Dairy products and health: a review of the epidemiological evidence

Eva-Elisa Álvarez-León[1], Blanca Román-Viñas[2] and Lluís Serra-Majem[1,2,3]*

[1]*Preventive Medicine Service, Complejo Hospitalario Materno-Insular, Las Palmas de Gran Canaria, Spain*
[2]*Community Nutrition Research Centre, Scientific Park of Barcelona, Spain*
[3]*Departamento de Ciencias Clínicas, Universidad de Las Palmas de Gran Canaria, Apto. Correos 550, E-35080 Las Palmas de Gran Canaria, Spain*

Evidence-based nutrition is essential to move forward in the science of community nutrition. The present study is a review of the epidemiological evidence of dairy products and health. There is an inverse association between the intake of dairy products and hypertension, stroke and colorectal cancer. There is no evidence of an association between the consumption of dairy products and breast cancer. There is some evidence linking high-fat dairy products and an incremental risk of prostate cancer and weak evidence of the protective capacity of dairy products on bone health. More prospective studies should be developed in order to establish better evidence of the relationship between dairy products and health. Due to the importance of dairy products in public health nutrition, quantitative recommendations should be established in the light of the scientific evidence.

Dairy products: Public health: Review literature

Public health nutrition should not be unaware of the importance of evidence-based medicine. Systematic reviews of the epidemiological evidence and the critical analyses of that evidence have resulted in a huge advance in the development of protocols and guides to clinical practice. Evidence-based medicine has resulted in more appropriate actions to solve everyday clinical problems, based on the critical evaluation of such evidence, instead of intuition or experience.

To develop public health nutrition policies based on scientific evidence, it is important to fight against misinformation of the general population about nutritional aspects of their daily food intake. Frequently, the benefits and risks are put down to dairy products on the basis of physiopathological theories, but with no epidemiological studies to support them.

The objective of the present work is to review papers covering dairy products in both health promotion and disease prevention. Focus is placed on the critical analysis of the scientific literature, pointing out future needs in the research for evidence between dairy products and health.

Methods

Relevant articles were obtained through searching the MEDLINE database (from 1966 to January 2005). Keywords used in this search were the MeSH term 'dairy products', defined as 'raw and processed or manufactured milk and milk-derived products' that included the following products: butter, cheese, ice cream, margarine, milk and cultured milk products (yoghurt) and some health conditions. The selection of health conditions was carried out on the basis of their public health importance (prevalence and/or severity) and included neoplasms, CVD (myocardial infarction, hypertension or cerebrovascular accident), and osteoporosis or bones. The MEDLINE search was complemented with the automatic PubMed clinical queries strategy, which combined 'dairy products' search with citations identified as systematic reviews, meta-analyses, reviews of clinical trials, evidence-based medicine, consensus development conferences and guidelines. Citations from journals specializing in clinical review studies were also included. To be eligible, works had to fulfil the following criteria: abstract must be available, be written in Spanish, English or French and cover human population. Priority was given to meta-analysis and systematic reviews.

Evidence from epidemiological studies of dairy products and health was summarized. To evaluate the strength of the evidence, validity and accuracy were taken into account. Validity was assessed by analysing the presence of possible systematic bias in the design or execution of the studies. Accuracy was assessed by considering the size of the sample and the wideness of the confidence intervals.

Results

There were more than 85 000 articles on the consumption of dairy products. Once the inclusion criteria were applied, fourteen meta-analyses or systematic reviews about dairy products and the selected health conditions were identified, six on cancer, six on CVD and two about bone health. The results are presented separately by health condition.

Dairy products and cancer

There were six meta-analyses and one systematic review that specifically analysed the consumption of dairy products and cancer risk (one for colorectal cancer, three for breast cancer and three for prostate cancer).

Colorectal cancer

One of the articles analysed the risk of colorectal cancer. It was a pooled analysis of ten cohort studies carried out by Cho *et al.* (2004) as a part of the Pooling Project of Prospective Studies of Diet and Cancer. This pooling project accumulates data from subjects who had participated in different prospective studies world-wide. Once amassed, the data were reanalysed, which resulted in a bigger sample size and longer follow-up period than those of the original study alone. To date, three pooled analyses have been published for this pooling project: fat intake and breast cancer; alcohol intake and colorectal cancer; and more recently, dairy foods and Ca and colorectal cancer.

