Milk, heart disease and obesity: an examination of the evidence

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Abstract

Milk drinking causes a rise in serum cholesterol level and it is therefore assumed that this will increase vascular disease risk. At the same time, a reduction in blood pressure by milk is largely ignored. An overview of large, long-term cohort studies gives no evidence of an increase, but rather, a significant reduction in vascular disease risk in subjects with a high milk intake relative to those who report drinking little or no milk.

Overweight is a positive factor in vascular disease and a common perception of milk is that it causes an increase in body weight. However, many observational studies show a negative association and while there have been only a few randomised trials, overall these support a beneficial effect of milk on weight, on body fat, and upon weight loss achieved by a calorie reduced diet. The mechanisms involved in these relationships are inadequately understood, but calcium is likely to be involved. Milk is the major source of calcium, and yet milk intakes in the UK and in many other countries have been falling for many years.

In view of the evidence of benefit in vascular disease and on body weight, it is argued that every effort should be made to reverse the present decline in milk consumption.

Key words: milk, ischaemic heart disease, stroke, body weight.

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Introduction

The consumption of milk appears to be widely believed to be an important positive factor in heart disease risk and at least 10 mechanisms have been advanced in the literature to support this.[1]

The Chief Medical Officer in England and many others have identified obesity as a major health problem. It is said that overweight "will soon surpass smoking as the greatest cause of premature loss of life (and) will entail levels of sickness that will put enormous strains on the health service".[2] Overweight is a significant factor in heart disease[3,4] and milk drinking is widely thought to promote weight gain.[5-7] Advice on the reduction of cardiovascular risk therefore often includes a limitation on the amount of milk in the diet.[8,9]

These perceptions of milk as a factor in heart disease and in weight gain have led to a very marked reduction in milk consumption over the past 25 years in the UK and in other countries.[5,6,10-12] As a consequence, dietary intakes of calcium by adolescents and by women now fail to reach the levels recommended by appropriate authorities.[13-15]

In this report we summarise evidence identified in literature searches on the relevance of milk consumption to vascular disease, and to body weight.

Milk and vascular disease

A literature search identified 10 cohort studies of milk consumption and vascular disease incidence[16-25] and an overview has been reported elsewhere.[26] The studies were all large and long-term (table 1). Only one[20] gives a suggestion of an increased risk from milk consumption, but this had involved a cohort of selected vegetarians and the estimate had been based on only 63 heart disease deaths. On the other hand, pooled weighted estimates of the relative odds in all 10 studies, based on 8,500 vascular disease events, yield risk estimates in the subjects with the highest intakes of milk or dairy produce that are consistent with a reduction compared with subjects with the lowest milk consumption. In summary, the relative risks are: 0.83 (0.77 to 0.90) for ischaemic stroke; 0.87 (95%C.I. 0.74 to 1.03) for ischaemic heart disease; and 0.84 (0.78 to 0.90) for either vascular event.

In all 10 studies, estimates of milk consumption had been derived from food frequency questionnaires. This technique has been criticised, although the errors appear to be small for a clearly identifiable food item such as milk. Furthermore, within one of the cohorts, estimates of milk consumption had been derived from seven-day weighed intake records kept by a subsample of 665 men, and a similar reduction in vascular disease incidence was observed.[27] It is, of course, possible that the observed protection results from residual confounding. However, the 10 stud-

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Table 1. Cohort studies of milk/dairy consumption and vascular disease

