



# Is there real evidence for a link between milk and mortality?

## Introduction

A growing evidence base supports an inverse relationship between intake of milk and other dairy foods and the incidence of obesity, type 2 diabetes, hypertension and certain cancers (World Cancer Research Fund, 2018; Thorning et al., 2016; Rice et al., 2013).

The majority of current dietary guidelines include dairy products as part of a healthy diet (Weaver, 2014; Heaney, 2013; Rice et al., 2013). However, a Swedish study (Michaëlsson et al., 2014) controversially showed that a high intake of milk was associated with higher mortality in one cohort of women and in another cohort of men, and with higher fracture incidence in women. In a following publication, the same authors reported that a high intake of fruit and vegetables diminishes the risk of mortality due to milk consumption (Michaëlsson et al., 2017). In an effort to identify possible mechanisms, Michaëlsson et al. (2014) cite an animal study (Cui et al., 2006), and hypothesise that galactose derived from lactose in milk may induce oxidative stress, chronic inflammation, a decreased immune response and neurodegeneration, thus contributing to the risk of mortality and fracture. However, Michaëlsson et al. (2014) acknowledge that the possibility of residual confounding and reverse causality cannot be ignored (for example, women who were aware that they had osteoporosis may have consumed more milk than women without osteoporosis). For such reasons, experts suggest cautious interpretation of the results (Bonneux, 2014; Sahni et al., 2017; Labos and Brophy, 2014). Commentaries published in response to the study have questioned a number of issues, including that the multivariate model did not adjust for osteoporosis or bone mineral density (Labos and Brophy, 2014). Other criticisms included that major sex differences were not accounted for (Bonneux, 2014) and that vitamin D status and season may have impacted on both fracture risk and all-cause mortality (Hill, 2014). Sundar (2014) also suggested that the synthetic substances used in milk production at the time when cohorts were recruited may have impacted on the mortality reported in the study. Van den Heuvel and Steijns (2018) pointed out that, in addition to high levels of milk consumption compared with that in most other

countries, the dietary questionnaires were performed in 1987–1990 and 1997, when milk in Sweden was fortified with a high dose of vitamin A. High levels of vitamin A have been linked to increased fracture risk and although retinol intake was considered as a confounding factor in the Swedish studies, it is questioned whether the single assessments of intake are valid enough; owing to the high variance ratio (ratio of intrasubject to intersubject variances) of vitamin A, multiple assessments would have been required.

As confounding is a limitation of observational studies, randomised controlled intervention trials are required to investigate causality. In the case of milk intake, however, interventions need to be implemented over a long period to investigate the association between milk intake and any outcome (e.g. mortality). This is often not realistic. As an alternative, Mendelian randomisation studies are useful to indirectly investigate the association in a similar way as in a randomised controlled intervention trial. As Bergholdt et al. (2015) have noted, ‘in a Mendelian randomisation study, a genetic variant is used as a proxy for the exposure to lactose-containing milk products, and the Mendelian randomisation design can be very useful when large long-term interventions are not feasible. Indeed, the random assortment of alleles at conception ensures random distribution of confounding factors, and this approach thereby circumvents reverse causation and most confounding factors that may influence results from observational studies.’

In view of the mentioned limitations and in the absence of evidence from randomised controlled trials (which would be unethical to perform), the results of the Michaëlsson study need to be interpreted with caution. It should be emphasised that the analysis of women in the initial study by Michaëlsson et al. (2014) is strikingly different from other published studies, as shown by the meta-analysis of Larsson et al. (2015): a clear linear dose–response with very narrow confidence intervals (suggesting a very limited effect of potentially confounding factors on the outcome) as compared with 13 other studies with non-linear associations and much wider confidence intervals.

Nonetheless, the study has cast doubt on the health benefits of milk. For this reason, the current fact sheet aims to summarise the recent evidence on milk and mortality.