For the pooled analysis of dairy products and Ca and colorectal cancer (Cho *et al.* 2004), ten prospective studies were identified. Studies had to meet predefined criteria: assessment of dietary intake by a validated method, and at least fifty people diagnosed with colorectal cancer. Finally, 534 536 men and women were included, with a follow-up period that ranged from 6 to 16 years. In that period 4992 incident cases of colorectal cancer were documented.

In relation to consumption, researchers took into account different groups of dairy foods: milk (including skimmed, low-fat, medium-fat, whole, evaporated and butter milk), cheese (including high-fat, hard, cottage and ricotta) and yoghurt (including low-fat, regular yoghurt and yoghurt dressing). They also considered intakes of Ca from the diet (and from supplements when available) categorized in deciles.

Other variables associated with colorectal cancer risk were also considered. Results were adjusted for health-related variables BMI, height, family history of colorectal cancer, use of non-steroidal anti-inflammatory drugs and use of multivitamins), life-style variables (smoking, education, physical activity, alcohol intake) and dietary variables (intakes of total energy, red meat and dietary folates). In women, oral contraceptives and postmenopausal hormone use were also considered.

Original studies providing subjects for the pooling project came from the USA, Canada and north European countries (Holland and Sweden). This geographical variability gave the project a wide range of intra-individual variation in the consumption of dairy products. Mean intake of milk ranged from 137 to 687 g/d, mean intake of yoghurt ranged from 11 to 104 g/d, and mean intake of cheese ranged from 8 to 27 g/d. Dietary Ca intakes ranged from 674 to 1051 mg/d.

Milk consumption was inversely related to colorectal cancer. Compared with participants who consumed less than 70 g of milk daily, the relative risk (RR) for colorectal cancer was 0·85 (95 % CI 0·78, 0·94) for those who consumed 250 g/d or more, as shown in Fig. 1. In other words, people who consumed less than a quarter of a glass of milk every day had 15 % more risk of colorectal cancer than those who consumed ≥1 glass of milk a day. The association between milk consumption and reduced risk of colorectal cancer was limited to cancer of the distal colon and rectum.
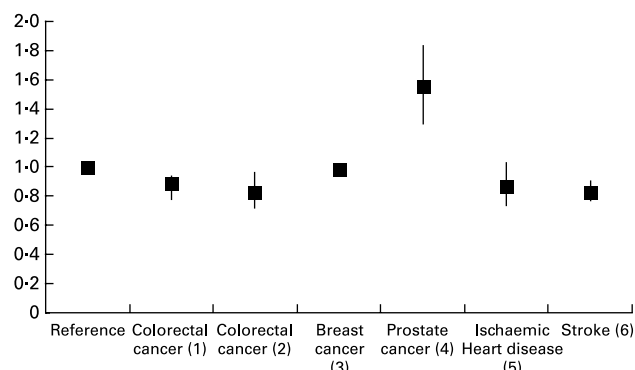

Fig. 1. Relative risk (RR) of different diseases for dairy products intake. (1) RR for subjects who consumed ≥250 g milk daily compared with participants who consumed < 70 g/d (Cho *et al.* 2004). (2) RR for subjects who consumed ≥25 g cottage or ricotta cheese daily compared with those who did not consume that kind of cheese (Cho *et al.* 2004). (3) RR for every 100 g liquid dairy products consumed daily (Missmer *et al.* 2002). (4) Odds for highest *v.* lowest milk consumption categories (Qin *et al.* 2004). (5, 6) Relative odds for highest *v.* lowest milk consumption categories (Elwood *et al.* 2004).

Cheese intake was analysed in two ways. Subjects who consumed ≥25 g of cottage or ricotta cheese daily had a RR of 0·83 (95 % CI 0·72, 0·96) of colorectal cancer, compared with those who did not consume cottage or ricotta cheese. Consumption of other kinds of cheese – excluding cottage and ricotta – was weakly positively associated with colorectal cancer, although confidence intervals were not significant for any of the different categories nor was the test for trend between categories.

