milk grew 0.11 in (0.3 cm) more the following year than girls who consumed <1 serving per day[163]. Further, the addition of 245mL of milk per day to a child's regular diet may increase height by 0.4 cm per year of growth.

Cancer

Some research indicates that dairy foods, including milk, may protect against cancer by reducing the risk of colon cancer, with calcium playing a key role in protecting the colon[164–167]. Overall, the evidence indicates that dairy foods have no effect on breast cancer[168–170].

Cow's milk allergy and lactose intolerance

Cow's milk protein allergy (CMPA) involves an immunological reaction and requires elimination of all dairy from the diet. In Australia around 2% (one in 50) babies are allergic to cow's milk and dairy foods. Most children outgrow CMPA by the age of four and ongoing symptoms in adults are very rare[171]. Cow's milk elimination from the diet during infancy and childhood for CMPA should be recommended only after confirming the diagnosis with a health professional. It is important to ensure appropriate substitution where milk needs to be eliminated, to minimise the risk of nutritional inadequacy and poor growth.

It is important that CMPA is not confused with lactose maldigestion or lactose intolerance.

People with diagnosed lactose intolerance do not need to avoid milk or other dairy foods, unlike CMPA. There are several recommended strategies to manage lactose intolerance; there is evidence that gradually increasing lactose intake over time can result in colonic adaptation[172]. Most people can usually tolerate up to 12g of lactose (the amount in one glass of milk) without symptoms, particularly if it is consumed with other foods and in smaller quantities across the day[173]. Lactose-free milks are also available and contain a similar nutrient profile to regular milk. According to the NIH Consensus Development Conference Statement on Lactose Intolerance and Health, dairy exclusion diets may exacerbate the risk of osteoporosis and negatively impact other health outcomes such as blood pressure control[172], so it is important symptoms and dietary changes are managed in conjunction with a health professional.

THE ROLE OF MILK IN A HEALTHY, SUSTAINABLE DIET

The concept of eating sustainably takes into account not only environmental factors such as greenhouse gas emissions (GHE), water and land use, but also the importance of nutritious, affordable and culturally acceptable foods.[174] The FAO and WHO guiding principles of sustainable healthy diets assert that "Sustainable Healthy Diets are dietary patterns that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact, are accessible, affordable, safe and equitable; and are culturally acceptable."[175]

Due to the multitude of issues that can be considered crucial for the sustainability of human eating habits, assessing the sustainability of diets can be challenging. Furthermore, measuring the environmental impact of a food system is highly complex; how a food is grown, transported, sold, processed, consumed and if it is wasted contributes to a food's environmental impact.

Research confirms dairy's role in healthy dietary patterns and its contribution to all sustainability domains.[176]

Socioeconomic domain

A serve of fresh milk costs, on average, $0.43[177] and offers an accessible and affordable source of high-quality nutrition with proven health benefits. The ability to buy locally made milk ensures money goes back into local communities and families through income and job creation.

Nutrient Bang for Buck

Health

A recent Australian study conducted by CSIRO has shown that core dairy foods, such as milk, play an important role in meeting nutrient intakes in a healthy and lower GHE dietary pattern in Australia. Results suggest that dairy foods make a critical nutritional contribution to a lower GHE diet and that current dairy recommendations in Australia are no barrier to achieving a lower GHE diet (40% lower).[178]

The Australian dairy industry is committed to continually improving practices to minimise our environmental footprint for the long-term, which is reflected in the Australian Dairy Industry Sustainability Framework and goals.[179]

Environmental impact

Like any agricultural industry that uses natural resources, dairy farming does impact the environment. However, the dairy sector has one of the smallest carbon footprints per unit of animal product in the world. Producing milk, and indirectly meat, accounts for 4% percent of all global greenhouse gas (GHG) emissions from human activities. Overall contribution of milk production, processing and transportation represents 2.7% of GHG global emissions.[180]

The Australian dairy industry is committed to reducing its environmental impact, which includes reducing greenhouse gas intensity by 2030; the dairy manufacturing sector alone has reduced emissions intensity by 23.5% and absolute emissions by 27% since 2010/11.[181] For more information on Australian dairy's sustainability commitments and targets, visit **dairy.com.au/sustainabilityframework**

HOW DOES MILK COMPARE TO PLANT-BASED BEVERAGES?

Over the past decade, there has been an increase in the number of plant-based milk alternatives available. Plant-based beverages are derived from nuts, seeds, cereals or legumes, or any combination of these, with the addition of filtered water and other ingredients for stability, shelf-life, flavour etc. Plant-based beverages are highly processed foods, involving multiple food production steps to produce the final food product, and often have little in common with the plants they are derived from. Milk contains only one ingredient – milk – and, for plain varieties, production involves only processes which are deemed necessary for health and safety. There is a wealth of research supporting the role of milk and other dairy foods (cheese and yoghurt) as an important part of a healthy, balanced diet, and the association with reduced risk of many chronic diseases (see Health Benefits of Milk). In contrast, the amount of research on the health benefits of plant-based beverages is small, with the exception of soy-based foods which offer a dietary source rich of proteins, fat and isoflavones.[182, 183]

The nutrient composition of plant-based beverages depends on the source, methods of processing, and whether the products are fortified.[184] FSANZ recognise that generally plant-based beverages do not have the same nutrient content as milk, which contains higher levels of protein and a wider range of naturally occurring vitamins and minerals.[185] The Australian Dietary Guidelines consider only plant-based beverages that are fortified with 100mg of calcium per 100mL as substitutes for milk[186], however the type of calcium used in fortification is less bioavailable than that naturally found in milk.

There is little known research on the health effects of commercially available plant-based beverages, aside from its nutritional differences to milk. The evidence is currently insufficient to conclude that plant-based beverages possess health benefits, as the limited available evidence mostly focuses on the beneficial effects of their constituents (e.g. soy protein, unsaturated fat) on disease markers (e.g. cholesterol) and extrapolates these to product effects. Moreover, unlike the research on milk, there is little or no evidence supporting the beneficial effects on disease endpoints.

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4988 | Jan 2023