## The evidence

Despite the limitations described above, the study by Michaëlsson et al. (2014) did include two large independent cohorts of women (61 433) and men (45 339), with a mean follow-up of 20 and 13 years, respectively. Although these authors reported an association between higher milk consumption (i.e. three or more glasses per day ( $\geq 600$  g/d) compared with less than one glass per day ( $< 200$  g/d)) and increased all-cause mortality, it is peculiar to note that they also found that cheese, yoghurt and soured milk consumption was significantly associated with a decrease in all-cause mortality.

A number of meta-analyses have assessed the association between dairy and mortality.

Stroke deaths accounted for 11.8% of total deaths worldwide in 2015 (Benjamin et al., 2018). Dairy consumption and risk of stroke was systematically reviewed based on studies from Asian and Western countries. This meta-analysis of 18 prospective observational studies, with between 8 and 26 years of follow-up and including 762 414 individuals (29 943 stroke events), showed that consumption of milk and cheese was inversely associated with risk. Dose-response analyses revealed that risk reductions were maximal around 125 g/day for milk and from 25 g/day upwards for cheese. An increment of 200 g of daily milk intake was associated with a 7% lower risk of stroke. Dose-response relationships for milk are non-linear, as also described by Hu et al. (2014) in their meta-analysis: relative risks were 0.88, 0.82, 0.83, 0.85, 0.86, 0.91 and 0.94, respectively, for every increment of 100 ml within the range up to 700 ml per day.

Guo et al. (2017) estimated the mortality risk of milk and dairy consumption from an analysis of 29 cohorts, which spanned 938 465 participants, 93 158 deaths, 25 416 cases of cardiovascular disease and 28 419 cases of coronary heart disease. Overall, neutral associations were demonstrated between intake of dairy products and cardiovascular and all-cause mortality, taking into

account various sensitivity analyses, such as removing the female cohort of the study by Michaëlsson et al. (2014). This has been confirmed by the Prospective Urban Rural Epidemiology (PURE) study by Dehghan et al. (2018). Findings from this multinational cohort study, which included individuals aged 35–70 years across 21 countries and five continents, showed that dairy consumption was associated with a lower risk of mortality and major cardiovascular disease.

Others investigators have chosen to compare milk intake as part of dietary habits associated with better dietary quality, as, overall, milk and milk product intake is associated with better dietary quality. For example, the hypertensive benefits of a diet rich in fruit, vegetables and low-fat dairy, coupled with reduced total fat and saturated fat intake, have been demonstrated in the Dietary Approaches to Stop Hypertension (DASH) clinical trial (Appel et al., 1997), with about 50% of the reduction in blood pressure associated with the DASH diet ascribed to dairy consumption. A recent meta-analysis showed that high adherence to diet quality indices such as DASH was associated with a 22% decrease in the risk of all-cause mortality (Schwingshackl and Hoffmann, 2015).

More recently, Schwingshackl et al., (2017) completed a meta-analysis of prospective studies, in which they investigated the associations of intake of 12 food groups with all-cause mortality risk. For the dairy food group they included 27 studies (126 759 mortality cases; overall intake range: 0–1041 g/d).

When they compared mortality of participants with the highest versus the lowest dairy intake, no association was observed for either of these intake levels, nor for 200-g increments of additional dairy intake daily. In subgroup analyses, no significant difference was observed between consuming low-fat and full-fat dairy products. A non-linear dose-response association was seen between intake of dairy products and all-cause mortality (12 studies); no detrimental effects were observed up to an intake of 750 g/d. The risk of mortality decreased by 11% with increasing intake of vegetables up to 300 g/d; no benefit was apparent when increasing intake above this value. With regard to fruit intake, the risk of all-cause mortality decreased by 10%, with increasing intake up to

250–300 g/d; no benefit was apparent when increasing intake above this value. An association with all-cause mortality was found for 9 of the 12 food groups based on categorical or continuous dose-response analyses. An inverse association was present for consumption of whole grains, vegetables, fruit, nuts, legumes and fish, whereas a positive association was present for consumption of red meat, processed meat, eggs and sugar-sweetened beverages. Dairy products were not used for optimal consumption calculations because of the two cohorts in the study published by Michaëlsson et al. (2014).