Study	Number of subjects followed	Intake comparison	Number of events/deaths	Relative risk of an event+
Snowdon *et al.*[16]	8,724 men; 15,048 women (45–64 years)	Seven+ cups of milk/day *vs.* none	758 male fatal IHD 841 female fatal IHD	0.94 1.11
Shaper *et al.*[17]	7,735 men (40–59 years)	Men with high intake *vs.* men who took 'none'	608 IHD events	0.88
Vijver *et al.*[18]	1,340 men; 1,265 women (40–65 years)	Top fifth of total calcium intake *vs.* bottom fifth	366 male IHD deaths 178 female IHD deaths	0.77 0.91
Abbott *et al.*[19]	3,150 men (55–68 years)	Top 1/3 of 'portions' of milk drunk *vs.* lower 1/3	229 strokes	0.67
Mann *et al.*[20]	10,802 vegetarians (16–79 years)	Those who drank 1/2 pint/day *vs.* less than 1/2 pint	63 IHD deaths	1.50
Bostic *et al.*[21]	34,486 women (55–69 years)	Top 1/4 of 'milk products' *vs.* lowest 1/4	387 IHD deaths	0.94
Iso *et al.*[22]	85,764 women (34-59 years)	Women who drank 1 1/3+ pints per day *vs.* < 1/3 pint	347 strokes	0.70
Kinjo *et al.*[23]	223,170 men and women	Top fifth of total calcium intake *vs.* bottom fifth	3,085 strokes	0.85
Ness *et al.*[24]	5,765 men (35–64 years)	Two glasses of milk drunk/day *vs.* none	892 IHD deaths 196 stroke deaths	0.68 0.84
Elwood *et al.*[25]	2,512 men (45–59 years)	Men who drank 1+ pint per day *vs.* under 1/3 pint/day	440 IHD events 173 ischaemic strokes	0.71 0.66

Key: + Risk of a vascular event (stroke or ischaemic heart disease event) in the subgroup with the highest intake of milk and or dairy produce (as defined in the original paper), relative to the risk in the subgroup with little or no milk consumption; IHD = ischaemic heart disease.

ies had been conducted by different observers, in different populations and with adjustments in each study for a variety of possible confounding factors. It is difficult to see how some further, unknown factor(s) related to milk consumption could turn pooled negative relationships into positive ones.

Many mechanisms have been suggested to support the belief that milk drinking is a positive factor in vascular disease, but most attention has focused on the rise in blood cholesterol levels that milk drinking causes. A large number of short-term studies have been reported which investigate this effect, with somewhat inconsistent results. Nevertheless, Roberts *et al.*,[28] based on a review of experimental data, judged that milk drinking raises blood cholesterol by about 9%, or about 30% of a SD.

On the other hand, there is evidence that drinking milk lowers blood pressure. The best evidence probably comes from an overview of randomised trials,[29] in nine of which the extra calcium came from milk or dairy products. Calcium from dairy sources was judged to have a greater effect on blood pressure than a calcium carbonate preparation, and the estimation of its effect was a reduction of 2.16 (3.04 to 1.29) mmHg systolic and 1.28 (1.86 to 0.69) diastolic. These each represent lower blood pressures by about 15% of a SD.

Milk and body weight

Cross-sectional data in many reports show that subjects who drink milk have a lower body weight, or a lower body mass index, than subjects who take little or no milk. Similarly, many cohort studies show a negative relationship between the consumption of milk or dairy produce at base-line and in subsequent changes in weight. A full review of observational studies is clearly outside the scope of this report but details of some studies[5,7,17-19,21,22,24,25,30-37] are given in table 2. On the whole they support a negative association.

There appear to have been relatively few randomised trials of the effect of changes in the consumption of milk or dairy produce on body weight. Table 3 gives details of trials that have been identified in a literature search.[6,38-48] These differed greatly in design. Two trials[6,47] gave no evidence of any weight advantage from dairy food consumption but the other studies all suggest an enhancement of weight loss by milk or by a calcium supplement.

In their report of an overview, Davies *et al*.[39] found the relationships between calcium intake and body weight to be homogenous in four observational studies and one randomised trial, all based on female subjects. They judged that the relationship was much stronger in young women and they estimated an odds ratio of 2.25 for overweight (BMI over 26 kg/m^2) in those whose calcium intakes were below average.

In another overview which included two of the randomised trials above and a number of trials on animals, Teegarden[42] judged that calcium intake negatively predicts changes in weight and fat mass, but only in subjects whose calorie intakes were

