Summary of Evidence

Heart Foundation

Dairy & Cardiovascular Health

Summary of Evidence

This Summary of Evidence presents the contemporary evidence relating to dairy foods and cardiovascular health and underpins the Heart Foundation's Position Statement: Dairy and Heart Healthy Eating.[1]

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Summary

The relationship between dairy foods and cardiovascular outcomes is mixed. Overall diet quality is a more important indicator of cardiovascular risk than one food group or one nutrient. On balance the existing evidence on dairy foods and cardiovascular risk points to a 'neutral'* effect, and a possible 'protective'^ effect, with consumption of dairy foods and hypertension, stroke and type 2 diabetes risk, and with the consumption of yoghurt and type 2 diabetes risk.

There is an increased risk observed with total dairy intake and heart failure and there is mixed evidence on the effect of cheese, with different studies reporting reduced, no or increased risk.

Studies on the relationship between dairy fat and cardiovascular health appear similar to studies of total saturated fat intake, where cardiovascular risk is reduced when dairy fat is replaced with unsaturated fat and wholegrain carbohydrates (but not when replaced by trans-fat and refined carbohydrates). There is evidence dairy fat from cheese and yoghurt do not raise LDL cholesterol in the same way that dairy fat from butter does, and there is evidence that LDL-C response to dairy fat is higher for those with elevated LDL-C.

It appears the influence of dairy products or dairy fat depends on a person's broader eating pattern and the nature of the foods which replace (or are replaced by) dairy or dairy fat products. Put simply:

- Milk, yoghurt, and cheese are healthy snack options in preference to discretionary foods (i.e. sugary drinks, alcohol and heavily processed foods) and can contribute to healthy meals when eaten with vegetables, wholegrains or fruit.
- Milk, yoghurt and cheese can feature in a healthy eating pattern as long as foods such as fish, olives, seeds, nuts and the oils which are made from them are the primary sources of fat
- Reduced fat and unflavoured milk, cheese and yoghurt are the preferred choices for people who would benefit from LDL-C lowering dietary interventions due to the LDL-C increasing nature of dairy fat, and the reduced added sugar in these products. Those who would benefit include people with elevated LDL-C and those with existing heart disease. Many reduced fat milks, cheeses and yoghurts are also lower in kilojoules.

It is likely the consumption of milk, yoghurt and cheese (regardless of fat modification) may not affect cardiometabolic risk, if consumed at the currently recommended amounts and in the context of a dietary pattern rich in vegetables, fruit, legumes, nuts, seeds, wholegrains, healthy oils and low in discretionary food and drinks (i.e. sugary drinks, alcohol and heavily processed foods).

Adding more dairy (or dairy fat) to an unhealthy eating pattern will not produce any cardiovascular health benefit. Overall diet quality is a more important indicator of cardiovascular risk than one food group or one nutrient.

The evidence for milk, yoghurt and cheese does not necessarily extend to butter, cream and ice-cream. There is good evidence to limit butter consumption, particularly for those with elevated LDL-C.

* Neutral: no association in observational studies
^ Protective: inverse association in observational studies

Background

Dairy foods provide a source of calcium, protein, vitamin A, vitamin B12, magnesium, phosphorus, potassium, riboflavin and zinc. The nutritional composition of dairy products varies depending on type (milk, cheese, yoghurt, cream, butter) and fat modification (full fat, reduced, low or no fat and skimmed products). Regular milk, for example, contains 87.6% water, 4.7% carbohydrates, 3.8% fat, 3.3% protein and 0.6% vitamins and minerals. Cheese, on the other hand, can have a protein content between 7 and 35% and a fat content between 11 and 34%, depending on the type.[2]

Dairy fats are mostly saturated fatty acids (SFA) with varying carbon chain lengths. By weight, dairy fat consists of triglycerides (98%), phospholipids (1%), cholesterol (0.5%) and free fatty acids (0.1%). Approximately 70% of dairy fats are SFA, 25% are mono-unsaturated fatty acids (MUFA), 2.3% are cis-polyunsaturated fatty acids and 2.7% are ruminant trans fatty acids (tFA).[3] Short-chain SFA (C4:0–10:0) comprise approximately 11% of milk fat, while longer-chain SFA (C12:0–18:0), that raise low density lipoproteins (LDL-C), comprise 56%.[4,5] The main type of tFA in milk fat is vaccenic acid (C18:1 trans-11) which is a precursor for conjugated linoleic acid (CLA).[6]