## Conclusion

In light of all the reviewed evidence, an association between the consumption of milk products and mortality risk is not justified. The vast majority of evidence evaluated does not support an association between consumption of milk and other dairy products and increased all-cause mortality.

Studies vary considerably with regard to study design,

participants (age, weight, ethnicity, health status, amount of milk consumed and cause of mortality) and dairy products included. Although they have been adjusted for in some publications, factors that may impact on health outcomes include smoking, alcohol consumption and other dietary confounders (such as total energy intake, calcium intake, fruit and vegetable intakes, and intakes of red meat and processed meat).

Several potential bioactive components in milk have been proposed, including calcium, vitamin D, dairy proteins (casein, whey and milk peptides such as lactotriptides), dairy fat (especially trans-palmitoleic acid) and lactose. Furthermore, Thorning et al. (2017) have suggested that the different dairy food matrices may have distinct effects on health. Although various components of milk have been reported to potentially be responsible for health properties, nutrients and foods are usually consumed in combination, which makes it difficult to determine the component responsible for a specific observed effect. Furthermore, a combination of nutrients may have an effect that would not be visible in isolation.

## Reference list

- Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med.* 1997;336(16):1117-1124.
- Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, et al. Heart Disease and Stroke Statistics—2018 Update: Chapter 13. *Circulation.* 2018;137:e67–e492.
- Bergholdt HKM, Nordestgaard BG, Varbo A, Ellervik C. Milk intake is not associated with ischaemic heart disease in observational or Mendelian randomization analyses in 98 529 Danish adults. *Int J Epidemiol.* 2015;44(2):587-603. doi: 10.1093/ije/dyv109.
- Bonneux L. Unaccounted sex differences undermine association between milk intake and risk of mortality and fractures (Letter to the editor). *Brit Med J.* 2014;349:g7012. doi: 10.1136/bmj.g7012.
- Cui X, Zuo P, Zhang Q, Li X, Hu Y, Long J, et al. Chronic systemic D-galactose exposure induces memory loss, neurodegeneration, and oxidative damage in mice: protective effects of R-alpha-lipoic acid. *J Neurosci Res.* 2006;83:1584-1590.
- CUP. World Cancer Research Fund, 2018; <https://www.wcrf.org/dietandcancer/exposures/meat-fish-dairy>
- Dehghan M, Mente A, Rangarajan S, Sheridan P, Mohan V, Iqbal R, et al. Association of dairy intake with cardiovascular disease and mortality in 21 countries from five continents (PURE): a prospective cohort study. *Lancet.* 2018. Published online September 11, 2018. [http://dx.doi.org/10.1016/S0140-6736\(18\)31812-9](http://dx.doi.org/10.1016/S0140-6736(18)31812-9)
- Guo J, Astrup A, Lovegrove JA, Gijsbers L, Givens DI, Soedamah-Muthu SS. Milk and dairy consumption and risk of cardiovascular diseases and all-cause mortality: dose-response meta-analysis of prospective cohort studies. *Eur J Epidemiol.* 2017;32:269-287.
- Heaney RP. Dairy intake, dietary adequacy, and lactose intolerance. *Adv Nutr.* 2013;4(2):151-156. doi: 10.3945/an.112.003368.
- Hill TR. Vitamin D status, bone fracture, and mortality. *Brit Med J.* 2014;349:g6995.
- Hu D, Huang J, Wang Y, Zhang D, Qu Y. Dairy foods and risk of stroke: a meta-analysis of prospective cohort studies. *Nutr Metab Cardiovasc Dis.* 2014. 24(5):460-469. doi: 10.1016/j.numecd.2013.12.006
- Labos C, Brophy J. Statistical problems with study on milk intake and mortality and fractures (Letter to the editor). *Brit Med J.* 2014;349:g6991. doi: 10.1136/bmj.g6991.
- Larsson SC, Crippa A, Orsini N, Wolk A, Michaëlsson K. Milk consumption and mortality from all causes, cardiovascular disease, and cancer: a systematic review and meta-analysis. *Nutrients.* 2015;7:7749-7763. doi:10.3390/nu7095363
- Michaëlsson K, Wolk A, Langenskiöld S, Basu S, Warensjö Lemming E, Melhus H, et al. Milk intake and risk of mortality and fractures in women and men: cohort studies. *Brit Med J.* 2014;349:g6015.
- Michaëlsson K, Wolk A, Lemming EW, Melhus H, Byberg L. Intake of milk or fermented milk combined with fruit and vegetable consumption in relation to hip fracture rates: a cohort study of Swedish women. *J Bone Miner Res.* 2017;33(3):339-457. DOI 10.1002/jbmr.3324.
- Michaëlsson K, Wolk A, Melhus H, Byberg L. Milk, fruit and vegetable, and total antioxidant intakes in relation to mortality rates: cohort studies in women and men. *Am J Epidemiol.* 2017;185(5):345-361.
- Rice BH, Quann EE, Miller GD. Meeting and exceeding dairy recommendations: effects of dairy consumption on nutrient intakes and risk of chronic disease.