Yoghurt intake showed a weakly protective property over colorectal cancer, although CI and test for trends were again not significant. Other fermented dairy products (including yoghurt, buttermilk and sour cream) showed similar results to those of yoghurt. The other dairy products measured, including butter, cream and ice creams, were analysed, but there was no statistical significance with relation to colorectal cancer risk.

As shown in Fig. 1, a high intake of Ca was also associated with a lower risk of colorectal cancer. Subjects in the highest quintile of dietary Ca intake had RR of 0·86 (95 % CI 0·78, 0·95) of colorectal cancer, compared with subjects in the lowest quintile. For total Ca (combining dietary and supplemental sources), the RR of the highest quintile was 0·78 (95 % CI 0·69, 0·88).

In conclusion, milk and Ca intake were associated with a lower risk of colorectal cancer. One of the strengths of the pooled analysis presented here is that all studies included were prospective, avoiding the bias associated with the different recall of dietary habits once a subject knows the diagnosis of a digestive cancer. Another strength is that all studies used validated diet assessment methods, minimizing the possibility of an incorrect registration of the actual intake of dairy products. Finally, the analysis of a database of more than 500 000 subjects from different countries gave sufficient statistical power to analyse specific dairy products categories. However, it is remarkable that the authors did not adjust for some dietary variables related with colorectal cancer, such as fibre or fruit and vegetables. Although the authors mentioned that additional adjustment for dietary fibre intake did not materially change the results for total Ca intake, it could be relevant to adjust for those dietary variables, taking into account that consumers with a higher consumption of dairy

products could have other healthy dietary habits, such as a diet rich in fruit, vegetables and fibre.

Breast cancer

In the presence of growing evidence about the importance of the environment in the risk of breast cancer, many studies analysing the dietary factors in this risk have been undertaken. Among these dietary factors, dairy products were the main variable analysed in more than twenty articles. However, results were contradictory. With the purpose of getting broader evidence, some 10 years ago a Canadian team of researchers published the first meta-analysis to combine the results of five cohort and twelve case–control studies about dairy product consumption and breast cancer risk (Boyd *et al.* 1993). This meta-analysis found a small increased risk of breast cancer in women with greater intakes of milk, with RR of 1·17 (95 % CI 1·04, 1·30). Since this work was published, more studies have been undertaken with different results. Almost 10 years later, in 2002 and forming part of the Pooling Project, a pooled analysis of eight cohort studies was published by Missmer *et al.* (2002). For this pooled analysis, eight prospective studies with at least 200 cases of breast cancer each were included, bringing a total of 351 041 healthy women and 7379 invasive breast cancer cases. The inclusion criteria were similar to those mentioned for the colorectal cancer pooled analysis. With respect to dairy products, different food groups were considered. Dairy products were divided into solid (butter and cheese) or liquid (milk, yoghurt, ice cream, etc.). Subgroups were also considered (whole, semi-skimmed or skimmed milk). Thus, ten different subgroups of dairy products were considered. Dairy product intake was analysed as a continuous variable (with increments of 100 g daily for all products except butter and cream, and 10 g for the latter) and as categorical variable comparing higher *v.* lower quartiles of intake. Other dietary and non-dietary factors associated with breast cancer were also considered, like total energy or alcohol intake, parity, menopausal status and BMI.

Similar to the data mentioned in the colorectal cancer pooling project, the geographical variability achieved here permitted a wide range of intra-individual variation in dairy product consumption. In that way, women in the fourth quartile of liquid dairy products consumed almost 630 g of this kind of dairy product every day, whereas women in the first quartile consumed 360 g.

As shown in Fig. 1, researchers did not find any relationship between dairy product intake and breast cancer risk, neither treating dairy products as a continuous variable nor treating it as a categorical one. They did not find statistically significant associations in any of the ten subgroups of dairy products considered, either. They concluded that, taking into account data of more than 350 000 women, there was no evidence that a diet rich in dairy products during middle or advanced age could increase or modify the risk of breast cancer in North American or European women.