The role of dairy consumption in cardiovascular health and/or risk has long been a topic of interest for health professionals, researchers and the community. In a review of different dietary patterns and cardiovascular health outcomes, dairy foods were found to feature in some but not all healthy eating patterns.[7] This indicates a heart healthy eating pattern can exist with or without dairy foods. In a review of dietary fats and cardiovascular health outcomes, replacing saturated fat with unsaturated fat and wholegrain carbohydrates was associated with a lower risk of heart disease and improved lipid profiles.[8] For this reason, reducing dairy fat is one recommended strategy to limit saturated fat intake for those who would benefit from LDL-C lowering dietary interventions. The saturated fat, and to a lesser extent sodium, content of dairy products has been the reason for recommendations to limit consumption.

The Australian Dietary Guidelines recommend that "milk, yoghurt and cheese, mostly reduced fat" are included in a healthy eating pattern.[9] Other national guidelines promote low fat dairy (milk, cheese and yoghurt).[10] The rationale for specifying 'low fat' or providing a caveat for 'mostly reduced fat' includes limiting total, saturated fat and trans fat intake and limiting kilojoule intake. The New Zealand Heart Foundation advises the evidence base is stronger for reduced fat dairy for some, but not all, cardiovascular risk factors.[11] The Harvard Public Health School (HPHS) is one of the few guidelines which does not promote dairy, recommends it is limited to two serves per day and does not include a stand-alone recommendation for dairy, instead categorising dairy into 'protein' or 'drinks'.[12]

Given the current understanding of dietary patterns[7] and macro-nutrient balance[8], the Heart Foundation sought to determine the role of dairy (milk, cheese and yoghurt) in a heart healthy eating pattern through a review of systematic reviews and meta-analyses. This Summary of Evidence summarises the available evidence and informs the Heart Foundation's position on dairy[1] and is complementary to the Heart Foundation's broader position on healthy eating.[13,14]

Method

The following steps were taken to produce this Summary of Evidence:

1. A systematic review was undertaken of meta-analyses published between 2013 – 2018 using key words "milk or cheese or yoghurt", "dairy", "low fat dairy", "reduced-fat dairy", "cardiovascular disease", "type 2 diabetes", "cholesterol", "LDL", "cardiovascular risk factors", "triglycerides", "hypercholesterolaemia".
2. This was supplemented with handsearching reference lists and key reports, to identify reviews, trials and meta-analyses published since 2009 (i.e. the cut-off point for the Evidence Review informing the Australian Dietary Guidelines).[10,15,16]

Summary of evidence

The evidence base is primarily observational studies, with a small number of controlled trials for outcomes including weight gain, blood pressure and blood lipids. Based on the literature scan, a considerable number of studies are narrative reviews and summaries of observational studies. For brevity, only meta-analyses of cohorts and RCTs, and pooled analyses of cohorts are reported in this Summary of Evidence.

An obvious and serious limitation with much of the available data is the absence of standard classifications for dairy products or standard volumes for servings. In this position statement, dairy products (e.g. milk or yoghurt or cheese or reduced fat or high/full fat) and the amounts or serving size associated with outcomes are reported as they are reported in the original meta-analysis or review. Most of the associations relate to highest compared to lowest categories of intake, unless otherwise specified.

The following section is an overview of the studies, summarised in the following way:

- Total dairy intake and cardiovascular risk factors and outcomes
- Dairy sub-group and cardiovascular risk
- Whole, full fat, reduced fat and low fat dairy and cardiovascular risk
- Existing GRADE Evidence Summary for total dairy and subgroup dairy intake
- Dairy fat and cardiovascular risk
- Relevance to dietary patterns
- Comments on the characteristics of the evidence base

Total dairy intake and cardiovascular risk factors and outcomes

In studies which compare highest to lowest intakes of all dairy products regardless of type of product (i.e. total dairy), there was mixed evidence on the relationship between dairy products and cardiovascular outcomes.