Nutr Res. 2013;71:209-223.

Sahni S, Soedamah-Muthu SS, Weaver CM. Higher milk intake increases fracture risk: confounding or true association? *Osteoporos Int.* 2017;28:2263-2264.

Schwingshackl L, Hoffmann G. Diet quality as assessed by the Healthy Eating Index, the Alternate Healthy Eating Index, the Dietary Approaches to Stop Hypertension score, and health outcomes: a systematic review and meta-analysis of cohort studies. *J Acad Nutr Diet.* 2015;115:780-800.e5.9

Schwingshackl L, Schwedhelm C, Hoffmann G, Lampousi A, Knüppel S, Iqbal K, et al. Food groups and risk of all-cause mortality: a systematic review and meta-analysis of prospective studies. *Am J Clin Nutr.* 2017;105(6):1452-1473. doi: 10.3945/ajcn.117.153148.

Sundar S. Milk and mortality: the potential effects of modern milk production. *Brit Med J.* 2014;349:g7006.

Thorning TK, Bertram HC, Bonjour J, De Groot L, Dupont D, Feeney E, et al. Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. *Am J Clin Nutr.* 2017;105(5):1033-1045. doi: 10.3945/ajcn.116.151548.

Thorning TK, Raben A, Tholstrup T, Soedamah-Muthu SS, Givens I, Astrup A. Milk and dairy products: good or bad for human health? An assessment of the totality of scientific evidence. *Food Nutr Res.* 2016;60:3252

Van den Heuvel EGHM, Steijns JMJM. Dairy products and bone health: how strong is the scientific evidence? *Nutr Res Rev.* 2018. 21:1-15., doi:10.1017/S095442241800001X.

Weaver CM. How sound is the science behind the dietary recommendations for dairy? *Am J Clin Nutr.* 2014;99:1217S-1222S.

pel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med.* 1997;336(16):1117-1124.

Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, et al. Heart Disease and Stroke Statistics—2018 Update: Chapter 13. *Circulation.* 2018;137:e67–e492.

Bergholdt HKM, Nordestgaard BG, Varbo A, Ellervik C. Milk intake is not associated with ischaemic heart disease in observational or Mendelian randomization analyses in 98 529 Danish adults. *Int J Epidemiol.* 2015;44(2):587-603. doi: 10.1093/ije/dyv109.

Bonneux L. Unaccounted sex differences undermine association between milk intake and risk of mortality and fractures (Letter to the editor). *Brit Med J.* 2014;349:g7012. doi: 10.1136/bmj.g7012.

