DAIRY PRODUCTS NUTRITION & HEALTH - MAJOR STUDIES

BEST of 2012

Beneficial effects of dairy products on diabetes & weight management

Editorial

Dairy products to fight against diabetes

The last twenty years have seen an increase in the frequency of type II diabetes and obesity (its main risk factor) around the world. The term **diabesity** (a combination of diabetes and obesity) is gaining in popularity as a way of describing this association which entails numerous complications (particularly in terms of cardiovascular health).
Diabesity represents a heavy social and economic cost and has become a real public health issue in the majority of industrialised countries. Prevention is mainly based around lifestyle measures (in particular limiting excessive inactivity) and dietary changes.

Many studies have highlighted the benefits of eating dairy products on weight management and potentially on preventing type II diabetes. This means that dairy products could well be used as a tool in the fight against diabesity.

This *Best of* is a compilation of recently published studies on obesity and diabetes that demonstrate the beneficial effects of dairy products.

Yvette Soustre & Corinne Marmonier

For words in italics see glossary at the end of the document

Every year sees **positive scientific studies** published on the nutrition and health benefits of dairy products. In order to track them and make them easily usable by **dairy professionals** at various levels (regulatory, lobbying, communication, R&D, etc.), the scientific and technical division of CNIEL has created the "Best of". This publication compiles summaries (written for you) of (positive) articles on a given topic. The language has been **simplified** as much as possible in order to be accessible to as many people as possible and to highlight the essentials of the subject.

BEST of

A theme-based publication of the Scientific and Technical Affairs Division of CNIEL aimed at professionals in the dairy industry.

For this issue

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Foreword:
Dairy products, weight management and obesity

Over the last 15 years, the average weight of French people has risen by around 3.6 kg whereas their average height has only increased by 0.7 cm. Their average waistline has grown from 85 to 90 cm.
In 2012, some 32% of adults living in France (over the age of 18) were overweight and 15% were obese. The rate of obesity was slightly higher in women (15.7% versus 14.3% in men) and in people with a lower level of education and/or income.

Although the obesity rate in France is one of the lowest of the OECD countries and is only rising slowly, it is still worrying.

A number of factors contribute to the development of obesity:
genetics of course, but also diet, lack of physical activity, some diseases, some medication, stress and social background, etc.

Excess kilos can quickly create health problems that themselves lead to significant health costs. The risk of cardiovascular disease and high blood pressure in particular increase with weight gain. However, one of the complications the most often associated with obesity is diabetes. This disturbance of the body's ability to metabolise glucose is extremely frequent in overweight people, so much so that we now talk of a "diabesity" epidemic.

The prevention of excess weight and obesity has therefore become an important public health issue. It is against this background that milk and dairy products could be called upon to play a role.

It was in 2000 that an American team first noticed the "calcium-dairy products-weight management" link. They reported that people who consumed very small amounts of calcium and dairy products had a higher risk of being overweight than those who consumed large amounts. They also showed that, as part of a calorie-controlled diet, the consumption of low-fat dairy products was linked to greater weight and fat loss.

Since then, several epidemiological and clinical studies have been carried out to verify the hypothesis that there is a link between dairy consumption and body weight in adults, children and adolescents.

This *Best of* provides an overview of the scientific articles that have been published over the last two years in support of this hypothesis.

Several mechanisms have been suggested to explain how dairy products are able to have a positive influence on body weight. This effect is partly attributed to calcium and partly to proteins and bioactive peptides in milk (which might act independently or in synergy with calcium). In concrete terms, it seems that calcium promotes the oxidation of lipids while also reducing fat absorption (by increasing its elimination in faeces). It appears that protein act through their satiating power by stimulating the secretion of certain hormones involved in controlling food consumption, which helps to moderate calorie intake.

"No dairy product has a 'negative effect on weight'..."

- Intake of dairy products of any kind do not have a negative effect on weight.
- An exhaustive review of 19 epidemiological studies.

Dairy consumption and overweight and obesity: a systematic review of prospective cohort studies.

Louie JC, Flood VM, Hector DJ, Rangan AM, Gill TP.
Cluster for Public Health Nutrition, Boden Institute of Obesity, Nutrition, Exercise and Eating Disorders, The University of Sydney, Sydney, New South Wales, Australia.
Obesity Reviews 2011; 12 (7): e582-92.

"Contrary to popular belief, in this review we did not find low-fat dairy products to be more beneficial to weight status than regular-fat dairy products. In fact, the data suggest the reverse may be true."

Australian researchers carried out an exhaustive review of *epidemiological studies* published between 1980 and 2010 focusing on the link between dairy consumption and the risk of becoming overweight or obese, assessed through weight change, *body mass index (BMI)* or fat percentage.

A total of 19 epidemiological studies were assessed: 10 studies covered children and adolescents aged between 2 and 14 and 9 studies covered adults aged between 18 and 75. Of the 19 studies:

- 8 studies (3 on children and 5 on adults) found that dairy consumption protects against weight gain,
- 1 study found the protective effect only in men who were overweight at the start of the study,
- 7 studies found no effect,
- 1 study found an increased risk of obesity in children, which could be explained by higher calorie intake rather than by the consumption of the dairy products themselves,
- 2 studies found differing results depending on the type of dairy products consumed.

The authors stressed that there did not seem to be a different effect on weight caused by the consumption of full-fat or low-fat dairy products.

While the beneficial effects were more often associated with milk consumption, some studies also showed beneficial effects from consuming yoghurts or cheese.

In the end, the authors concluded that dairy products do not have a negative effect on weight in either children or adults. They also concluded that, contrary to popular opinion, low-fat dairy products do not seem to be more beneficial to weight than full-fat dairy products.

Full-fat or low-fat?

The nutritional guidelines in several countries promote the consumption of low-fat dairy products. This study shows that the consumption of dairy products of any kind does not have a harmful effect on weight It is therefore not necessary to advise people to eat low-fat dairy products. Consumers should be left to make their own choices depending on their tastes and overall diet.

"More calcium for a thinner waist"

- High calcium intakes are associated with a lower percentage of total body and abdominal fat.
- A cross-sectional study on 197 Canadian young adults.