Table 2. Observational studies of milk/dairy consumption and body weight

Authors	Details of study	Conclusions
McCarron *et al.*[30]	NHANES I data base: 10,372 subjects (18–74 years old)	Dietary calcium was associated negatively with BMI; r = -0.59, p<0.001
Shaper *et al.*[17]	Prospective study of 7,735 men	Proportion of men with BMI 28.0 or greater was 27% in fifth with lowest milk intake and 16% in fifth with highest intake
Vijver *et al.*[18]	Prospective study of 1,340 men, 1,265 women	Difference in base-line BMI in highest – lowest fifth of milk intakes – 0.6 kg/m^2 (22% of SD)
Abbott *et al.*[19]	Prospective study of 3,150 men	Difference in base-line BMI in highest – lowest fifth of milk intakes – 0.8 kg/m^2 (25% of SD)
Cadogan *et al.*[31]	82 girls (12 years) randomised to an extra 1 pint milk/day for 18 months	The extra milk caused a significant increase in bone acquisition, but no additional weight gain
Bostic *et al.*[21]	Prospective study of 34,486 women	Difference in base-line BMI highest – lowest fifth of milk intakes – 1.0 kg/m^2 (25% of SD)
Iso *et al.*[22]	Prospective study of 34,486 women	Difference in base-line BMI highest – lowest fifth of milk intakes – 0.3 kg/m^2 (9% of SD)
Zemel *et al.*[32]	Re-examination of NHANES III data	The odds ratio of 'obesity' in subjects with the highest milk intake was only 0.16 (0.03–0.80): calcium from dairy sources had a greater effect on fat deposition than a comparable amount of elemental calcium
Lin *et al.*[33]	Two-year prospective study in 54 women (18–31 years)	Calcium intake has a negative relationship with two-year changes in body weight and body fat in young women
Carruth & Skinner[34]	53 infants followed for up to eight years	Calcium intakes and servings of dairy foods were associated with lower body fat
Ness *et al.*[24]	Prospective study of 5,765 men	Difference in base-line BMI highest – lowest fifth of milk intakes + 0.9 kg/m^2 (SD not stated)
Pereira *et al.*[35]	Prospective study of 3,157 young adults (the CARDIA study)	Inverse associations found between dairy intake and development of obesity. Components of the insulin resistance syndrome lower by 2/3 in overweight subjects with high dairy food intake
Heaney[36]	Extrapolation from observational data on 564 women	Increasing calcium intake estimated to reduce the prevalence of "overweight" and "obesity" by "perhaps as much as 60–80%"
Jacqmain *et al.*[37]	235 men, 235 women	"A low calcium intake is associated with greater adiposity, particularly in women"
Phillips *et al.*[5]	Study of 196 girls (8–12 years), followed until four years after menarche	Dairy food intake fell with age (15% over six years) but there was no relationship between this and either BMI or per cent body fat
Elwood *et al.*[25]	Observational study of 2,512 men	BMI in men who drank 1 + pint per day was 25.4 kg/m^2, those who drank little or none 26.7 kg/m^2 (p<0.001)
Novotny *et al.*[7]	Study of 323 girls (9–14 years)	Calcium intake negatively associated with skinfold thickness and positively associated with height

Key: BMI = body mass index; SD = standard deviation; NHANES = National Health and Nutrition Examination Survey

below the mean. She estimated that dairy calcium intakes account for between 10 and 13% of the variability between individuals in the loss of weight and fat mass. A further estimate made by Teegarden was that in women with intakes of around 1,800 calories/day, a calcium intake of 1,000 mg/day would predict a weight loss over two years which would be lower by about 2.6 kg, compared with a gain of about 1.8 kg if the calcium intake were only 500 mg/day.

In a re-examination of six observational and three intervention trials Heaney *et al.*[43] estimated that each increment of 300 mg of dietary calcium, most of which came from milk, is associated with approximately 1 kg less body fat in children and 2.5–3.0 kg less body weight in adults.

Several mechanisms have been identified which might explain this apparent association between milk drinking and body weight. It could be that milk and other liquids taken with a meal increase satiety but the evidence on this is inconclusive.[49] Nevertheless, it appears that dietary fat increases short-term satiety[50] and if milk taken with a meal does increase satiety and reduce calorie intake, the effect could well be greatest with full-fat milk, but this hypothesis requires testing.