Hypertension: In a meta-analysis of prospective cohorts, total dairy was inversely associated with hypertension (RR=0.89, 95% CI=0.86-0.93)[17] but the same inverse relationship was not found in a meta-analysis of RCTs.[18] Earlier meta-analyses of prospective cohorts also reported inverse relationships between hypertension and highest compared to lowest total dairy intake.[19,20]

Type 2 Diabetes Mellitus: Total dairy intake was inversely associated with type 2 Diabetes with 3% less risk per 200g intake per day (RR=0.97, 95% CI=0.95-1.00, P=0.04) in a meta-analysis of 16 prospective cohorts.[21] There was a stronger association in a subgroup analysis for Asian compared to European populations, and for studies which did not adjust for confounders. Similar relationships were observed in earlier meta-analyses of prospective cohorts.[22-24]

Stroke: Total dairy intake was inversely associated with stroke in a meta-analysis of prospective cohorts (RR=0.88, 95% CI=0.82-0.95).[25] In contrast, a meta-analysis of 12 prospective cohorts published in the same year reported no association with total dairy intake and stroke (RR=0.98, 95% CI=0.96-1.00).[26]

Coronary Heart Disease: In the last 5 years, meta-analyses of prospective cohorts have consistently reported no association with total dairy intake and coronary heart disease (CHD).[25-28] This conflicts with earlier meta-analyses on milk/dairy on which the current Australian Dietary Guidelines are based which reported an inverse relationship with CHD.[29,30]

Heart Failure: Of note, an increased risk between total dairy intake and heart failure was reported in a meta-analysis of 3 prospective cohorts (RR=1.08, 95% CI=1.01-1.15).[26] No other studies identified in the search strategy reported on associations between dairy and heart failure.

Cardiovascular Disease (combined stroke and heart disease): An inverse relationship between total dairy and CVD was reported in two recent meta-analyses (RR=0.90, 95% CI=0.81-0.99).[25,27] However a pooled analysis of 3 US prospective cohorts reported no association (RR=1.02, 95% CI=0.98- 1.05).[31] The inverse relationship with CVD (which includes both CHD and stroke) may be driven by the inverse relationship with stroke given the absence of a relationship between dairy and CHD reported in these studies.[25,27,28]

Dairy sub-group and cardiovascular risk (milk, yoghurt, cheese, cream and butter)

In studies which compared highest to lowest intakes of specific dairy products including milk, cheese and yoghurt, there was also mixed evidence for cardiovascular outcomes.

Milk: Milk consumption was not associated with CHD (RR=1.05, 95% CI=0.96-1.15) or stroke (RR=0.91, 95%CI=0.81-1.01) in the most recently available metanalysis.[32] However inverse associations have been reported in 'older' meta-analyses for hypertension (RR=0.96, 95% CI=0.94-0.98) and CVD (RR=0.94, 95% CI=0.89-0.99).[20,28] Milk consumption (total, whole or low fat) was not associated with diabetes in any of the meta-analyses identified, but whole milk was associated with increased risk in a pooled analysis of 3 US cohorts (HR=1.10, 95% CI=1.04-1.16).[33]

Cheese: Cheese intake was inversely associated with stroke but not CHD in the most recent meta-analysis of prospective cohorts (RR=0.93, 95% CI=0.88-0.99).[32] In two earlier meta-analyses of prospective cohorts, both stroke and CHD were inversely associated with cheese consumption: (stroke RR=0.87, 95% CI=0.77-0.99; CHD RR=0.82, 95% CI=0.72-0.93)[34] and (stroke RR=0.91, 95% CI=0.84-0.98; CHD RR=0.84, 95% CI=0.71-1.00).[27]

When looking at cardiovascular risk factors, a meta-analysis of RCTs concluded cheese consumption raised total and LDL-C, compared with tofu or fat-modified cheeses, but did so to a lesser degree than butter.[35] A similar conclusion was made in a recent RCT comparing butter and cheese intake to PUFA/MUFA enriched diets. Importantly, LDL-C response was greater for individuals with a higher baseline LDL-C.[36] In another RCT, there was not a significant difference when comparing regular to reduced fat cheese with lipoprotein particle and size, or LDL-C levels when 80g/d was consumed for 12 weeks.[37,38] Lastly, camembert cheese (60g/d) compared to full fat yoghurt (250g) did not modify lipid levels or blood pressure over 3 weeks.[39] Cheese was associated in observational studies with a small but statistically significant change in weight per year of +11g.[40]

Cheese appears to have inconsistent associations for diabetes risk. In the most recent meta-analysis of prospective cohorts, cheese was not associated with diabetes in adults (RR=1.00, 95% CI=0.99-1.02), although subgroup analysis in men demonstrated increased risk (RR=1.05, 95% CI=1.02-1.09).[21] In a pooled analysis of 3 US cohorts, cheese was associated with increased risk (HR=1.07, 95% CI=1.03-1.11).[33] In two of the three earlier meta-analyses, cheese was inversely associated with diabetes risk (RR=0.92, 95% CI=0.86-0.99).[22,23]