Dietary and total calcium intakes are associated with lower percentage total body and truncal fat in young, healthy adults.

Skinner ML, Simpson JA, Buchholz AC.
Department of Family Relations and Applied Nutrition, Macdonald Stewart Hall, University of Guelph, Guelph, Canada.
Journal of the American College of Nutrition 2011; 30 (6): 484-90.

"Our findings support a relationship between dietary and total calcium intakes and lower percentage total body and truncal fat in this young adult population, even after adjusting for physical activity scores."

The risks and complications related to excess weight and obesity are linked to the distribution of body fat. The most problematic type of obesity is characterised by fatty deposits mainly situated around the abdomen *(abdominal or visceral obesity)*. Abdominal fat is a risk factor for *metabolic syndrome* disorders, *cardiovascular diseases* and *diabetes*. In this Canadian study, the relationship between the different sources of calcium and the percentage and distribution of fat was assessed in 76 men and 121 women, all in good health. They were aged between 18 and 28. The results show that young people who consume more total calcium (1489 mg/d) have a lower percentage of total and abdominal fat than those who consume less (357 mg/d). This still applies once an adjustment has been made for physical activity.
This study did not find any specific link with calcium from dairy products. However, the authors believe that this may be explained by an under-estimation of calcium intake from dairy.

The authors conclude that adequate calcium consumption could help weight control and limit abdominal fat. They advise consuming at least 1,000 mg of calcium per day regardless of the known benefit of calcium on bone health.

Overweight or obese people have an increased risk of developing health problems

In France:
- the risk of cardiovascular disease is 14 times higher in obese people and 5 times higher in overweight people than in people with a normal body weight.
- the risk of being treated for high blood pressure is multiplied by 2.3 in overweight people and 3.6 in obese people.
- there are 7 times more obese people and 3 times more overweight people treated for diabetes than people with normal body weight.

Preventing excess weight and obesity therefore constitutes a major challenge for our healthcare system...

(Source: Obépi 2012)

"Whole milk dairy products do not have a negative effect on corpulence"

- There is no benefit in replacing full-fat dairy products with low-fat varieties.
- A review of 16 epidemiological studies.

The relationship between high-fat dairy consumption and obesity, cardiovascular, and metabolic disease.

Kratz M, Baars T, Guyenet S.
Division of Public Health Sciences, Cancer Prevention Program, Fred Hutchinson Cancer Research Center, Seattle, USA.
European Journal of Nutrition 2012 Jul 19. [Epub ahead of print].

"The observational evidence does not support the hypothesis that dairy fat or high-fat dairy fodds contribute to obesity or cardiometabolic risk, and suggests that high-fat dairy consumption within typical dietary patterns is inversely associated with obesity risk."

In several countries, public health guidelines stress the importance of reducing intake of fat and saturated fatty acids to lower the risk of certain illnesses (cardiovascular diseases, obesity, diabetes, etc.). This often results in nutritional guidelines that advise eating low-fat dairy products. However, no study has shown that the consumption of full-fat dairy products constitutes a health risk.

American researchers have just reviewed 16 *epidemiological studies* focussing on the link between consuming full-fat dairy products and the risk of obesity and metabolic disorders (such as diabetes and cardiovascular diseases).

► 11 of the 16 studies show that people who consume more fat from milk and/or dairy products are slimmer or put on less weight than people who consume less of the same!

► None of the studies show an adverse association between the consumption of full-fat dairy products and corpulence.

However, the authors found differences between American and European studies. The majority of European studies (8 out of 9) show an inverse association between the consumption of full-fat dairy products and corpulence. Fewer American studies (3 out of 7) found the same inverse association or found no association (4 out of 7). The authors believe that this difference may be partly explained by the fact that, in the United States, fat, and therefore non-low-fat products, generally has a bad reputation. Consequently, it is likely that only those who do not look after their health and have an unhealthy lifestyle (inactivity, smoking, etc.) consume them. This would mean that the consumption of full-fat dairy products would not be damaging on its own but it is associated with behaviour that is not conducive to good weight management. Furthermore this geographical split could be related to the way in which dairy products are consumed. In the United States, fat from milk and dairy products are often consumed as ingredients in savoury or sweet processed products. Europeans, on the other hand, tend to consume these products "as they come" (yoghurt, butter and cheese). Finally, the authors put forward the hypothesis that different types of fat (CLA, trans-palmitoleic acid, *branched-chain fatty acids*) are found in milk in the United States and Europe due to different breeding practices. Some milk fats may have specific beneficial effects on metabolic disorders.

Whatever the reason, the authors conclude that there are no health benefits to be gained from replacing full-fat dairy products with low-fat dairy products.

French people overestimate the fat content of dairy products

When asked about everyday dairy products, consumers, on average, thought that the fat content of whole milk was 43%, semi-skimmed milk 25%, skimmed milk 11%, 21% for full-fat plain yoghurt, 42% for hard cheese such as emmental and 45% for soft cheese such as camembert.*

Health professionals (including dieticians) questioned did not fare much better, believing that whole, semi-skimmed and skimmed milk had a 36%, 19% and 5% fat content respectively, full-fat yoghurt 21%, emmental 46% and camembert 48%.**

It should also be noted that, in France, dairy products (with the exception of butter and cream) are not the main lipid contributors. Furthermore, butter and cream only account for half of the fat intake.***

** study Cniel/CSA 2010; **study Cniel/CSA 2012*
**** Contribution des produits laitiers dans les apports lipidiques de la population française [Contribution of dairy products to the fat intake of the French population] Grandjean-Ceccon V, Noblet B, Marmonier C, Coudray B. Sciences des Aliments 2011, 30(45-59).*

"When dieting, dairy products are to be preferred"

- In the context of a weight-loss diet, dairy products increase weight and fat loss while protecting muscle mass and bone health.
- A study on 100 overweight or obese Canadian women.

Increased consumption of dairy foods and protein during diet- and exercise-induced weight loss promotes fat mass loss and lean mass gain in overweight and obese premenopausal women.

Josse AR, Atkinson SA, Tarnopolsky MA, Phillips SM.
Exercise Metabolism Research Group, Department of Kinesiology, McMaster University, Hamilton, ON, Canada.
Journal of Nutrition 2011; 141 (9): 1626-34.