In a similar way, Moorman & Terry (2004) in their recent review about consumption of dairy products and risk of breast cancer concluded that published epidemiological data do not provide consistent evidence for an association between the consumption of dairy products and breast cancer risk. They mentioned some limitations that must be considered. One is the moderate reliability of the methods used to assess dairy product intake, which could lead to some misclassification. This misclassification could make it more difficult to detect the relatively small effects of most dietary factors on cancer risk, which is especially important in prospective studies, where the intake of dairy products could change greatly over the long follow-up period.

Other limitations mentioned by authors is that consumption of dairy products may be associated with other dietary habits or other variable nutrient content of dairy products (such as vitamin D, subject to whether the food is fortified or not) that could also influence breast cancer risk. All these factors should be considered in the adjusted model.

Prostate cancer

Prostate cancer is the most prevalent cancer in men in Europe and the USA (Quinn & Babb, 2002; Jemal *et al.* 2005). It is not known which factors induce this cancer and which agent leads to latent prostate tumours – whose incidence is very high in men world-wide – progressing to a clinically detectable prostate cancer, the incidence of which, by contrast, shows a high variation in different geographical areas. There are different risk factors proposed that included hormonal factors, familial antecedents and dietary variables. Among dietary variables, fat consumption was of great interest because animal studies suggested that fat intake, in combination with other dietary variables, could increase tumour growth. Dairy product intake was considered in three different reviews all published in 2004.

In Canada, Fleshner *et al.* (2004) reviewed articles published over the last two decades looking at the relationship between prostate cancer and fat intake (total fat intake or fat in specific foods like dairy products). They analysed seven cohort studies, including more than 180 000 subjects, and only one showed a statistically significant association, once adjusted; the other six found no association. The Health Professionals Follow-Up Study observed that subjects with higher intakes of dairy products had twice the risk of metastatic prostate cancer than subjects with low intake, but the authors mentioned that most of the excess risk could be explained by known nutritional components of these foods (Ca and fatty acids). The Netherlands cohort study showed a positive trend in prostate cancer risk for consumption of milk products ($P=0.02$), but not for Ca intake.

A meta-analysis of eleven case–control studies comparing incidence of prostate cancer in higher *v.* lower consumers of milk was published by Qin *et al.* (2004). The combined estimated odds ratio (OR) was 1·68 (95 % CI 1·34, 2·12), slightly smaller when adjusted for some variables: 1·56 (95 % CI 1·30, 1·83; Fig. 1). In the discussion, the authors mentioned that eight studies used hospital-based controls, which are more prone to bias than population-based controls. Also, milk consumption was difficult to classify because of the ambiguity of food items used in some questionnaires. They declined to make a meta-analysis of cohort studies because all were developed in America and northern Europe, where the high levels of consumption of dairy products would make it difficult to find a group free from dairy product consumption. Another difficulty mentioned for the inclusion of cohort studies in the meta-analysis was that in these studies the endpoint was not always the same.

Finally, in 2004, Dagnelie *et al.* reviewed prospective cohort and intervention studies to analyse the effect that

individual foods and nutrients had on prostate cancer. The authors excluded case–control studies due to the inconclusive results obtained and for the greater possibility of selection and information bias. They identified twenty-seven studies that analysed relationship between milk and dairy product consumption and prostate cancer risk. Results were equally distributed between a positive association (thirteen reported) and a null result (fourteen reported). However, only five of these prospective studies mentioned that the dietary questionnaire used was validated. Of these five studies, two had statistically significant results. The Health Professionals Follow-Up Study showed an increased risk of prostate cancer for different dairy products. The RR of higher quartiles of intake v. lower quartiles ranged from 1·06 for cottage/ricotta cheese to 1·25 for milk (both whole and skimmed or low-fat) and to 1·42 for butter. A Norwegian study of more than 25 000 men showed that men consuming skimmed milk had an RR of 2·2 (95 % CI 1·3, 3·7) of prostate cancer compared with men consuming whole milk. The other three studies found no significant association between dairy product intake and prostate cancer risk. Based on these results, one of the conclusions mentioned by the authors is that the available evidence for specific dairy products remains limited or inconclusive, which prevents firm conclusions on that food product. One important limitation mentioned is that studies used incidence, mortality, or both, as an endpoint. In aetiological studies, incidence is more appropriate because mortality could be determined by other non-dietary variables (such as treatment).