Other possible mechanisms include the facts that calcium has a key role in regulating adipocyte lipid metabolism and triglyceride storage, and by modulating energy use it further attenuates the risk of obesity oxidation.[32,51,52]

Table 3. Randomised controlled trials of dairy produce and weight loss

Authors	Details of study	Results	Conclusions
Recker *et al.*[38]	A calcium supplement was randomised to 216 elderly women for four years. Data on weight reported by Davies *et al.*[39]	Weight loss was 0.67 kg/year in women given a 1,200 mg calcium supplement, 0.33 kg/year in the control women	Weight loss in women given the calcium supplement was doubled
Barr *et al.*[40]	At random, 101 subjects given extra three cups of milk; 103 subjects had usual diet for 12 weeks.	The milk group gained 0.6 kg more than the control group given no extra milk	Weight gain from milk was less than expected suggesting there is some compensation for the added energy from the milk
Zemel *et al.*[41]	11 obese men randomised to additional calcium in yoghurt. Data on weight reported by Teegarden.[42] Weight data also reported by Heaney *et al.*[43]	Control men had around 500 mg calcium/day, men on yogurt had around 1,000 mg/day. After one year men on yogurt had significantly less body fat	Two helpings of yogurt per day for one year led to a 4.9 kg decrease in body fat
Barger-Lux *et al.*[44]	Three-year, double-blind, placebo-controlled three-year trial in 52 women. Data reported by Teegarden[42]	Women given 1,500 mg calcium supplement per day had a reduced body fat increase	The benefits of a calcium supplement in young women may include attenuation of the gain in body fat mass
Weaver *et al.*[45]	54 women randomised into an exercise or non-exercise group. Data on weight reported by Teegarden[42]		Dietary calcium negatively predicted changes in weight and body fat
Zemel *et al.*[46]	RCT with 32 obese adults randomised to low calcium diet, a calcium supplemented diet and a high dairy diet for 24 weeks	Fat loss was similar but weight loss was 6.4% of body weight on the low calcium diet, 8.6% on the high calcium diet and 10.5% on the high dairy diet ($p<0.01$)	Increased calcium leads to an increased loss of weight and fat, and a decrease in waist circumference. Calcium from dairy sources led to the greatest changes
Bowen *et al.*[47]	50 overweight adults assigned at random to iso-caloric diets high in dairy protein, or mixed protein, for 12 weeks	Weight loss was independent of diet. The diet high in dairy protein led to a small but significant reduction in bone resorption	A diet high in dairy protein led to no additional weight loss
Lappe *et al.*[6]	59 girls (nine years old) randomised to additional dietary calcium mostly from dairy foods	Girls on the calcium-rich diet received 70% more calcium than girls on their usual diet, but over two years they gained no more weight or body fat	A calcium-rich diet caused no additional body weight or fat during growth
Shapses *et al.*[48]	100 women randomised to 1 g additional calcium for 25x3 weeks during a weight loss programme	There were small but non-significant differences in weight and fat loss: placebo -6.2 kg, calcium -7.0 kg (n.s.)	The magnitude and direction of the effect are consistent with a hypothesised small effect

Discussion

Vascular disease

While mechanisms relevant to milk and body weight appear to have been well studied, those that may be relevant to milk and vascular disease have been inadequately studied. This appears to have been due to the way that an effect on blood cholesterol level has dominated the attention of research workers and commentators. In fact, the literature on cholesterol is somewhat inconsistent and one hesitates to assess the magnitude of the effect of milk drinking. In any case, while it is possible to predict the likely effect of a rise in cholesterol level on vascular disease risk, and to take into account at the same time the beneficial effect of milk on blood pressure, any attempt to do so would make the unwarranted assumption that these are the only two mechanisms relevant to milk consumption and vascular disease.

It is unlikely that the direct relationship between the consumption of milk and dairy produce and vascular disease will ever be adequately tested in a randomised trial. The numbers of subjects that would be required and the duration and degree of compliance that would be demanded would be unacceptable.

The best available evidence on milk drinking and vascular disease has to come from cohort studies and the 10 such studies identified give no convincing evidence of any increased vascular risk. Rather, they indicate that milk drinking is associated with a reduction of about 15% in the risk of vascular disease.[26]

Unfortunately there is almost no evidence on the relative merits of full fat and reduced fat milks and there probably never will be. Again, a randomised trial of adequate size would be unacceptable. Nevertheless, all the 10 cohort studies had been set up when fat-reduced milks were unavailable, and it would seem reasonable to assume that the risk estimates obtained relate very largely to the consumption of whole milk. A case-control study[53] is of limited help in this context, in that a comparison of the past diets of hospital patients admitted with acute myocardial infarction, gave an odds ratio for milk drinking of 0.89 (0.57 to 1.38) for 59 patients whose diet had included full fat milk, compared to 0.83 (0.59 to 1.16) in 330 patients who had taken semi-skimmed milk.