Yoghurt and Fermented Milk: The role of fermented dairy products in eating patterns are an emerging area of research, although these foods have long been part of some traditional eating patterns. One meta-analysis of 9 prospective cohorts determined a dose-response relationship between consumption of yoghurt >200g/day and a lower risk of CVD in a subgroup analysis of 6 of the 9 studies (RR=0.92, 95% CI=0.85-1.00), but no relationship between yoghurt consumption and CHD, stroke, or total CVD.[41] Consumption of >1 serving compared to no intake was inversely associated with the composite outcome in the PURE cohort (HR=0.86, CI=0.75-0.99, p-trend=0•0051).[42] An earlier Cochrane review did not find any effect of fermented milk on HTN.[40] A meta-analysis exploring observational studies and weight-related outcomes found an inverse association for yoghurt consumption with a weight change per year of - 41g (abdominal obesity RR=0.81, 95% CI=0.71-0.92).[40]

Yoghurt and fermented dairy have consistent inverse associations with diabetes risk. In the most recent meta-analysis of cohorts, yoghurt (RR=0.86, 95% CI=0.83-0.90) and fermented dairy (RR=0.88, 95% CI=0.82-0.94) were both inversely association with risk but with no evidence for a dose response relationship.[21] The authors commented the inverse association was not observed above 80g of yoghurt per day, and cautioned this inverse relationship was unlikely to apply to yoghurts with added sugars. Yoghurt was also inversely associated with diabetes risk in the pooled analysis of 3 US cohorts,[33] and two of the three earlier meta-analyses.[23,24]

Most cheeses are also fermented however cheese is discussed separately in the section above.

Butter: Butter and cream were not associated with stroke in the most recent meta-analysis of prospective cohorts (Butter RR=0.95, 95% CI=0.85-1.07; Cream RR=0.97, 95% CI=0.88-1.06).[32] In the same analysis, there was also no association between CHD and butter (RR=0.99, 95% CI=0.89-1.11) and cream (RR=0.96, 95% CI=0.87-1.06).[32] A systematic review and meta-analysis of prospective cohorts investigating butter consumption found a weak association with total mortality (per tablespoon/day RR=1.01, 95% CI=1.00-1.03, p=0.045), no statistically significant associations with cardiovascular disease, coronary heart disease or stroke, and an inverse association with incidence of diabetes (RR=0.96, 95% CI=0.93-0.99, p=0.021).[46] In controlled trials, butter intake consistently increases total cholesterol, LDL-C, non-HDL cholesterol, and apolipoprotein B:apolipoprotein A-I ratio. This impact is reported when compared to cream, to cheese, and to controls enriched with MUFA, PUFA or CHO.[35,36,47]

'Whole', full-fat, reduced fat & low-fat dairy and cardiovascular risk

Many studies discuss the limited evidence base comparing reduced fat to full fat or whole dairy. Most studies do not directly compare 'reduced fat' to 'full fat' dairy products; instead studies investigate highest to lowest intakes of 'reduced fat' and 'full fat' separately. The following relevant studies are summarised by cardiovascular risk and outcome. There is no standard way to classify dairy products in the research, so the following section reports products as per the original studies including 'low fat', 'non fat', 'whole fat' and 'high fat'.

Hypertension: The most recent meta-analysis of prospective cohorts reported an inverse association for total dairy intake and risk of hypertension, but no significant differences when comparing 'low fat' and 'high fat' dairy products.[17] Earlier meta-analyses of prospective cohorts reported inverse relationships between hypertension and total dairy, 'low-fat' dairy and milk/yoghurt (which are lower fat dairy products) but not 'high fat' dairy which had no significant associations.[19,20]

Weight: A meta-analysis of prospective cohorts reported no statistically significant associations between 'whole fat' dairy and weight-related outcomes with a weight change per year of 14.35g (95% CI=7.12-35.82); (abdominal obesity RR=0.83, 95% CI=0.64-1.07).[40] A meta-analysis from 20 RCTs that evaluated 'high fat' and 'low fat' dairy products reported that both caused modest weight gain.[43]

