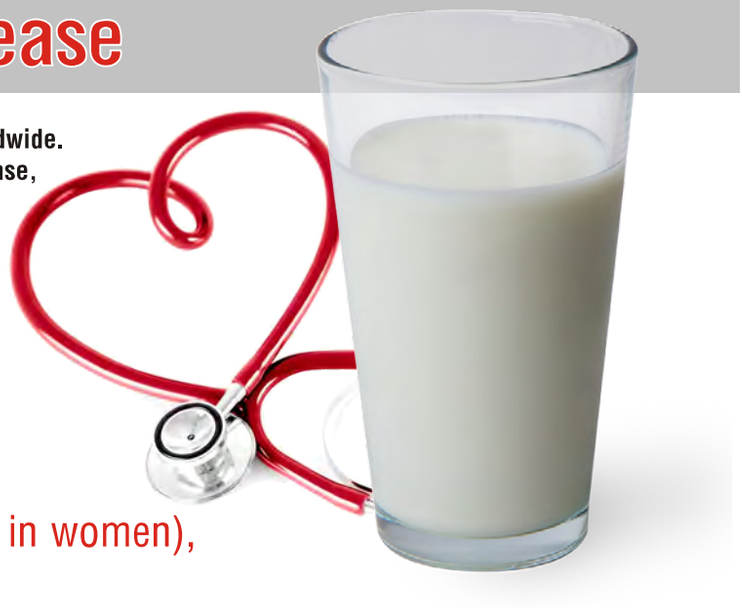
Dairy and cardiovascular disease



Cardiovascular disease (CVD) is the leading cause of death worldwide. In the USA, one in every three deaths were related to heart disease, stroke or other CVDs in 2014.[1] According to the NHANES 2011–2014 data, the prevalence of hypertension among US adults is 34%.[2]

The most recent South African mortality profile indicates cardiovascular incidents to be the second highest cause of death among South Africans (14.7% in men and 20.7% in women), following HIV/AIDS and tuberculosis.[3]

In addition, the recent South African Demographics and Health Survey indicates that 46% of adult women and 44% of adult men suffer from hypertension,[4] together with a high prevalence of overweight and obesity among South Africans (68% in women and 31% in men).[4]

Recommendations

Raised LDL and triglyceride levels, reduced HDL cholesterol levels and high blood pressure are known risk factors for CVD. In addition, lifestyle-related factors such as obesity, inactivity and smoking also appear to contribute to the risk.[5-9] Intervention strategies to assist with the prevention and treatment of CVD should focus on addressing all cardiometabolic risk factors, with a special focus on lowering LDL cholesterol and blood pressure.[5]

The intake of saturated fat generally results in an increase in LDL cholesterol, which increases the risk of atherosclerotic components[1] and so may contribute to the development of CVD.[1,6,8,10-13] Substituting saturated fat with polyunsaturated fatty acids in the diet reduces the incidence of CVD.[1] As high-fat dairy foods have high concentrations of saturated fat,[14] dietary guidelines recommend the use of low-fat dairy to reduce saturated fat intake.[5,12]

Current dietary guidelines have moved away from nutrient-based approaches and now advocate food-based dietary patterns,[15] which consider the effect of the overall diet on health rather than focus only on the effect of individual nutrients. It is believed that interactions occur between nutrients in food and that the cumulative effects are more pronounced than that of individual nutrients.[6,15] Examples of food-based dietary plans for the treatment of CVD include the Dietary Approaches to Stop Hypertension (DASH) diet, the Mediterranean diet and the American Heart Association (AHA) dietary pattern.[15]

Dietary patterns provide a good indication of overall food consumption and are regarded as a better indicator of CVD risk than individual nutrient intake.[6] The dietary pattern approach is also included in the South African Hypertension Guidelines,[16] which urge patients diagnosed with hypertension to modify their lifestyle through weight reduction, following the DASH diet pattern (decrease total and saturated fat intake and increase fruit and vegetable intake), restricting their sodium intake to less than 6 g per day, increasing their level of physical activity and consuming alcohol in moderation.[16]