Diets higher in dairy foods and dietary protein support bone health during diet- and exercise-induced weight loss in overweight and obese premenopausal women.

Josse AR, Atkinson SA, Tarnopolsky MA, Phillips SM.
Journal of Clinical Endocrinology and Metabolism 2012; 97(1): 251-60.

"Thus, our data provide a good rationale to recommend consumption of dairy foods to aid in high quality weight loss and the promotion of bone health in young women who are at the age when achieving and maintaining peak bone mass is of great importance."

This study was carried out on around one hundred overweight or obese women, around thirty years old, who generally eat low quantities of dairy products. The researchers spent 4 months testing the effectiveness of daily physical exercise alongside three different diets. The diets allowed varying amounts of protein and calcium from milk. The first diet was extremely rich in protein (30% of calorie intake) and dairy products (DP) (6 to 7 portions/day). In the other two diets, protein intake matched the guideline amounts (15% of calorie intake) while dairy intake was either average (3 to 4 DP/day) or low (max. 1 DP/day). One portion of DP corresponded to 250 ml of milk, 45-50 g of cheese or 175 to 250 ml of yoghurt (American and Canadian portion guidelines). The study assessed weight loss, body composition (distribution of body fat and muscle) and the signs of bone health.

The greatest weight loss was observed in women following the diet with the highest protein and dairy intake, particularly in terms of abdominal fat loss (fat around the abdomen). An increase in lean body mass (muscle) was also observed in women following this diet. With the second diet, lean body mass merely stayed the same. However, women on the third diet, who were eating very low quantities of dairy products, lost lean body mass. Finally, the signs of bone metabolism improved in the first two diets.

Therefore it would seem that the consumption of dairy products during weight loss is beneficial to body composition, leading to more weight and fat loss while preserving or increasing lean body mass (muscle) and bone health.

The beneficial role of milk proteins on muscle mass

Weight loss is accompanied by a loss of fat but also by a loss of lean body mass (muscle). This weakens muscle mass and thereby reduces calorie expenditure (muscles burn calories even when resting). This is why it is particularly important when losing weight to reduce the fat/lean body mass ratio while maintaining lean body mass. The consumption of dairy products helps people on low-calorie diets to maintain their lean body mass. This effect on lean body mass is mainly due to milk proteins. This is because *branched-chain amino acids,* particularly leucine, which is found in great quantities in dairy products, are a key element in protein synthesis and plays a vital role in protein metabolism. This amino acid has an anabolic effect on muscles and thereby promotes the maintenance of lean body mass.

"Dairy products help weight loss as part of a diet"

- 3 to 4 dairy products per day help people on a weight loss diet lose weight and fat.
- A meta-analysis of 14 clinical studies covering 883 adults.

Effect of dairy consumption on weight and body composition in adults: a systematic review and meta-analysis of randomized controlled clinical trials.

Abargouei AS, Janghorbani M, Salehi-Marzijarani M, Esmaillzadeh A.
Food Security Research Center, Department of Community Nutrition, School of Nutrition and Food Science, Isfahan University of Medical Sciences, Isfahan, Iran.
International Journal of Obesity 2012; 36(12): 1485-93.

"…, consumption of high-dairy calorie-restricted diets might result in a greater weight loss and higher reduction of WC (waist circonference) and fat mass compared with conventional calorie-restricted diets."

Several *clinical studies* were carried out to examine the effect of consuming calcium from dairy products on weight and other body composition variables (fat, lean mass, waist circumference, etc.).
Results from 14 studies were compiled in a *meta-analysis* in order to reach an overall conclusion. This made it possible to analyse data compiled on 883 adults aged 18 to 85. .
In the various studies taken into account, the calcium intake of the "control" groups was between 200 and 800 mg/d. In the "test" groups, dairy products provided an additional 550-1,000 mg. The dairy products used were generally low-fat varieties.
An initial analysis reveals that subjects consuming more dairy calcium had greater weight loss tendencies than those eating fewer dairy products.
The extreme heterogeneity of the studies prompted the researchers to carry out a second analysis in which they separated studies on subjects on low-calorie diets (-500 kcal) from studies in which the subjects had no such restrictions.
Result: subjects on a calorie-controlled diet saw a greater loss of weight, fat and waist circumference when combined with additional calcium intake through dairy products. They also saw increased lean mass (muscle) gain.
However, dairy products did not have any effect on subjects that were not following a calorie-controlled diet.
The authors concluded that the consumption of 3-4 dairy products per day in adults:

- has no effect on the weight and various body composition variables as part of a normal diet,
- increases loss of weight, fat and waist circumference as part of a weight loss programme.

In perspective

This is the first study to assess the effect of dairy products on weight using clinical studies. Another *meta-analysis* was published a few months later. It covered a greater number of studies (29 studies and 2,101 people). Its results concur with the first study: as part of a low-calorie diet, the consumption of dairy products increases weight and fat loss in short-term studies (between 3 and 6 months) and has no effect on people who are following their usual diet.
However, for longer-term studies (between 1 and 3 years), this second meta-analysis did not observe any effect from dairy products (whether the subjects were restricting their calorie intake or not). It should be noted that there were fewer longer-term studies, which reduces their statistical importance. Furthermore, in the majority of these studies, the subjects were not following a calorie-controlled diet and so it is possible that the weight gain observed in some studies could be explained by excess calories linked to the additional consumption of dairy products rather than by the effect of the dairy products themselves.

Chen M, Pan A, Malik VS, Hu FB. Effects of dairy intake on body weight and fat: a meta-analysis of randomized controlled trials. Am J Clin Nutr. [Epub ahead of print]. 2012 August 29

"Milk facilitates appetite control during a diet"

- Milk reduces hunger caused by weight loss when dieting, and drinking milk improves the chances that the diet will succeed in the long-term.
- A study on 41 dieting Canadian women who drank an additional 3 glasses of milk per day for 6 months.

Milk supplementation facilitates appetite control in obese women during weight loss: a randomised, single-blind, placebo-controlled trial.