A meta-analysis developed with cohort studies or even an intervention study would clarify the relationship between total fat intake and prostate cancer in order to establish public health recommendations.

Dairy products and osteoporosis/bone health

There have been two meta-analyses or review articles on bone health and dairy product intake, the most recent one by Weinsier and Krumdieck published in 2000. They found twelve articles with the highest level of evidence, i.e. a randomized trial with a control group or cohort studies with ≥3000 participants and an average follow-up period of 5 years and results adjusted by more than three factors, such as age, sex, BMI, physical activity, menopausal status and/or substitutive hormonal therapy. The authors did not develop a meta-analysis of these studies, and conclusions were based on the comparison of the amount of studies with positive, negative or non-definitive results. Among the twelve articles, there were six that found no effect between the intake of dairy products and bone health, five found a positive effect and one found a negative effect. Women under 30 years seem to gain the most benefit. Although studies which analysed the composition of dairy products are scarce, milk seems to be the most protective. The authors mentioned limitations to the work published up to that moment, both in methodology and sample size. These limitations make it difficult to obtain conclusions and firm evidence about the effects of dairy product consumption on bone health. It is important to mention that some results are statistically significant but clinically of little relevance because Ca intake could be responsible for only 1 % of the inter-individual variability in bone mass. Another difficulty is that what is important for the level of density of the bone system is not the present dairy intake,

but the habitual intake throughout life. In addition, as a further limitation mentioned by other authors, articles must take into account the presence of other dietary and life-style variables that could influence bone health, such as fruit intake, soda beverages, physical activity, smoking and alcohol intake.

In 1997, Cumming and Nevitt published a systematic review to assess the effectiveness of Ca (as supplements or from dietary sources) for the prevention of osteoporotic fractures in postmenopausal women. This work was more restricted than the previous one because only studies with fracture outcome were eligible. They found fourteen studies that evaluated Ca supplements (four randomized trials, three non-randomized trials and seven observational epidemiological studies) and twenty-three observational studies that evaluated dietary Ca (non-randomized trials). All four randomized trials reported a reduced risk among women receiving Ca supplements. The reduction in fracture risk ranged from 26 to 70 %, with a mean Ca dose of 1050 mg/d. The authors mentioned some limitations; in one trial subjects were taking Ca and vitamin D_3 at the same time, and in others the definition of fracture differed (radiological reduction in vertebral body weight; ratio of anterior to posterior vertebral body height; or symptomatic fractures of wrist and hands). The authors could use the meta-analysis method to analyse results of sixteen of the observational studies that evaluated the effect of dietary Ca, although among these studies individual findings were not consistent because of the heterogeneity. Pooling the results of these sixteen studies, authors reached an OR for hip fracture of 0·96 (95 % CI 0·93, 0·99) per 300 mg/d increase in dietary Ca and 0·88 (95 % CI 0·80, 0·97) per 1000 mg/d. 300 mg is equivalent to one glass of milk daily and 1000 mg is the amount in a typical Ca supplement. If they restricted analysis to the five cohort studies, the pooled OR for 300 mg/d was also 0·96, but the 95 % CI was no longer significant (from 0·91 to 1·02). The main conclusion emphasized by the authors was that increased Ca intake among postmenopausal women appeared to be associated with a small reduction in risk of fracture, with about a 30 % reduction in fracture risk among those taking higher amounts of Ca (1 g daily as a supplement). The authors mentioned that statistical pooling of results does not remove any scientific bias in the pooled studies, and mentioned the need to develop larger studies with symptomatic fractures as the outcome.

Dairy products and cardiovascular diseases

CVD is a broad group that embraces heart diseases (including coronary diseases and myocardial infarction) and vascular diseases (including hypertension and cerebrovascular accident or stroke). There have been almost 100 systematic reviews involving CVD and dairy products, between other dietary and non-dietary variables. However, only six were more specifically oriented to the intake of dairy products.