Dyslipidaemia: A meta-analysis from 20 RCTs that evaluated 'high fat' and 'low fat' dairy products reported 'low fat' dairy had more favourable (but not statistically significant) impacts on the lipid profile than 'high fat' dairy. 'High fat' dairy non-significantly increased LDL (+3.30 mg/dl, −4.3 to 10.90 mg/dl) and decreased HDL (-0.69 mg/dl, −3.04 to 1.67 mg/dl), while 'low-fat' dairy non-significantly decreased LDL (-1.42 mg/dl, −4.74 to 1.91 mg/dl) and increased HDL (+0.73 mg/dl, −2.50 to 3.96 mg/dl).[43] In a subsequent controlled crossover trial, 124 free-living individuals consumed 3 servings of dairy ('low fat' milk and yoghurt, and 'regular fat' cheese) or an energy-equivalent control (fruit juice, cashews and a cookie) for 4 weeks each, separated by a 4-week washout period.[44] In this trial, the dairy intervention increased LDL levels (2.99mmol/l vs 2.91 mmol/l; p=0.04) and LDL:HDL ratio (2.12 mmol/l vs 2.07mmol/l; p=0.03). In an earlier controlled trial of normolipidemic individuals, 500ml/day 'non fat' milk for 2 weeks resulted in a less atherogenic lipid profile than 500ml/day 'whole' milk.[45]

Type 2 Diabetes: The most recent meta-analysis of prospective cohorts reported an inverse association with total dairy intake with a 3% less risk per 200g intake per day (RR=0.97, 95% CI=0.95-1.00, p=0.04). An inverse association was also seen with 'low fat' dairy intake albeit with less confidence with a 4% lower risk per 200 g/d (RR=0.96, 95% CI=0.92-1.00, p= 0.072). There was no association for 'high fat' dairy intake per 200 g/d (RR=0.98, 95% CI=0.93-1.04, p =0.52).[21] Similar relationships were observed in earlier meta-analyses of prospective cohorts where 'low fat' dairy was consistently inversely associated with diabetes risk and 'high fat' was not associated with diabetes risk.[22-24]

Stroke: A meta-analysis of 16 studies reported an inverse association between total dairy and stroke was attributable to 'low fat' dairy (RR=0.94, 95% CI=0.90-0.98, p=0.61) and not 'high fat' dairy (RR=0.95, 95% CI=0.91-1, p=0.61).[23] A meta-analysis of 12 prospective cohorts published in the same year reported similar findings.[26] Two earlier meta-analyses reported an inverse association with 'low fat' dairy and stroke.[27,34]

Coronary Heart Disease: In a meta-analysis of 17 prospective cohorts, there were no associations between either 'low fat' or 'high fat' dairy and CHD.[25] A meta-analysis of 13 prospective cohorts published in the same year reported the same conclusions.[26] An earlier meta-analysis of 4 prospective cohorts found no association between total dairy intake and CHD, but an inverse association with 'low fat' dairy intake and CHD (RR=0.90, 95% CI=0.82-0.98).[34] 'High fat/full fat' dairy was not associated with CHD (RR=1.05, 95% CI=0.93-1.19).

Existing GRADE summary for total and sub-group dairy intake

Drouin-Chartier et al (2016) provides a snapshot of the evidence, using GRADE, in a review produced with an unrestricted grant from the dairy industry.[48]

High-quality evidence supports favourable associations between:

- total dairy intake and hypertension risk;
- 'low-fat' dairy and yogurt intake and the risk of type 2 Diabetes.

Moderate-quality evidence suggests favourable associations between:

- intakes of total dairy, 'low-fat' dairy, cheese, and fermented dairy and the risk of stroke;
- intakes of 'low-fat' dairy and milk and the risk of hypertension;
- total dairy and milk consumption and the risk of Metabolic Syndrome;
- total dairy and cheese and the risk of type 2 Diabetes.

High- to moderate-quality evidence supports neutral associations between:

- total dairy, cheese, and yoghurt and CVD risk;
- any form of dairy, except for fermented, and CAD risk;
- regular and high-fat dairy, milk, and yoghurt and stroke risk;
- regular and high-fat dairy, cheese, yoghurt, and fermented dairy and hypertension risk;
- regular and high-fat dairy, milk, and fermented dairy and type 2 Diabetes risk.