Gilbert JA, Joanisse DR, Chaput JP, Miegueu P, Cianflone K, Alméras N, Tremblay A.
Division of Kinesiology, Department of Social and Preventive Medicine, Faculty of Medicine, Laval University, Quebec City, QC, Canada.
British Journal of Nutrition 2011; 105 (1): 133-43.

"In conclusion, milk supplementation provided to low Ca consumer women during an energy-restricted diet programme attenuated the weight loss-related increase in appetite."

Weight loss tends to stimulate appetite and the desire to eat, which at least partly explains the high failure rate in people trying to lose weight. Starting from this observation, the authors of this clinical study tested the effect on appetite of additional milk consumption (568 ml/d, i.e. 1,000 mg of calcium) compared with the consumption of a placebo (rice drink with the same calorie content, i.e. 250 kcal) in overweight or obese women on a low-calorie diet (600 kcal less than their usual diet) for 6 months. At the start of the study, these women were not consuming much calcium (less than 800 mg/d). The total calcium intake of the "milk" group was around 1,500 mg of calcium per day, compared with 700 mg for the placebo group. Out of 41 women, 25 "stayed the course". Appetite indicators (desire to eat, hunger and feeling full) were measured using self-assessment scales.

Over the six months of dieting, the "milk" group lost 8 kg, while the "placebo" group lost 5.8 kg. This difference was not considered significant. The women in the "milk" group consumed an average of 130 kcal/day less than women in the "placebo" group. This difference can be explained by improved appetite control in the "milk" group. Thus, while feelings of hunger increased in both groups as expected due to the calorie reduction, all of the signs of appetite were significantly better in the "milk" group: reduced hunger and desire to eat combined with an increased feeling of fullness.

Therefore, it seems that milk consumption in a calorie-controlled diet can facilitate appetite control and help to maintain the new weight in the long term. The authors believe that this improved appetite control could be linked to the intake of calcium and milk proteins (whey and casein). This constitutes yet another reason to choose dairy products within the context of a diet.

Analysis

The positive effect of dairy products on weight management has been attributed to several components of milk, such as calcium and milk proteins. It is these milk proteins, particularly whey proteins, that could best explain the beneficial effect of dairy products on appetite control and satiety. The ingestion of proteins sends several signals to the brain before and after they are absorbed. This helps to control food intake. Whey proteins have the ability to stimulate the secretion of various hormones at the gastrointestinal level (CCK, ghrelin, peptide YY and GLP-1). These hormones are neurotransmitters that are involved in controlling feelings of hunger and fullness. Moreover, amino acids, and particularly branched-chain amino acids such as leucine, may play a direct role in regulating appetite in the brain, without first synthesising a neurotransmitter. Whey proteins are rich in leucine.

Biochemical and metabolic mechanisms by which dietary whey protein may combat obesity and Type 2 diabetes. Jakubowicz D, Froy O. J Nutr Biochem. 2013 Jan;24(1):1-5. doi: 10.1016/j.jnutbio.2012.07.008. Epub 2012 Sep 17.

Foreword:
Dairy products to combat type II diabetes

Diabetes appears when the body does not produce enough *insulin (type I diabetes)* or does not use it correctly *(type II diabetes)*. Blood sugar levels become too high, which, if not controlled, can seriously damage the body. Thus diabetes can lead to complications affecting the heart and blood vessels (it is a significant risk factor in cardiovascular diseases), the eyes, the kidneys and the nervous system, etc.

Type II diabetes, or mature-onset diabetes, accounts for most cases of diabetes (around 90 % of cases in France). It generally appears in people over the age of 45 and is linked to hereditary and environmental factors (obesity and a sedentary lifestyle). It is caused when the body's cells (mainly those in the muscles and the liver) develop a resistance to insulin. It is mainly treated with a weight-loss programme and/or medication.

There are believed to be around 3,500,000 diabetics undergoing treatment in France (=4% of the population) and 700,000 diabetics as yet undiagnosed. The World Health Organisation (WHO) has called the progression of type II diabetes around the world an epidemic. There are an estimated 190 million diabetics globally, a number that is expected to rise to 366 million in 2030 with considerable human and economic consequences The prevention of type II diabetes and its risk factors therefore pose a particularly important public health challenge.

Several epidemiological studies have shown a link between the consumption of dairy products and a reduced risk of developing type II diabetes. This *Best of* reports on the most recently published of those studies.

Several hypotheses have been advanced to explain the potentially beneficial effect of dairy products on type II diabetes, including:

- their beneficial role in weight management (pages 3 to 9)
- their role as signs of a healthier diet and/or lifestyle: people who consume dairy products are better at spreading their meals out, do more physical activity and drink fewer sugary drinks, etc.
- the role of some of their ingredients: protein (milk serum), minerals (calcium, magnesium and phosphorus), fat-soluble vitamins (A, D and K2), water-soluble vitamins (B12 and riboflavin) and fatty acids (medium-chain, trans-palmitoleic acid, etc.)

Further studies are needed, however, to gain a better understanding of the mechanisms involved and, in particular, of the seemingly particularly beneficial role of certain categories of dairy products (namely cheeses and yoghurts).

Diabetes is more common in some French departments (overseas departments, the north, the north-east, some departments in the Ile-de-France region, etc.), in those from less favourable socio-economic backgrounds and in women of Maghreb origin. In France, the cost of diabetes is estimated at around 14 billion euros/year.

"The protective role of dairy products against type II diabetes: a meta-analysis"

- A meta-analysis of 7 studies covering more than 320,000 people.
- Overall, dairy consumption reduces the risk of type II diabetes by 14%.

Dairy consumption and risk of type 2 diabetes mellitus: a meta-analysis of cohort studies.

Tong X, Dong JY, Wu ZW, Li W, Qin LQ.
Department of Nutrition and Food Hygiene, School of Radiation Medicine and Public Health, Soochow University, Suzhou, China.
European Journal of Clinical Nutrition 2011; 65 (9): 1027-31.

"In conclusion, our findings indicated an inverse association of daily intake of dairy products with T2DM, suggesting a beneficial effect of dairy consumption in the prevention of T2DM".