A so-called 'healthy dietary pattern' is described as one consisting of higher intakes of fruit and vegetables, whole grains, low-fat or fat-free dairy, seafood, nuts and legumes. Moderate intake of alcohol and a lower intake of red and processed meat, sugar and sugar-sweetened foods and beverages and refined grains are advised.[2]

Research evidence

The recommendation to reduce the intake of saturated fats from dairy may not be evidence based as cheese and yoghurt have recently been shown to have a protective effect against cardiovascular outcomes.[13,17]

A recent review based on meta-analyses of observational studies and randomised controlled trials (RCTs) investigating the effect of milk and dairy on human health reported that the consumption of milk and dairy is associated with a number of health-promoting effects.[18] These include the facilitation of weight loss, a neutral or reduced risk for type 2 diabetes mellitus, a reduced risk for CVD (especially stroke) and a beneficial effect on bone mineral density. Inverse associations with various cancers (colorectal, bladder, gastric, breast) were also reported. No association was seen for either the incidence of bone fractures or all-cause mortality.

A prospective cohort study over 24 years reported that following the DASH diet was significantly associated with a reduced risk of CVD and stroke.[7] A higher DASH score was also associated with lower levels of the known markers of cardiometabolic risk, namely C-reactive protein and IL-6.

The effect of dairy intake and associated calcium and vitamin D intake on hypertension was determined as part of the Women's Health Study. This prospective cohort of 28 886 US women showed an inverse relationship between the intake of low-fat dairy products, calcium, vitamin D and risk for hypertension.[19] No association was reported between the intake of high-fat dairy and hypertension. Similarly, no association was found between the intake of calcium and vitamin D supplements and hypertension.

In this study, low-fat dairy intake was positively associated with healthier food choices (i.e. regular consumption of whole grains, fruit and vegetables, and reduced consumption of red meat and cholesterol-rich foods). Participants who consumed more high-fat dairy products had a less favourable lifestyle (including smoking, alcohol consumption and inactivity) and a less healthy dietary profile,[19] which may have contributed to benefits being seen only with the intake of low-fat dairy.

A meta-analysis of RCTs investigated the effects of cheese consumption on lipid parameters.[10] The effect on blood lipid levels was compared for hard cheese and dairy fat (butter, milk, tofu and fat-modified cheese) over 2–8 weeks. An intake of 3–5 servings of cheese per day (145 g) resulted in a reduction of both LDL and HDL levels. No effects were noticed for triglyceride levels.[10] Another meta-analysis, which involved various study types (n = 12), found that conflicting results were reported in observational studies (n = 4), ranging from no association to both increased and decreased risk. In intervention studies that compared the effects of cheese with that of butter, cheese intake resulted in reduced total and LDL cholesterol.[11]

Guo et al.[20] performed a meta-analysis to investigate the dose–response relationship between the consumption of milk and dairy products and all-cause mortality, CVD and coronary heart disease. A total of 29 prospective cohort studies were included, with data from 783 989 participants. Pre-defined portion sizes were used to compare data. The average duration of follow-up was 13 years (range: 5–25 years). A neutral association was found between the incidence of CVD and the intake of total dairy, high-fat dairy and low-fat dairy.[20]