Dairy fat and cardiovascular risk

Dairy products, and dishes made from them, are leading contributors to saturated and trans fat intake. There are established relationships between saturated fat (lauristic C12:0, myristic C14:0 and palmitic C16:0) and ruminant trans fat and elevated LDL-C[49,50] There are associations between elevated LDL-C and heart disease[51,52] and there is evidence that replacing saturated with unsaturated fat reduces the risk of heart disease.[8] For this reason, reducing dairy fat intake is one recommended strategy to limit saturated fat intake for those who would benefit from LDL-C lowering dietary interventions. This section summarises evidence relating to dairy fat and cardiovascular risk.

Observational studies: In a pooled analysis of three key US cohort studies (Nurses' Health Study, Health Professionals Follow-Up Study and Nurses' Health Study II), dairy fat was not associated with CVD risk.[31] This finding was similar to studies of saturated fat intakes when the replacement macro-nutrient is not evaluated.[53] When analysing by source of kilojoules, a 5% increase in dairy fat was not associated with CVD, CHD or stroke risk compared to a comparable increase in energy from carbohydrates (excluding fruit and vegetables).[31] Replacement of 5% of energy from dairy fat with polyunsaturated fat, vegetable oil or wholegrains was associated with a reduced risk of CVD, while replacement with other sources of animal fat was associated with an increased risk of CVD. These findings mirror the relationship between saturated fat and unsaturated fat and carbohydrates described in a recent systematic review[8] which informs the Heart Foundation's position on dietary fat.[14]

For diabetes, a pooled analysis of 16 prospective cohorts reported higher levels of circulating and tissue odd chain saturated fats (15:0, 17:0) and ruminant trans fat (t16:1n-7) were associated with lower incidence of type 2 diabetes mellitus.[54] These circulating biomarkers are associated with dairy intake, however they do not distinguish between different sources of dairy fat (i.e. milk vs cheese vs yoghurt) and may also be influenced by other background factors.

Controlled trials: A small number of trials were identified which investigated the impact of dairy fat from yoghurt, cheese and butter on lipid profiles – primarily LDL-C. It appears, from these studies, the impact of dairy fat on lipid profiles depends on the type of dairy product. For example, cheese and whipping cream did not impact lipid profiles in the same way as butter.[36,47] Both whipping cream and cheese elevate LDL-C, and whipping cream elevated non-HDL, apolipoprotein B:apolipoprotein A-I ratio and total cholesterol, while butter raised those factors to a considerably greater degree. Importantly, Brassard et al (2017) demonstrated the LDL response to butter was greater for individuals with a higher baseline LDL-C.[36] Brassard et al (2017) also demonstrated that both cheese and butter enriched diets increased LDL-C greater than diets enriched with MUFA, PUFA or CHO. This is as would be expected from established evidence on the impact on LDL/HDL from the replacement of saturated fat with MUFA, PUFA and/or CHO.[36] Engel & Tholstrup (2015) demonstrated the effect of practical advice to use oils rich in MUFA rather than butter in a controlled, double-blind, randomised 2 x 5 week crossover trial.[55] They found butter intake increased total cholesterol and LDL cholesterol more than did olive oil intake ($p=0.05$) and the run-in period ($P<0.005$ and $P<0.05$, respectively). Butter also increased HDL cholesterol compared with the run-in period ($P=0.05$). There are limited studies comparing fat modified versions of the same dairy subgroup. In two papers from the same study, 'reduced fat' cheese compared to 'regular fat' cheese did not result in differing impacts on lipid profiles.[37,38] Lastly, camembert cheese (60g/d) compared to 'full fat' yoghurt (250g) did not modify lipid levels or blood pressure over 3 weeks.[39]

Mechanisms of action: There are several possible ways in which dairy fat may have differing impacts on cardiovascular risk factors depending on the food source. Rosqvist et al (2015) suggest it is whether the Milk Fat Globule Membrane (MFGM) is intact which explains the difference in cholesterol outcomes. (MFGM is intact in cream but not in butter).[47] Soerensen et al (2014) suggest the presence of calcium attenuates the expected response of cheese on cholesterol by increasing faecal fat excretion[56] while Ataie-Jarfari et al (2009) suggest probiotic bacteria may play a role.[57] Concerningly, the LDL-C response to dairy fat seems of greater magnitude in people with high baseline LDL-C[33] which suggests caution for inclusion of butter, and to a degree high fat dairy products, in dietary recommendations for people with elevated LDL-C.