This *meta-analysis* of 7 studies covering more than 320,000 people shows that dairy consumption has a preventative effect on the risk of developing type II diabetes. Overall, the risk is reduced by 14% in people who consume large quantities of dairy products (2 to 3 servings, across all categories of dairy products). This figure rises to 18% for consumers of low-fat varieties and to 17% for people who eat yoghurt. The authors do not highlight any association (negative or positive) between the consumption of whole milk or fatty dairy products and diabetes. A more detailed data analysis of three of the studies concentrating on the "dose/response" effect of dairy products suggests that the consumption of an additional portion of dairy products every day may reduce the risk of developing type II diabetes by 6% (a reduction that could reach 10% with the consumption of low-fat varieties). The authors cite several mechanisms to explain this protective effect of dairy products. In particular, they mention certain components of milk (vitamin D, calcium, protein and trans-palmitoleic acid, etc.) and the beneficial effect of dairy products on weight or blood pressure. However, there may also be other factors. For example, the relationship between dairy products and diabetes could be more significant in women (probably because they generally consume more dairy).

Components of milk and diabetes prevention: an attempt to find a mechanistic approach

Trans-palmitoleic acid: In animals, trans-palmitoleic acid (C16:1 n-7) protects from diabetes by improving insulin sensitivity (in the liver and muscles). A study on more than 3,700 human subjects showed that increased plasma concentrations of palmitoleic acid were linked to an improved lipid profile (lower triglyceride levels, more HDL cholesterol, etc.), inflammatory markers, lower insulin resistance and a lower risk of diabetes. Dairy fat is the main dietary source of trans-palmitoleic acid[1].

Calcium & Vit D: Calcium from dairy may act on diabetes by reducing the accumulation of body fat and accelerating weight and fat loss as part of a calorie-controlled diet. Calcium may also increase the oxidation of fat and reduce the effects of inflammatory stress. Vitamin D is thought to improve the body's ability to burn food and oxidise fat.

Proteins: Whey proteins may have a beneficial effect on weight but studies in animals also show that they could have a more direct effect via their bioactive peptides and essential amino acids capable of stimulating insulin production[2].

[1] Annals of Internal Medicine 2010; 153(12): 790-9 - [2] Journal of Nutrition and Biochemistry 2013; 24(1): 1-5.

"Self-perceived lactose intolerance results in an increased risk of diabetes"

- A study on around 3,500 American adults.
- People who believe they are lactose intolerant consume fewer dairy products and are more often affected by diabetes and high blood pressure.

Self-perceived lactose intolerance results in lower intakes of calcium and dairy foods and is associated with hypertension and diabetes in adults.

Nicklas TA, Qu H, Hughes SO, He M, Wagner SE, Foushee HR, Shewchuk RM.
US Department of Agriculture/Agricultural Research Service, Children's Nutrition Research Center, Baylor College of Medicine, Houston, USA.
The American Journal of Clinical Nutrition 2011; 94 (1): 191-8.

"This study has important implications. Health professionals need to be aware that fewer people experience the symptoms of lactose intolerance than previous estimates indicate, and the self perception of lactose intolerance may have a detrimental effect on nutrient intake and health outcomes."

Some people say they are "lactose intolerant" without having any proof and do not wait for a real medical diagnoses before changing their diet. They generally start by drastically reducing their dairy product consumption.

This is confirmed in this study carried out on 3,542 adults in the United States. It shows that people who believe they are lactose intolerant (12% of the sample) consume significantly fewer dairy products than those who do not think they have such a problem. More importantly, they were much more likely than the others to be affected by type II diabetes and high blood pressure. These illnesses were definitely real and confirmed by a medical diagnosis.

The authors of the study believe that these diseases are linked with the low consumption of calcium from dairy in people who have "self-perceived lactose intolerance". Therefore, they recommend that doctors make sure they diagnose the cause of the symptoms that their patients are sometimes overly keen to ascribe to lactose intolerance and implement strategies to enable their patients to continue consuming dairy products, whether or not they are actually lactose intolerant.

Lactose intolerant people can consume dairy products

It is even currently accepted that lactose intolerant people can consume small quantities of lactose each day, mainly by dividing up their dairy intake or including it in various dishes. Moreover, it should be remembered that some dairy products contain little or no lactose (yoghurts and refined cheese) and so do not cause a problem in the case of lactose intolerance

"Dairy products during adolescence reduce the risk of diabetes in adulthood"

- High school students who consume dairy products have a lower risk of developing diabetes in adulthood.
- A study on more than 37,000 American women.

Adolescent dairy product consumption and risk of type 2 diabetes in middle-aged women.

Malik VS, Sun Q, van Dam RM, Rimm EB, Willett WC, Rosner B, Hu FB.
Department of Nutrition, Harvard School of Public Health, Boston, MA, USA.
The American Journal of Clinical Nutrition 2011; 94 (3): 854-61.

"In conclusion, higher consumption of dairy products during adolescence is associated with a reduced risk of T2D in adulthood and appears to provide additional benefit to that observed with current dairy product intakes, possibly because of the persistence of the consumption pattern."

Using a "sample" of 37,038 women from the Nurses' Health Study, Harvard researchers (including the eminent WC Willett) analysed the impact of dairy consumption during adolescence on the risk of developing type II diabetes in adulthood.

Result: the young women who consumed the most dairy products between the ages of 13 and 17 (regardless of whether the products were low-fat or not) had a significantly lower risk of developing diabetes in adulthood compared to the group who consumed less. This risk was reduced by 30-40% according to the criteria taken into account in the statistical analysis and particularly depending on their dairy consumption during adulthood. Women who had always consumed large quantities of dairy products had the lowest risk of diabetes. Furthermore, this study confirmed that women who consume dairy products in adolescence generally continue to consume them in adulthood. The authors did not express an opinion on the mechanisms that could be behind the beneficial effect of dairy products on the diabetes risk. Aside from their possible effect on the various factors relating to the illness (weight, insulin resistance or high blood pressure), it is also possible that dairy consumption is linked to healthier life styles and/or behaviours. So, in this study, the adolescents who consumed dairy products also did more physical activity, had gained less weight at the age of 18 and drank fewer sugary drinks.

Note: the effects are the same regardless of whether the dairy products are low fat or not.