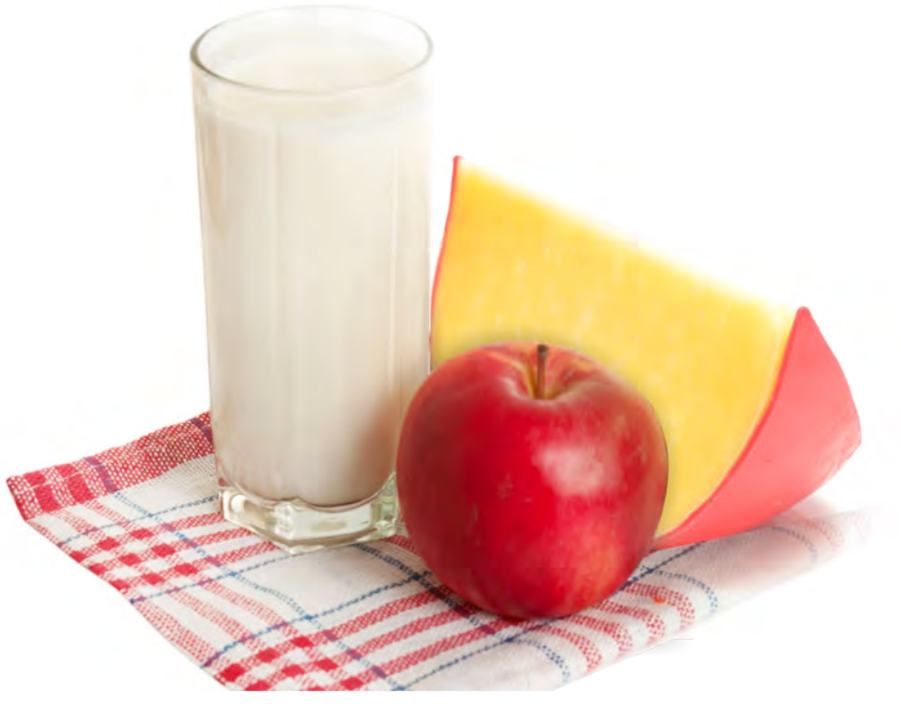
Another meta-analysis of prospective cohort studies investigating the relationship between total dairy intake and CVD (including coronary heart disease and stroke) included 27 studies published until September 2014.[21] In this analysis, an inverse association was found between both total dairy intake and CVD (10% risk reduction) and total dairy intake and stroke (12% risk reduction). No association was found between dairy intake and coronary heart disease. This study again highlighted the protective effect of dairy intake. Similarly, a meta-analysis of 13 biomarker studies (n = 7680 participants) showed insufficient evidence to support an association between dairy fat and an increased risk of CVD.[13]

Chen et al.[14] used data from three different cohorts (43 652 men from the Health Professionals FU Study: 1986–2010; 87 907 women from the Nurses Health Study 1: 1980–2012, and 90 675 women from the Nurses Health Study 2: 1991–2011) to assess the association between dairy fat and the incidence of CVD. Dairy fat intake was not significantly associated with risk of total CVD [Relative risk (RR) = 1.02], coronary heart disease (RR = 1.03) or stroke (RR = 0.99). However, replacing dairy fat with equivalent energy from other sources yielded different results. For example, the risk of CVD was 10% and 24% lower when 5% energy from dairy fat was replaced with energy from vegetable fat or polyunsaturated fatty acids, respectively. Replacing dairy fat with other animal fat sources was associated with a 6% higher risk. Replacing dairy fat with whole-grain carbohydrates resulted in a 28% reduced risk.[14] Therefore, although the effect of dairy fat on CVD risk was neutral, replacing animal and dairy fat with plant fat (including polyunsaturated fatty acids) and healthy carbohydrates is associated with significant risk reductions. These results support the current recommendations to replace animal fats with vegetable fat options.[14]

Drouin-Chartier et al.[17] conducted a systematic review of meta-analyses (n = 21) of prospective cohort studies to determine
(i) the link between total dairy intake and cardiovascular health and
(ii) whether dairy fat intake (high versus low levels) resulted in different outcomes.

Findings related to CVD, coronary artery disease, hypertension and stroke were considered in the review. All evidence was rated as neutral, positive (i.e. significant risk reductions) or negative (significant increased risk) and accompanied by levels of the evidence (high, moderate or low) based on defined criteria describing the quality of evidence. Figure 1 provides a summary of the findings. Owing to the heterogeneity of the data, most recommendations are at the moderate level.