Cui X, Zuo P, Zhang Q, Li X, Hu Y, Long J, et al. Chronic systemic D-galactose exposure induces memory loss, neurodegeneration, and oxidative damage in mice: protective effects of R-alpha-lipoic acid. *J Neurosci Res.* 2006;83:1584-1590.

CUP. World Cancer Research Fund, 2018; <https://www.wcrf.org/dietandcancer/exposures/meat-fish-dairy>

Guo J, Astrup A, Lovegrove JA, Gijbbers L, Givens DI, Soedamah-Muthu SS. Milk and dairy consumption and risk of cardiovascular diseases and all-cause mortality: dose-response meta-analysis of prospective cohort studies. *Eur J Epidemiol.* 2017;32:269-287.

Heaney RP. Dairy intake, dietary adequacy, and lactose intolerance. *Adv Nutr.* 2013;4(2):151-156. doi: 10.3945/an.112.003368.

Hill TR. Vitamin D status, bone fracture, and mortality. *Brit Med J.* 2014;349:g6995.

Hu D, Huang J, Wang Y, Zhang D, Qu Y. Dairy foods and risk of stroke: a meta-analysis of prospective cohort studies. *Nutr Metab Cardiovasc Dis.* 2014. 24(5):460-469. doi: 10.1016/j.numecd.2013.12.006

Labos C, Brophy J. Statistical problems with study on milk intake and mortality and fractures (Letter to the editor). *Brit Med J.* 2014;349:g6991. doi: 10.1136/bmj.g6991.

Larsson SC, Crippa A, Orsini N, Wolk A, Michaëlsson K. Milk consumption and mortality from all causes, cardiovascular disease, and cancer: a systematic review and meta-analysis. *Nutrients.* 2015;7:7749-7763. doi:10.3390/nu7095363

Michaëlsson K, Wolk A, Langenskiöld S, Basu S, Warensjö Lemming E, Melhus H, et al. Milk intake and risk of mortality and fractures in women and men: cohort studies. *Brit Med J.* 2014;349:g6015.

Michaëlsson K, Wolk A, Lemming EW, Melhus H, Byberg L. Intake of milk or fermented milk combined with fruit and vegetable consumption in relation to hip fracture rates: a cohort study of Swedish women. *J Bone Miner Res.* 2017;33(3):339-457. DOI 10.1002/jbmr.3324.

Michaëlsson K, Wolk A, Melhus H, Byberg L. Milk, fruit and vegetable, and total antioxidant intakes in relation to mortality rates: cohort studies in women and men. *Am J Epidem.* 2017;185(5):345-361.

Rice BH, Quann EE, Miller GD. Meeting and exceeding dairy recommendations: effects of dairy consumption on nutrient intakes and risk of chronic disease. *Nutr Res.* 2013;71:209-223.

Sahni S, Soedamah-Muthu SS, Weaver CM. Higher milk intake increases fracture risk: confounding or true association? *Osteoporos Int.* 2017;28:2263-2264.

Schwingshackl L, Hoffmann G. Diet quality as assessed by the Healthy Eating Index, the Alternate Healthy Eating Index, the Dietary Approaches to Stop Hypertension score, and health outcomes: a systematic review and meta-analysis of cohort studies. *J Acad Nutr Diet.* 2015;115:780-800.e5.9

Schwingshackl L, Schwedhelm C, Hoffmann G, Lampousi A, Knüppel S, Iqbal K, et al. Food groups and risk of all-cause mortality: a systematic review and meta-analysis of prospective studies. *Am J Clin Nutr.* 2017;105(6):1452-1473. doi: 10.3945/ajcn.117.153148.

Sundar S. Milk and mortality: the potential effects of modern milk production. *Brit Med J.* 2014;349:g7006.



**International Dairy Federation**  
www.fil-idf.org