From what age can dairy consumption protect from the future onset of diabetes?

This question is even more relevant now that more and more studies are showing the importance of early nutrition - during childhood, early childhood and even during the antenatal period - to the onset of various illnesses in adulthood. However, we still have a lot to learn on the influence of a baby's diet on the future risk of developing type II diabetes. Studies have shown that some factors relating to this illness (excess weight, high blood pressure, *hyperinsulinism*, etc.) can start to develop in childhood, a long time before the illness itself develops. Dairy products can reduce the effects of these factors.

“Men who eat a dairy-rich diet have a reduced risk of diabetes”

- An Australian study of 5,582 participants over 5 years.
- Men who consume the most dairy products have half the risk of developing diabetes.

The association between dairy food intake and the incidence of diabetes in Australia: the Australian Diabetes Obesity and Lifestyle Study (AusDiab).

Grantham NM, Magliano DJ, Hodge A, Jowett J, Meikle P, Shaw JE.
Baker IDI Heart and Diabetes Institute, Melbourne, Victoria, Australia.
Public Health Nutrition: page 1 of 7 doi:10.1017/S1368980012001310

“Dietary patterns that incorporate high intakes of dairy food may reduce the risk of diabetes among men”.

A team of Australian researchers monitored 5,582 adults over the age of 25 for a period of 5 years to study the links between their diet and the possibility of developing type II diabetes. During the course of the study, 220 cases of diabetes were diagnosed. After adjustment for various variables (age, family history, calorie intake and expenditure, smoking, etc.), the researchers observed that the risk of developing type II diabetes was almost halved in men who consumed more dairy products. The same link was also found in women (although less strongly) but it was not considered to be statistically significant. The more detailed study on the impact of different categories of dairy products suggests that the overall beneficial effect of dairy consumption in men is mainly due to the consumption of lower fat dairy products and cheeses.

The researchers believe that the benefits relating to the consumption of lower fat dairy products are not directly attributable to their fat content but rather to the fact that they are highly indicative of an overall healthier diet.

What about women?

The risk of diabetes increases with age and is higher in post-menopausal women. The WHI (Women’s Health Initiative) study analysed the diets of 82,076 post-menopausal women who did not have diabetes at the start of the study. They were monitored for 8 years, during which 3,946 were treated for type II diabetes. Overall, no link was found between the risk of diabetes and the total consumption of dairy products. Nor was any link found with full-fat or high-fat dairy products. On the other hand, women who consume large quantities of low-fat dairy products (between 1.5 and 3 portions per day) have a smaller risk of diabetes (between 40 and 50%) than women who only consume a small amount. While this benefit does not seem to depend on family history, physical activity or even ethnicity, it seems to be particularly pronounced in obese women or women with a high body mass index.

Journal of Nutrition 2011; 141 (11): 1969-74.

"Fermented dairy products in the fight against diabetes"

- A study on more than 340,000 people across 8 countries.
- Protection against type II diabetes by consumption of fermented milk products.

The amount and type of dairy product intake and incident type 2 diabetes: results from the EPIC-InterAct Study.

Sluijs I, Forouhi NG, Beulens JWJ, Van der Schouw YT, Agnoli C, Arriola L, et al.
University Medical Center Utrecht, Netherlands.
American Journal of Clinical Nutrition 2012; 96(2): 382–90.

"Our findings suggest inverse associations with specific dairy subtypes, cheese and fermented dairy products in particular".

While a large number of studies have shown a positive association between dairy consumption and a reduced risk of type II diabetes, others have not found any link. These different results can often be explained by reference to the different methodologies used in the studies and also by the extreme heterogeneity of the categories and quantities of dairy products consumed. The researchers looked at the wide-reaching EPIC study (European Prospective Investigation into Cancer and Nutrition) carried out on 340,234 people across 8 countries in order to try and gain a better understanding of the role played by dairy products. During the study, 12,403 cases of type II diabetes were diagnosed. While the authors did not find a link between the total consumption of dairy products (of all kinds) and the risk of diabetes, different results were obtained following a more detailed product-by-product analysis. This analysis highlighted the potentially beneficial effect of cheese. Compared to people with a low daily intake of cheese (11 g or less per day), people who consume 55 g per day (a little under two portions) reduce their relative risk of diabetes by 12%. Similarly, the combined consumption of cheese, yoghurts and other fermented milk products is inversely associated with the risk of type II diabetes. The researchers believe that the fermentation mechanism could be responsible for these positive results. the probiotic bacteria found in fermented dairy products are capable of producing menaquinones (vitamin K2), which are molecules associated with a reduced risk of type II diabetes. Additional work is needed to confirm these results.

Is microbiota responsible for the beneficial effect of fermented dairy products?

Researchers have found that diabetics have an unbalanced gut microbiota. As a result, they have fewer bacteria producing butyrate (anti-inflammatory), more disease-causing microbes and some of their microbial functions are modified (such as protection against oxidative stress). While these results are important in our understanding of the role of microbiota in the onset and development of this illness, they also suggest that other fermented dairy products could have a beneficial effect through their influence on the digestive tract.

Nature 2012; 490 (7418): 55-60.

VITAMIN K2 and diabetes: further information...

The 2 active forms of vitamin K are vitamin K1 (or phylloquinone, mainly found in leafy vegetables) and vitamin K2 (or menaquinones, which exist in various forms in meat, eggs and dairy products). Vitamin K is known for its action on one hormone, osteocalcin, which plays a role in bone mineralisation and also in insulin sensitivity and therefore potentially in type II diabetes. A recent study on more than 38,000 Dutch people showed that - after 10 years of monitoring - the intake of vitamins K2 and K1 was associated with a lower risk of diabetes. In this study, cheese accounted for more than half of the K2 intake.

Diabete care 2010; 33 (8): 1699-1705.

“Better blood sugar level in people who eat fermented dairy products ”

- Nearly 6,000 Danish people monitored over 5 years.
- No link between total dairy consumption and the onset of type II diabetes. On the other hand, cheese and other fermented dairy products found to have a slightly beneficial effect on blood sugar levels.

Dairy product intake in relation to glucose regulation indices and risk of type 2 diabetes.