Dairy products and hypertension

Hypertension is a major risk factor for CHD and stroke, with a high prevalence in Europe. A wide review published in a supplement of the *British Journal of Nutrition* by Hermansen (2000) demonstrated that the prevention and management of hypertension – at individual and at population level – should

be a priority for public health authorities. One essential step to achieve this objective by the least intrusive means is dietary modification. The review tried to explain that the evidence was that dietary modifications influence the propensity to develop hypertension. It was pointed out that there was no direct evidence that reducing blood pressure through dietary measures reduces the risk of CVD. In this review dietary modification was re-examined. Two meta-analyses pooled data from randomized controlled trials to assess the effects of dietary Ca supplementation on blood pressure (Hermansen, 2000). Both showed a change in systolic blood pressure (SBP) between -0.5 and -1.7 mmHg (higher reduction in hypertensive subjects), but diastolic blood pressure (DBP) was not affected. One point mentioned in the review is that, with the exception of alcohol consumption, there were no clinical intervention studies about the relationship between macronutrient intake and blood pressure regulation. They mentioned one inherent problem in studying the effect of a change in a specific macronutrient. In order to maintain total energy intake, subjects must simultaneously change the intake of other macronutrients and the genuine cause of the health outcome could, therefore, remain uncertain. Besides changes in one micro- or macronutrient, changes in overall dietary pattern may be of great value. The Dietary Approach to Stop Hypertension (DASH) study was specifically mentioned in the review. The DASH study is a successful randomized controlled clinical trial that started in 1995 and has shown that a diet rich in low-fat dairy products, fruits and vegetables could lower blood pressure levels. The intervention consisted of following a 'combination diet' for 3 weeks. It was rich in fruit and vegetables (ten servings daily) and rich in low-fat dairy products (three servings daily involving 360 ml skimmed or semi-skimmed milk, 86 g yoghurt and 39 g cheese). This combination diet achieved a reduction in blood pressure in 2 weeks, suggesting that complex dietary changes may have greater effects on blood pressure than single-nutrient modification. In the conclusions, the author mentioned that life-style changes proposed to maintain adequate blood pressure control might have a wide range of additional beneficial effects, which is not true for most antihypertensive drugs.

In 2003, a review that summarized the results of the DASH diet was published by Craddick et al. Three to four daily servings of dairy products could diminish SBP in hypertensive and non-hypertensive subjects by -2.7 mmHg (97.5 % CI -4.6, -0.9) and DBP by -1.9 mmHg (97.5 % CI -3.3, -0.6), compared with a diet rich in fruits and vegetables but low in dairy products. On this basis, the authors recommended that subjects with blood pressure of $\geq 120/80$ mmHg follow healthy life-style habits, such as maintaining healthy weight, reducing Na intake, increasing regular physical activity, limiting alcohol intake and should follow the DASH diet, which is high in fruits, vegetables and low-fat dairy products and reduced in fat. This diet has been shown to reduce blood pressure significantly and also has been shown to reduce blood cholesterol and homocysteine levels and to enhance the benefits of antihypertensive drug therapy.

Another review published by Miller et al. (2000) went over the DASH study history and also made a revision of the prior evidence of observational studies pointed out in the literature about dietary Ca intake and hypertension. Cappuccio et al. in a meta-analysis that was revised by Birkett 3 years later,

summarized the observational studies in 1995. This meta-analysis estimated a pooled reduction of -0.39 mmHg (with a range of -0.47 to -0.31) in SBP, and of -0.21 mmHg (range 0.67 to -0.02) in DBP, per 100 mg dietary Ca increase. At the same time, Bucher and co-workers undertook another meta-analysis of randomized controlled trials of Ca supplementation for blood pressure control, and this meta-analysis was also updated some years later. Although Ca supplements are not in the scope of the present review, analysis of forty-two eligible studies revealed significant reductions in SBP (-1.44 mmHg, 95 % CI -2.2, 0.68) and also in DBP, -0.84 mmHg (95 % CI -1.44, -0.24).

Looking at the published evidence, a diet low in Na and with adequate intakes of Ca, Mg and K is recommended to prevent hypertension. Low-fat dairy products fulfil this recommendation.