Relevance to dietary patterns

A systematic review of dietary patterns and cardiovascular outcomes found dairy products feature in some but not all healthy eating patterns.[7] This indicates that a heart healthy eating pattern can exist with or without dairy foods. This section summarises evidence relating to dairy compared to other protein-based foods, and the role of dairy in specific dietary patterns.

Dairy compared to other foods

There is evidence the impact of dairy depends on the other products which replace dairy or are replaced when dairy is chosen. In a pooled analysis of two US cohorts replacing dairy with plant-based protein reduced the risk of cardiovascular and all-cause mortality.[58] In this analysis there appeared to be a 'hierarchy' of animal-based products with impacts on cardiovascular outcomes. Processed meat was associated with highest risk, followed by unprocessed meat and poultry, then dairy, then fish, then eggs. In an earlier model in the Nurses' Health Study which adjusted for energy intake, replacing one serve of red meat with one serve of either 'high fat' or 'low fat' dairy was found to reduce CHD risk. Replacing one serve of fish with one serve of dairy was associated with an increased CHD risk, regardless of whether the dairy was 'low fat' or 'high fat'.[59]

The conclusions from the pooled prospective cohort on dairy fat[31] indicate the influence of dairy fat on health outcomes depends on the nature of foods which replace or are replaced by a change in dairy fat intake. For example, an earlier review of dairy fat and cardiovascular risk concluded diets higher in saturated fat from whole milk and butter increased LDL-C when substituted for carbohydrates or unsaturated fatty acids,[60] cheese raised LDL-C to a greater extent than tofu or fat modified cheeses but to a lesser degree than butter,[35] and beef fat and cocoa butter raised LDL-C to a lesser extent than dairy fat.[61]

The role of dairy in specific dietary patterns

DASH Diet: The conclusion from studies cited above that 'lower fat' dairy products (such as milk, yoghurt and 'low fat' dairy subgroup) are inversely associated with hypertension, stroke and CVD is consistent with evidence from the Dietary Approaches to Stop Hypertension (DASH) trial. DASH demonstrated a diet rich in fruit, vegetables and 'low fat' dairy products (combination diet) reduced blood pressure in both normotensive and hypertensive subjects more than a fruit and vegetable diet or the control diet.[62] This clinical trial is suggestive of a key role for 'low fat' dairy products in blood pressure regulation, although it may be that 'full fat' products can also be included.

A recent randomised crossover trial in 36 participants concluded a modified DASH diet with 'full fat' dairy (HF-DASH) was equally effective as the original DASH diet with low-fat dairy products.[63] Blood pressure was reduced similarly with the DASH and HF-DASH diets compared with the control diet. The HF-DASH diet significantly reduced triglycerides and large and medium very-low-density lipoprotein (VLDL) particle concentrations and increased LDL peak particle diameter compared with the DASH diet. The DASH diet, but not the HF-DASH diet, significantly reduced LDL cholesterol, HDL cholesterol, apolipoprotein A-I, intermediate-density lipoprotein and large LDL particles, and LDL peak particle diameter compared with the control diet.

Mediterranean Diet: In an analysis of the sources of dietary fat in the PREDIMED study, butter (HR=2.42,95% CI=1.42-4.13, p<0.01) and cheese (HR=1.32,95% CI=1.15-1.52, p<0.01) consumption was associated with a higher risk of type 2 diabetes, while whole-fat yoghurt intake was associated with a lower risk (HR=0.65, 95% CI=0.45-0.94, p=0.02). There was no association with whole milk (HR=.95, 95%CI=0.72-1.25, p=0.71).[64]

Comments on the characteristics of the evidence base

Industry funding

The association between industry funding and study outcomes has not been assessed. Elsewhere, a statistically non-significant trend was observed for industry-funded studies favouring the interests of the sponsor/funding body.[65]

Of the studies summarised in this background paper,

- Meta-analyses and systematic reviews published 2013-2018: 2/20 received industry funding or authors declared previous support from industry funding
- Meta-analyses and systematic reviews published 2009-2013, identified in hand searching: 2/8 received industry funding
- Controlled trials published 2008-2018: 6/7 received industry funding

In this evidence overview for dairy products, the number of narrative reviews reporting industry funding or relationships is notable, as are their calls for guidelines to not discriminate against full-fat dairy. The presence of these reviews, coupled with their conclusions, gives the appearance of a considerable evidence base supporting the role of dairy regardless of fat-modification in improving heart health.