Struijk EA, Heraclides A, Witte DR, Soedamah-Muthu SS, Geleijnse JM, Toft U, Lau CJ.
Steno Diabetes Center A/S, DK-2820 Gentofte, Denmark; and Wageningen University, The Netherlands.
Nutrition, Metabolism, and Cardiovascular Diseases : NMCD (impact factor: 3.52). 07/2012; DOI:10.1016/j.numecd.2012.05.011

“The result of this study need to be confirmed in future high-quality population based observational studies and in intervention studies with the possibility to make the evidence for causality stronger”

Researchers spent 5 years monitoring 5,953 men and women, all living in the region of Copenhagen, who did not have diabetes at the start of the study. They estimated their overall dairy consumption and also provided a breakdown (full-fat vs. low fat; cheese vs. milk and dairy products; fermented vs. non-fermented dairy products, etc.). Blood samples were analysed to measure glucose and insulin levels and to calculate *HOMA indexes (IR and B)*, which are linked to the likelihood of developing diabetes.

Results: at the end of the 5 years, 214 cases of diabetes had been diagnosed. The statistical analyses found no link between dairy consumption (overall or per type of product) and the onset of diabetes. Nor did they find a link between overall dairy consumption and the various measurements of glycaemia and of the risk of diabetes *(HOMA indexes)*. On the other hand, blood sugar levels were more favourable in people who ate cheese and fermented dairy products.

The authors believe that further, more powerful, studies - such as clinical trials - are needed to gain a better understanding of the potentially beneficial role of dairy products, particularly fermented products, in the onset of type II diabetes.

Why do some studies find a beneficial relationship between dairy consumption and the risk of diabetes while others do not?

The size of the population studied, the quantity and type of dairy products consumed, the definition of dairy products, the study period, the criteria used to define type II diabetes and dietary habits, etc. vary greatly from one study to another. Furthermore, some factors (such as, for example, the times and ways of eating dairy products) are rarely taken into account (it could be important whether a person eats cheese on its own or with bread, for example).

Other interesting articles

Dairy calcium intake modifies responsiveness of fat metabolism and blood lipids to a high-fat diet.

Lorenzen JK, Astrup A. *Department of Human Nutrition, University of Copenhagen, Denmark.* British Journal of Nutrition 2011; 105(12): 1823-31.

► The beneficial effect of dairy products on weight could be partly explained by the effect of calcium on fat absorption. Calcium may reduce fat absorption by promoting the excretion of faecal fat. In other words: less fat absorbed, less fat stored. This study measured the effect of calcium on faecal fat excretion. Nine healthy men were administered different diets, each with high or low levels of calcium and/or high or low levels of fat. After 10 days on the diet, the authors of the study found that men on the high-calcium diets excreted more fat in their faeces.

Intake of total, animal and plant protein and subsequent changes in weight or waist circumference in European men and women: the Diogenes project.

Halkjær J, Olsen A, Overvad K, Jakobsen MU, Boeing H, Buijsse B, *et al. Danish Cancer Society, Institute of Cancer Epidemiology, Copenhagen, Denmark.*
International Journal of Obesity 2011; 35(8): 1104-13.

► The link between the consumption of protein from different sources (animal or vegetable) and changes in weight and waist circumference was studied in 38,094 people. No link was found between protein intake (total or source dependant) and changes in waist circumference. On the other hand, total and animal protein intake was linked to weight gain in both women and men. This positive association was not, however, found in milk protein consumption. Further analysis found that this positive association is linked to the consumption of meat and poultry protein and not fish or dairy protein

Milk intake is inversely related to body mass index and body fat in girls.

Abreu S, Santos R, Moreira C, Santos PC, Vale S, Soares-Miranda L, *et al. Research Centre for Physical Activity, Health and Leisure, Faculty of Sport, University of Porto, Porto, Portugal.*
European Journal of Pediatrics 2012; 171(10): 1467-74.

► In children, milk consumption generally reduces with age. A large number of adolescents reduce their milk consumption, mainly because they believe this will help them to control their weight. This epidemiological cross-sectional study, carried out on 1,001 Portuguese people between the ages of 15 and 18, examined the link between dairy consumption and corpulence *(BMI, body fat)*. Girls that consume more milk have a lower BMI and less body fat. No such result was observed in boys.

Human Obesity: Is Insufficient Calcium/Dairy Intake Part of the Problem?

Tremblay A, Gilbert JA. *Division of Kinesiology, Faculty of Medicine, Laval University, Quebec City, Quebec, Canada.*
Journal of the American College of Nutrition 2011; 30(5 Suppl 1): 449S-53S.

► In this review, the authors discuss the beneficial effects of dairy consumption and a calcium-rich diet on weight management and the mechanisms behind these beneficial effects.

Ruminant and industrial sources of trans-fat and cardiovascular and diabetic diseases.

Tardy AL, Morio B, Chardigny JM, Malpuech-Brugère C. *INRA, UMR 1019 Nutrition Humaine, Saint Genès Champanelle, France.* Nutrition Research Reviews 2011 Feb 15:1-7. [Epub ahead of print]

► A review of 108 published studies on the relationship between trans-fatty acids and diabetes.
► Few results but it seems that trans-fat - from any source - has no impact on *glucose tolerance* or *insulin resistance* and therefore does not affect the risk of diabetes.

Cross-sectional study of conjugated linoleic acid in adipose tissue and risk of diabetes.

Castro-Webb N, Ruiz-Narváez EA, Campos H. *Department of Nutrition, Harvard School of Public Health, Boston, MA , USA.* American Journal of Clinical Nutrition 2012; 96(1): 175–81.

► Measurements of CLA cis-9 and trans-11 (rumenic acid) and trans-10, cis-12 on the fatty tissue of 232 diabetic adults and 1512 non diabetics living in Costa Rica.
► The risk of diabetes is inversely related to the amount of rumenic acid present in adipose tissue, suggesting that this CLA could have an impact on insulin.

Ripened dairy products differentially affect hepatic lipid content and adipose tissue oxidative stress markers in obese and type 2 diabetic mice.