A positive effect was seen for all markers of cardiovascular health. Total dairy intake was associated with a significant reduction in risk for hypertension and stroke, while the intake of low-fat dairy and milk was associated with a significant reduction in risk for both hypertension and stroke. The intake of low-fat dairy, cheese and fermented dairy was associated with a significant reduction in stroke risk.



Dairy intake and related outcomes.

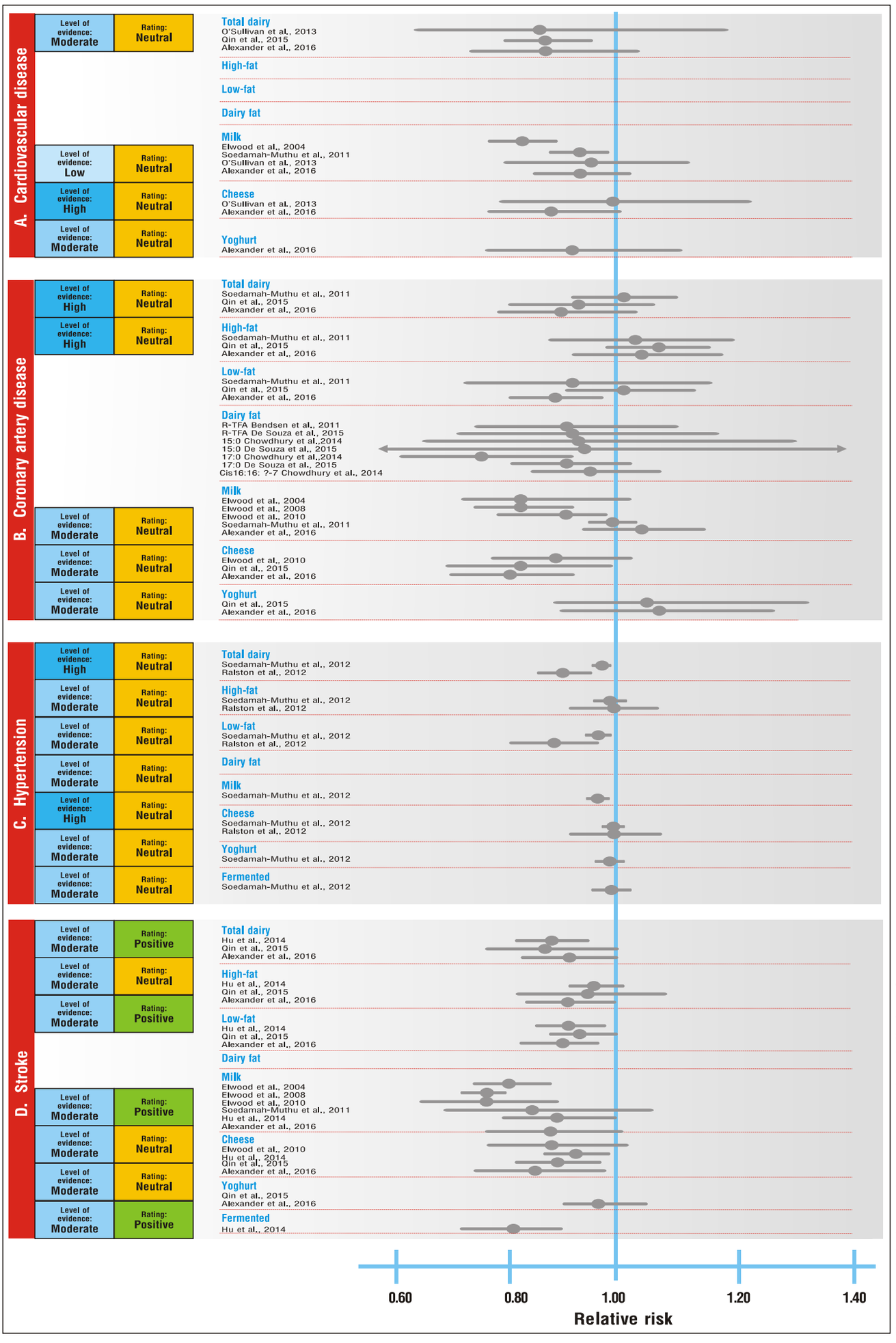


Figure 1:

Association between dairy intake and risk for (a) cardiovascular disease,(b) coronary artery disease,(c) hypertension and (d) stroke
(adapted from Drouin-Chartier et al.)[17]

Discussion

As reviewed here, it seems that literature describes inconsistent findings with regard to the association between dairy fat intake and the risk for CVD. Table 1 provides a summary of the impact of various dairy foods on cardiovascular outcomes. It is important to note that no harmful effects have been reported.[5] However, it is important to keep in mind that many factors can affect study outcomes and these should be considered in context when interpreting results.

One such factor may be duration of intake.[5] Short-term consumption, irrespective of the type of dairy or fat content, is unlikely to produce significant effects, whereas long-term consumption of total dairy and low-fat dairy and milk is associated with a reduced risk of hypertension.[5] Prolonged dairy intake also seems to have a favourable effect on glucose levels and insulin resistance.[5] The concept of a threshold effect is postulated, whereby individuals with a deficiency for a specific nutrient (e.g. calcium) will benefit from dairy intake, with little or no effect seen in those with adequate nutrient status.[6]

The adequacy of dietary intake assessment in population-based studies depends on a number of factors, namely
(i) the tools used to determine intake (e.g. food frequency questionnaires)
(ii) locally available products that the participants have to select from and that will influence their diet, and
(iii) agricultural practices (e.g. cows' diets, which can influence the composition of milk).[17]

Table 1:
Effect of dairy foods on various cardiovascular diseases[17,18,20]

Food	Favourable outcomes				Neatral outcomes				Unfavourable outcomes			
	CVD	CAD	STROKE	HT	CVD	CAD	STROKE	HT	CVD	CAD	STROKE	HT
Total dairy			X	X	X	X						
Low-fat dairy			X	X	X	X						
High-fat dairy				X	X	X	X					
Medium-fat dairy						X	X	X				
Milk				X		X	X					
Fermented dairy			X					X				
Cheese			X		X	X		X				
Yoghurt					X	X	X	X				

CVD: cardiovascular disease
CAD: coronary artery disease
HT: hypertension

Regional differences in dietary intake also cannot be ignored. For example, the average calcium intake of adults is six times higher in the USA than in China.[21] Such differences have to be considered when the results of regional studies are compared and before findings can be applied to a specific local setting.

The role of the food matrix – the combination of nutrients in the specific food structure – also should not be ignored. The food matrix affects the digestibility and absorption of nutrients and the health effects of nutrient combination may be different from those of the individual nutrients.[8,12] The collective effect of nutrients seem to be stronger than the influence of individual nutrients, which is why the nutritional value of a food item is not equal to the nutrient content of the individual nutrients.[6,12,21]

In addition to fat, dairy contains many other nutrients that may affect CVD risk.[22] The cholesterol-raising effects of saturated fatty acids in dairy seem to be attenuated by the food matrix. Consumption of cheese, and milk and yoghurt also to some extent, is not associated with negative effects on blood cholesterol and the reason for the protective effect needs further investigation.[5,10] The food matrix seems to affect LDL and HDL cholesterol levels, but does not seem to have as pronounced an effect on triglyceride levels.[5]

Table 2 summarises some of the cardiovascular health benefits associated with dairy nutrients and indicates potential mechanisms of action.

Table 2:
Summary of cardiovascular health, benefits of dairy nutrients and potential mechanisms of action.