Dairy products and stroke

Hypertension is the main risk factor for stroke. However, nearly 50 % of strokes occur in subjects with normal or in the high–normal limit of blood pressure. In 2001, a review of dairy food consumption, blood pressure and stroke was published by Massey. Two studies on dairy products and stroke were mentioned. The Honolulu study showed that men who did not consume milk suffer twice as many strokes than men who consume two glasses or more of milk daily (one glass = 240 ml). When they analysed the origin of the Ca (dietary or as supplement), they observed that only dietary Ca was protective against stroke. This may be due to the presence of other protective components in dairy products, or to the underlying adequate dietary Ca intake in those who also use Ca supplements. In the Nurses' Health Study, intakes of three minerals that are presents in dairy products (Ca, Mg and K) were associated with lower risk of ictus, with an RR around 0.7. This negative association was stronger for the Ca that came from dairy products than for the non-dairy Ca. Another review of nutritional factors and stroke was published by Gariballa (2000). The author evaluated one study that showed a protective effect of milk consumption on the risk of ischaemic stroke in middle-aged men included in the Honolulu Heart Program. Increases in the intake of dietary Ca from dairy sources appeared to have a protective effect against thromboembolic stroke that was independent of concomitant risk factors ($P<0.05$). There was a twofold excess risk of stroke in men who were not milk-drinkers v. those who consumed nearly 500 ml/d or more ($P<0.05$). In this study, Ca consumed from non-dairy sources did not show a protective effect, underlying the importance of other variables related to milk consumption. One limitation of this study is that the Honolulu cohort showed lower levels of dairy product intake than other population-based samples, so the effects of greater intakes of dietary Ca that are commonly observed in other communities (or the effects of dietary supplementation) could not be examined.

Although with limitations, evidence supports the hypothesis that the intake of dairy products could be associated with a lower risk of cerebrovascular accident or stroke. It is difficult to associate the protective effect of dairy products to a single micronutrient. An adequate metabolic balance between Ca, Mg and K is important. Dairy products are good food sources of these minerals. More studies to evaluate the effects of the intake of dairy products over long periods are necessary. In order to establish adequate recommendations for ictus

prevention, prospective studies must analyse overall dietary pattern and food consumption, rather than the intake of nutrients.

Dairy products and heart diseases

A cohort study review on milk consumption and IHD was published recently (Elwood *et al.* 2004). The authors included ten prospective cohort studies in which incident IHD were related with milk intake. A pooled estimate of the relative odds for IHD in the subjects with the highest milk intakes was 0·87 (95 % CI 0·74, 1·03), compared with those with the lowest intakes. Authors also calculated a pooled estimate of the odds of stroke, that was 0·83 (95 % CI 0·77, 0·90) for the same subjects (Fig. 1). Only three studies adjusted for total energy intake. The pooled estimate of the odds for a vascular event (IHD and/or ischaemic stroke) was 0·85 (95 % CI 0·70, 1·03). The authors mentioned that milk consumption is not associated with any increased risk of heart disease or stroke.

Conclusions

There are ethical and methodological limitations for the development of randomized controlled clinical trials in public health nutrition. In order to evaluate the effect of any dietary intervention, it is very important to solve the limitations of the available methodologies. It is possible to develop more standardized methods to recall dietary variables. It has been mentioned that different dietary assessment methods might yield different results, due to the misclassification of subjects. More investigations should be undertaken in order to develop tools that avoid this limitation in the assessment of dietary variables. It is important to accumulate the results of different studies, in a similar way to the Pooling Project (Boyd *et al.* 1993; Cho *et al.* 2004). In the Pooling Project, there were no participants from Mediterranean and south European countries. In these countries, the intake of dairy products and other dietary habits are quite different to those of north European and North American countries. Due to the wide variation in the average intake of dairy products, the same individual could be considered a big consumer of dairy products in one context and a low consumer in another. Dairy products nutrient composition could vary depending on the country, due to the different fortification policy followed in each one. Promoting prospective studies in different countries (such as the European Prospective Investigation into Cancer and Nutrition and the Supplementation en Vitamines et Minéraux Antioxydants studies in southern Europe) and including the data in the pooling project, could lead to a better understanding of the relationship between dairy products and health.