Geurts L, Everard A, le Ruyet P, Delzenne NM, Cani PD. *Metabolism and Nutrition Research Group, Louvain Drug Research Institute, Université Catholique de Louvain , Belgique.*
Journal of Agricultural and Food Chemistry 2012; 60(8): 2063-8.

► An experiment on 30 obese diabetic male mice.
► Ripening could have positives effects on markers of oxidative stress with even better results for cheese that has been ripened for longer.

Glossary

Diabetes: There are 2 main types of diabetes (officially *"diabetes mellitus"*).

- *Type 1 diabetes* (also known as insulin-dependent diabetes, juvenile diabetes or early-onset diabetes), which accounts for around 10 to 15% of cases. It normally appears in childhood or adolescence and, in general, before the age of 30. It is an autoimmune condition that manifests itself as a significant drop in insulin production. Sufferers must be treated with insulin for life.
- *Type 2 diabetes* (or mature-onset diabetes), which accounts for around 90% of cases in France. It generally affects people over the age of 45 and is often linked to environmental factors (obesity, sedentary lifestyle, etc.) but genetics also play an important role. This type of diabetes leads to the development of insulin resistance, mainly in the cells of the muscles and liver. It is mainly treated with a weight-loss programme and medication.

Epidemiological studies: The aim of these so-called observational studies is to find a statistical link between a population's nutrition/diet and health. They can be used to show whether a dietary factor is linked to the onset of an illness. However, they can never prove a causal link. Causal links can only be shown through clinical studies.

These studies may be cross-sectional, long-term (prospective or retrospective) or cohort studies or use control cases.

Cross-sectional: They examine the link between the health and diet of a population at a given moment, without considering changes over time.

Long-term: They enable health changes to be monitored over time and linked to dietary factors. They can be prospective or retrospective.

A **prospective** study measures food consumption before the onset of the health issue being studied. A **retrospective** study estimates previous food consumption in subjects affected by the illness.

Cohort studies: They compare the onset of a health issue in a group of subjects chosen for their exposure to a dietary factor (e.g. milk drinkers or not).

Control cases: They compare the food consumption of a group of people with the illness to a group of non-affected people (control group).

Nutritional clinical trial (RCT): The goal of a nutritional clinical trial is to demonstrate the beneficial effects of a food or an nutritional intervention on biological markers (LDL cholesterol, blood pressure, weight loss…) or health-related outcomes within a specific population.
The assignment of each participant to the interventional or control group must be randomized in order to reduce bias. The interventional group is compared with the control group. This type of study is also called "Randomized Controlled Trial". RCT is a type of experiment that is considered to be the gold standard for a clinical trial.

Glycaemia: Level of glucose in the blood. In the morning, before eating, the normal glucose level is around 1 gram per litre of blood (1 g/l). A diabetic is defined as a person with a fasting glucose level (after at least 8 hours of fasting) of more than or equal to 1.26 g/l. Blood glucose monitoring of type II diabetics also relies on testing glycated haemoglobin (or HbA1C - normal value between 4 and 6%) or the post-prandial blood glucose level (conducted after a meal).

HOMA indexes: *(Homeostasis MOdel Assessment):* These indexes are calculated using fasting glucose and insulin levels. A high HOMA-IR index (insulin resistance) and a low HOMA-B index (evaluating the secretory function of pancreatic beta-cell) are independently and "strongly" linked to an increased risk of developing diabetes.

Body Mass Index (BMI): BMI = weight (kg) / height (m) x height (m). Adults are said to be overweight if their BMI is between 25 and 29.9. Obesity corresponds to a BMI that is above or equal to 30 and morbid obesity corresponds to a BMI $\geq$ 40.

Insulin: Insulin is a hormone secreted by the pancreas (by the beta cells of the islets of Langerhans). It acts by allowing glucose (sugar) to enter the body's cells, which then use it as a fuel or store it. Insulin is produced constantly and also in response to the body's requirements and the food consumed. And so, after a meal, the pancreas secretes additional quantities of insulin to ensure that the blood glucose level (glycaemia) remains normal. Insulin therefore regulates glycaemia. Diabetes develops when the pancreas, for one reason or another, is not capable of providing a sufficient quantity of insulin or if the insulin does not work property.

Insulin resistance: Insulin resistance is when the cell receptors fail to respond to insulin. In general, when a large amount of sugar/glucose enters the blood stream, the pancreas secretes insulin, which binds to the body's cell receptors to allow the glucose to enter (the glucose is then transformed into "energy"). This keeps glycaemia at a normal level. There is a period of insulin resistance in some people (obese people, for example). Insulin continues to be secreted by the pancreas but no longer has an effect on the receptors: this is resistance. As a result, despite the presence of insulin, the glucose can no longer penetrate into the cells in the same way and so accumulates in the blood stream. This leads to a rise in glucose levels. This rise in glucose levels then results in excess insulin secretion by the pancreas. After a certain number of years, the pancreatic cells become tired and the body develops an intolerance to glucose, which leads to the onset of type II diabetes.

Glucose intolerance: This occurs when the body reacts less to insulin. The risk of becoming glucose intolerant increases in people that are overweight, obese, have a sedentary lifestyle or have a family history of diabetes.

Meta-analysis: The heterogeneity of methodologies used in studies lead to differing results, and sometimes even contradictions. Meta-analysis is a rigorous statistical approach that aims to combine the results of various studies on the same subject in order to reach a single conclusion.

Abdominal or visceral obesity: Abdominal or visceral obesity is when fat accumulates around the abdomen. Abdominal obesity refers to a waist circumference of more than 88 cm in women or 102 cm in men.

Metabolic syndrome: corresponds to the co-existence of at least 3 of the following metabolic problems (NCEP III 2001):

- Fasting glucose level ≥1.1 g/L
- Abdominal obesity >102 cm in men/88 cm in women
- Triglycerides ≥1.5 g/L
- HDL cholesterol <0.4 g/L for women and 0.5 g/L for men
- Blood pressure: ≥130/85 mm Hg

Metabolique Syndrome is a risk factor of type II diabetes and cardiovascular diseases.

For further information:

Questions on n°

- 46. Dairy products and weight management
- 47. Dairy products and diabetes

BEST of

- Dairy products and reduced cardiovascular risk

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