NUTRIENT	HEALTH BENEFITS	POTENTIAL MECHANISMS
Calcium	• Reduces risk for stroke.[20,23] • Reduces blood pressure.[18,19] • Weight loss.[19,22] • Suppresses inflammatory stress.[22] • Enhances insulin sensitivity.[19]	• Improves sodium–potassium balance and lowers the activity of the renin–angiotensin system.[19] • Inhibits constriction of vascular smooth muscle.[19] • Decreases platelet aggregation and total cholesterol by forming insoluble complexes with fatty acids (soap formation), thus preventing fat absorption.[10,11,21,23] • Binds bile acids and results in less bile salt reabsorption in the enterohepatic circulation. More cholesterol is then converted to bile acids, resulting in decreased cholesterol concentrations.[11] • Increases bioavailability of calcium and other minerals in milk owing to the lack of inhibitory factors such as phytates and oxalates, as well as the presence of lactose, which aids in the absorption of calcium.[6] • Increased fat oxidation.[22]
Protein	• Both casein and whey components of protein are associated with health benefits.[6,8,10-13] • Enhances satiety and reduced risk of overweight.[22] • Improves insulin sensitivity.[22] • Reduces blood pressure.[8,22] • Casein enhances calcium absorption.[23]	• Cheese consists mainly of casein.[12] It is postulated that the fat globules in cheese are trapped in the casein matrix, which is formed from aggregated micelles.[11] • The bioactive peptides found in casein and whey inhibit angiotensin-1-converting enzyme, which results in vasodilation.[6,8,9] • The bioactive peptides also act as opiod receptor ligands to increase nitric oxide production. This mediates the arterial tone.[6,8]
Fatty acid profile	• Reduces circulating cholesterol.[10-12,20] • Neutral to reduced risk for CVD.	• Short-chain fatty acids (SFAs) are produced through microbial fermentation in the gut, which results in beneficial effects such as a lowering of cholesterol levels.[10,12,20] Varying results have been found with different ratios of SFAs produced. Inconsistent outcomes and gender differences have also been recorded.[11] • Although cheese is the dairy product with the highest fat content (especially saturated fatty acids),[13,17] it is neutrally associated with most CVD risk factors.[11,17,20] One hypothesis is that saturated fat in dairy increases LDL particle size, which has a decreased ability to permeate into arterial walls.[11]
Vitamin D	• Weight management.[22] • Improved calcium absorption.[19] • Reduces blood pressure.[19]	• Enhances the thermic effect of food.[22] • Enhances the fat oxidation rate.[22] • Maintains calcium homeostasis in the body by regulating calcium absorption in the gut and interaction with parathyroid hormone.[19] • Affects the renin–angiotensin system.[19]
Vitamin K	• Reduces blood pressure.[10]	• Vitamin K_2 (menaquinone) protects against vascular calcification.[10] • Fermentation also enhances vitamin K production.[10]
Magnesium, potassium	• Reduced risk of stroke.[20,25] • Deficiency results in insulin resistance.[24]	• Exact mechanism unknown, but hypothesised that the effect may be secondary to the reduction in blood pressure.[25]
Microbiota	• Reduce cholesterol levels.[11]	• Different species and strains of bacteria used to ferment dairy products may exert different effects on cholesterol concentrations. The various fermentation periods used in the production of dairy products can also influence the outcomes.[11] • Bacteria found in fermented dairy products may bind bile acids and thus affect cholesterol metabolism.[11]

CONCLUSION

Studies have yielded varying results regarding the effect of dairy intake on risk for cardiovascular disease. Some of the factors that may influence the findings of these studies include the total fat content and type of fat, duration of intake and the synergistic effect of the food matrix.

However, current available evidence shows that total dairy intake has a protective to neutral effect on CVD risk. This is consistent with guidelines that focus on the importance of daily dairy intake and is also in line with the South African food-based dietary guidelines, which advises consumers to 'have milk, maas or yoghurt every day'.[9] Dairy consumption in line with current recommendations (three servings per day) is unlikely to increase the risk of CVD. More specifically, dairy consumption has been shown to be inversely associated with the risk for hypertension and stroke.[18]

Intake of both low-fat and medium-fat dairy appears to be associated with protective or neutral effects. This could suggest that the recommendation to focus on low-fat dairy intake needs to be revisited, as intake of medium-fat or high-fat dairy has not been found to be associated with adverse health outcomes.

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