Heterogeneity of data

Dairy products (specifically milk, yoghurt and cheese) appear on balance to have 'no association' with CVD outcomes in observational studies. There are limited intervention studies from which to draw conclusions. Freeman et al (2018) in an article on nutrition 'hypes' and controversies points out that the dominance of observational studies in the evidence base, along with the wide variation in dairy product definition, populations and study methods contributes to a significant degree of hetereogeneity in the data.[66] Further, Barnard et al (2017) suggest this hetereogeneity (in nutrition research more broadly) leads to null associations in meta-analyses.[67] What this means for the veracity of the current evidence base, and the ability to draw conclusions is unclear.

Observational studies

Most of the evidence available on dairy and cardiovascular health are observational studies. As such, only correlation can be commented on and the fact that dairy is a 'marker' for a higher quality diet can't be ruled out. Several papers refer to the 'milk effect', whereby consumption of dairy products is associated with characteristics of a generally accepted healthy lifestyle.[68-71] Some papers observed this milk effect to extend to the consumption of low fat dairy products.[19,29,71,72] These characteristics include young age, lower BMI, higher education status, more fruit and/or vegetable intake and reduced alcohol or tobacco consumption. While many studies attempted to adjust analyses for these confounders, the association with these behaviours means that controlling for such confounders may not fully capture the difference in determinants of health and/or socioeconomic status.

Conclusions

Studying the relationship between a food or nutrient and health outcomes is complex. The evidence base is mainly observational studies, primarily prospective cohorts, with a small number of randomised controlled trials (RCT) for outcomes including weight gain, blood pressure and blood lipids. These studies bring inherent limitations to understanding the relationships between food and health outcomes. A food cannot be studied in isolation without considering the effect of the food replacing it, observational studies are not able to determine causation, and most trials can only feasibly investigate short-term outcomes. Additionally, there is no standard classification for dairy products or standard volumes for measurement. This makes it difficult when pooling data in meta-analyses and reviews to fully understand the relationship between amounts and types of dairy products and specific health outcomes.

With these limitations in mind, the following conclusions can be made:

- The relationship between dairy foods and cardiovascular outcomes is mixed, but on balance the existing evidence on dairy foods and cardiovascular risk points to a 'neutral'[3] effect, and a possible 'protective'[4] effect with milk, cheese and yoghurt and hypertension, stroke and type 2 diabetes risk, and yoghurt and type 2 diabetes risk. The reported increased risk with heart failure and total dairy intake is of note, as is the mixed evidence on cheese with studies reporting inverse, neutral and increased risk with various cardiovascular outcomes.
- Some of the cohorts suggest inverse associations between reduced fat dairy, but not full fat, and hypertension, stroke and diabetes; while others have suggested neutral or inverse relationships with dairy regardless of fat modification.

Given this inconsistency in the evidence base there is not enough evidence to recommend fat modification (i.e. full fat over reduced fat, or reduced fat over full fat) for milk, cheese and yoghurt for the general population.

In trials, dairy fat increases LDL-C but its effect on other lipid markers and thus overall cardiovascular risk is mixed. Further, the impact of dairy fat on LDL-C depends on the type of product and the individual. Dairy fat in cheese and in cream does not raise LDL-C to the same extent as dairy fat in butter, and the LDL response to butter is greater for individuals with a higher baseline LDL-C.

This evidence suggests caution for dairy fat consumption for people with elevated LDL-C; and that milk, cheese and yoghurt should remain separately classified to butter when advising the inclusion of dairy products to include in a heart healthy eating pattern.

The influence of dairy foods on cardiovascular health depends on the quality of the broader eating pattern and the nature of foods which replace, or are replaced by, a change in dairy intake. A systematic review of dietary patterns and cardiovascular outcomes found dairy products feature in some but not all healthy eating patterns. This indicates that a heart healthy eating pattern can exist with or without dairy foods.

In summary, it is likely the consumption of milk, yoghurt and cheese (regardless of fat modification), at currently recommended amounts, in the context of a dietary pattern rich in vegetables, fruit, legumes, nuts, seeds, wholegrains, healthy oils and low in discretionary food and drinks (i.e. sugary drinks, alcohol and heavily processed foods) does not demonstrably affect cardiometabolic risk.

3 Neutral: no association in observational studies
4 Protective: inverse association in observational studies

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HH-PFN-006.1.0819