Body weight

It is difficult to summarise the data on body weight and milk drinking from the observational studies. A negative association seems likely (table 2), but it cannot be assumed that the relationships are independent of confounding. Nevertheless, the weighted mean of six of the studies, the design and presentation of which was fairly similar,[17-19,21,22,24] is a difference in BMI of about 0.6 kgm^2, which is about 16% of a SD.

The results from the randomised trials are also encouraging (table 3) although these too show inconsistencies. The ad-hoc trial by Zemel *et al.*[46] was a relatively straightforward test of milk and weight loss, and the authors commented that "increasing calcium augmented weight and fat loss secondary to calorie restriction and increased the percentage of fat lost from the trunk region, whereas dairy produce exerted a substantially greater effect". The conclusions drawn in some of the other trials either include value judgements or are based on previously unpublished data. Clearly there is a need for further ad-hoc randomised intervention trials.

The overviews reviewed above[39,42,43] give estimates of weight loss which can be achieved by additional dietary calcium of between about 0.5 and 1.9 kg/year/100 mg calcium. If confirmed in ad-hoc randomised trials, an effect of this magnitude would be considerable, given that milk contains about 1,190 mg calcium per litre (676 mg per pint). Such a relationship is of important public health potential, having implications both for the prevention and the reduction of obesity throughout the community and for the reduction of diseases consequent upon overweight.

The exclusion or limitation of milk in diets which attempt to achieve weight loss would appear to be ill-advised. Loss of skeletal calcium is increased during weight loss though a number of studies have shown that this can be reduced by a calcium-rich diet.[38,47] Davies *et al.*[39] offer the further opinion that the elimination of milk from reducing diets may be a partial reason for the frequent failure of weight-reducing diets.

Dietary calcium

Around half the dietary intake of calcium comes from milk and evidence from the Family Food Survey shows that the average milk consumption in the UK has fallen by one third during the past 25 years, and is still falling.[10] There is also evidence of a 10–20% lower dietary intake of calcium in UK households in social classes IV and V. Particular concerns focus on the fact that the calcium intakes of 12% of adolescent boys and 24% of adolescent girls do not even reach the 'lower reference dietary intake'. Similar concerns have been voiced in the USA, where there has been a decline in average milk consumption to about half the level in 1945[12] and, again, particular concern has been expressed about the calcium intakes by American youth.[5-7]

Apart from the benefit dairy foods may have in vascular disease and on body weight, an adequate intake of calcium is absolutely essential if the growth of children is to be optimal,[54] if an optimal bone mineral mass during growth is to be achieved,[31] if the bone loss with ageing is to be minimised[47] and if the risk of osteoporosis and fractures is to be minimised in the elderly.[38,55] There are yet other possible beneficial effects of calcium from dairy products which are outside the scope of this report, and which require further testing. These include a possible beneficial effect on the components of the insulin resistance syndrome, namely obesity, glucose intolerance, hypertension and dyslipidaemia, as suggested in the CARDIA study,[35] and a possible reduction in colon cancer.[56]

Key messages

- Milk drinking raises cholesterol level and reduces blood pressure
- A review of cohort studies indicates that milk consumption is associated with a reduction in the risk of heart attack and ischaemic stroke
- A review of evidence from observational studies and randomised trials suggests that consumption of dairy food is negatively associated with body weight and the inclusion of milk may enhance the effect of a weight-reducing diet
- Milk consumption is falling in the UK. Calcium intakes of many adolescents and adult females fail to reach the recommended dietary intake levels

Conclusion

While there is an urgent need for ad-hoc randomised trials to test some of the possible benefits of milk, including its relevance to weight and to weight and fat loss, there is evidence enough to justify the promotion of milk drinking throughout the community in order to reverse the present trend towards lower intakes and to attempt to restore milk to its rightful place in a truly healthy diet.

Conflict of interest

The study was supported by the Department of Epidemiology, Statistics and Public Health, Cardiff University. PE has received speaker's fees from the Dairy Council. JH and AF have no conflict of interest to declare.

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