Some considerations based on the studies mentioned could improve future studies. It is very important to consider all dietary and non-dietary variables that could influence disease risk. The consumption of dairy products is likely to be associated with higher or lower intakes of other nutrients and it will be associated with health behaviour or other beneficial factors which would be difficult to identify. It is also important to define the best endpoint for every disease. For example, symptomatic fractures would be a good endpoint in bone health studies and cancer incidence is a better endpoint than cancer mortality in cancer studies.

There is another inherent problem when the effect of a change in a specific macronutrient is under study. In order to maintain the total energy intake, subjects must simultaneously change the intake of other macronutrients. For this reason, the genuine cause of the health outcome could remain uncertain. It is also very important to evaluate the effects of the intake of dairy products over long periods. In order to establish adequate recommendations for disease prevention, prospective studies must analyse overall dietary pattern and food consumption, better than nutrient intake. When recommendations on dietary habits are made, it should be pointed out that life-style changes proposed to decrease risks may have an added value. These life-style changes have a wide range of additional beneficial effects, which cannot be said to be true for most drugs.

References

Boyd NF, Martin LJ, Noffel M, Lockwood GA & Trichler DL (1993) A meta-analysis of studies of dietary fat and breast cancer risk. *Br J Cancer* **68**, 627–636.

Cho E, Smith-Warner SA, Spiegelman D, *et al.* (2004) Dairy foods, Ca, and colorectal cancer: a pooled analysis of 10 cohort studies. *J Natl Cancer Inst* **96**, 1015–1122, Erratum in *J Natl Cancer Ins* **96**, 1724.

Craddick SR, Elmer PJ, Obarzanek E, Vollmer WM, Svetkey LP & Swain MC (2003) The DASH diet and blood pressure. *Curr Atheroscler Rep* **5**, 484–491.

Cumming RG & Nevitt MC (1997) Calcium for prevention of osteoporotic fractures in postmenopausal women. *J Bone Miner Res* **12**, 1321–1329.

Dagnelie PC, Schuurman AG, Goldbohm RA & Van den Brandt PA (2004) Diet, anthropometric measures and prostate cancer risk. *BJU Int* **98**, 1939–1950.

Elwood PC, Pickering JE, Huges J, Fehily AM & Ness AR (2004) Milk drinking, ischaemic heart disease and ischaemic stroke II. Evidence from cohort studies. *Eur J Clin Nutr* **58**, 718–724.

Fleshner N, Bagnell PS, Klotz L & Venkateswaran V (2004) Dietary fat and prostate cancer. *J Urol* **171**, S19–S24.

Gariballa SE (2000) Nutritional factors in stroke. *Br J Nutr* **84**, 5–17.

Hermansen K (2000) Diet, blood pressure and hypertension. *Br J Nutr* **83**, S113–S119.

Jemal A, Murray T, Ward E, Samuels A, Tiwari RC, Ghafoor A, Feuer EJ & Thun MJ (2005) Cancer statistics. *CA Cancer J Clin* **55**, 10–30.

Massey LK (2001) Dairy food consumption, blood pressure and stroke. *J Nutr* **131**, 1875–1878.

Miller GD, DiRienzo DD, Reusser ME & McCarron DA (2000) Benefits of dairy product consumption on blood pressure in humans: a summary of the biomedical literature. *J Am Coll Nutr* **19**, S147–S164.

Missmer SA, Smith-Warner SA, Spiegelman D, *et al.* (2002) Meat and dairy food consumption and breast cancer: a pooled analysis of cohort studies. *Int J Epidemiol* **31**, 78–85.

Moorman PG & Terry PD (2004) Consumption of dairy products and the risk of breast cancer: a review of the literature. *Am J Clin Nutr* **80**, 5–14.

Qin LQ, Xu JY, Wang PY, Kaneko T, Hoshi K & Sato A (2004) Milk consumption is a risk factor for prostate cancer: meta-analysis of case–control studies. *Nutr Cancer* **48**, 22–27.

Quinn M & Babb P (2002) Patterns and trends in prostate cancer incidence, survival, prevalence and mortality. Part I: international comparisons. *BJU Int* **90**, 162–173.

Weinsier RL & Krumdieck CL (2000) Dairy foods and bone health: examination evidence. *Am J Clin Nutr* **72**, 681–689.