

Spotlight

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Author

Maria Kalergis, PhD, RD, CDE, is a Registered Dietitian and certified diabetes educator with Master's and Doctoral degrees in human nutrition from McGill University. Prior to joining DFC in 2008 as Program Manager, Health Professional Communications, Maria worked as a research and clinical dietitian in the field of diabetes. She has also worked for Dietitians of Canada, developing content for Practice-Based Evidence in Nutrition (PEN), a tool to help health professionals make evidence-based practice decisions. Maria has a special interest in diabetes, obesity, evidence-based practice and scientific communication.

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Developed by the team of Registered Dietitians at Dairy Farmers of Canada



Weighing In on the Dairy Connection: Examining the Role of Milk Products in Weight Management

Synopsis

Overweight and obesity are considered to be among the most important health issues facing us today. The causes of obesity are complex and multi-factorial; resolving them therefore requires multiple strategies. Diet and lifestyle modifications remain the cornerstones of overweight and obesity management and prevention. Parallel to the growing issue of obesity, data from national surveys conducted in the US and Canada have identified the problem of under-consumption of vegetables, fruit and milk products. Data from several studies conducted over the past decade, including large landmark epidemiological studies and randomized clinical trials, indicate a positive role for milk product intake in weight management. These findings have been substantiated by studies outlining potential mechanisms by which several components in milk products may play a role in energy balance and thus in weight management.

Introduction

Over the past 20 years, obesity has become the most prevalent nutritional problem in the world.¹ In Canada, the prevalence of overweight and obesity has increased over recent decades among both children and adults, with 59% of the adult population now classified as overweight and 23% as obese.¹ More alarming is the problem of obesity among children and adolescents in Canada: it is advancing at an even more rapid

pace than obesity among adults.¹

The causes of obesity are complex and multi-factorial and involve environmental, social and genetic components. Therefore, multiple strategies will have to be employed to address this public health issue.

According to the first-ever Canadian clinical practice guidelines on the prevention and management of obesity, diet and lifestyle modifications remain the cornerstones of overweight

and obesity management and prevention.¹

Parallel to the growing concern about obesity, data from national surveys in the United States and Canada have demonstrated calcium and milk product intakes far below recommended levels in both children and adults.²⁻⁴ The Canadian Community Health Survey indicated under-consumption of two key food groups, namely Vegetables and Fruit and Milk and Milk Products, with 65% to 84% of Canadian adults (age 31 and over) not meeting the recommendations for milk product intake.⁴

The role of calcium and milk products in weight management has been the focus of several studies in the past decade and is also the subject of controversy.

This issue of *Spotlight* examines the evidence related to the role of calcium and milk products in weight management and explores potential mechanisms by which milk products may play an integral role in the prevention and management of overweight and obesity in the context of a healthy lifestyle.

Did you know?

The Dairy-Weight Connection: A Chance Finding

The role of milk products in weight management was first observed in a clinical trial studying the antihypertensive effects of dairy products in African Americans. An increase in participants' dietary calcium intake from 400 to 1000 mg per day with consumption of two cups of yogurt each day for one year led to a significant reduction in body fat.⁵ Since the publication of this study, several other studies have examined the association between milk products or components (particularly calcium) and body weight and body fat regulation.

Examining the Evidence

Epidemiological Studies

Data from the first National Health and Nutrition Examination Survey (NHANES I) demonstrated an association between increased calcium intake and lower body mass index among American adults.⁶ Since that survey, several epidemiological studies have looked at the role of milk products or components, such as calcium, in body weight regulation in both adults and children.

Prospective cohort studies have been conducted in adults⁷⁻¹⁴ and in children and adolescents.¹⁵⁻²² All but one of the studies of adults¹² demonstrated the beneficial role in body weight management of dietary calcium or milk product intake. All but one of the studies of children and adolescents¹⁹ found either a beneficial impact on body weight or no negative impact with respect to weight gain, which is common during this critical period of development.

Several large landmark population studies support an inverse relationship between dietary calcium and milk product intake and body fat, BMI and the incidence of obesity. These studies include:

- NHANES I⁶
- NHANES III⁵
- The Coronary Artery Risk Development in Young Adults (CARDIA) Study⁷
- The Quebec Family Study²³
- The HERITAGE Family Study²⁴
- The Continuing Survey of Food Intakes by Individuals²
- The Tehran Lipid and Glucose Study¹¹
- The Vitamins and Lifestyle Cohort Study²⁵

In the CARDIA Study, increasing milk product intake (regardless of whether the products were regular or reduced fat) was associated with a lower incidence of insulin-resistance syndrome (IRS) or metabolic syndrome and each of its components (obesity, hypertension, abnormal glucose and dyslipidemia). The 10-year incidence of IRS was 72% lower among overweight individuals consuming five or more servings of milk products per day than it was

among those consuming fewer than 1.5 servings of milk products per day. Furthermore, the associations were dose-dependent: each daily serving of milk products was associated with 21% lower odds of developing IRS (odds ratio = 0.79).⁷

Bottom line: Overall, epidemiological studies, including large landmark studies, suggest a beneficial role for milk products in body weight regulation.

Randomized Controlled Trials

Several randomized, controlled trials have been conducted to address the hypothesis of an association between milk product consumption or calcium intake and body weight in adults^{26–39} and in children and adolescents.^{40–42} The majority of these studies demonstrated either an augmentation of loss of body weight or fat with caloric restriction, or prevention of weight gain. Three studies found no association,^{28,32,35} but the findings from these three studies may be due to the “threshold effect” described in the next column.

The strongest evidence to date of a link between weight control and milk product consumption comes from the landmark Women’s Health Initiative study, a randomized, double-blind, placebo-controlled trial of 36,282 postmenopausal women followed for three to seven years.³⁸ This study demonstrated that calcium and vitamin D supplementation helped prevent or limit weight gain, primarily in women with baseline calcium intakes below the recommended intake of 1200 mg per day.³⁸

Bottom line: The majority of randomized, controlled trials, including a landmark study, clearly demonstrate that milk products or components, such as calcium, have a beneficial impact on body weight regulation.

The Threshold Effect

Although the evidence is still inconclusive, it is believed that a threshold level of calcium intake exists, above which there may be no further benefits with respect to weight management. While there is insufficient data to precisely calculate that threshold, it has been suggested that it may be around 800 mg per day, with a range of 600 to 1200 mg per day.⁴³ Regardless of the exact number, it is suggested that calcium plus vitamin D or dairy product supplementation could enhance fat-mass loss better than a control condition in overweight or obese individuals that have habitual calcium intakes well below recommended levels for their age group.⁴³

The lack of association between milk products and weight control in some studies may be partially attributed to the threshold effect.^{28,32,35}

Dietary Patterns

Although it is important to understand the role of individual nutrients and food groups, an individual’s overall diet or dietary pattern will likely have a greater impact on weight control.

Three prospective cohort studies have indicated that a higher intake of lower-fat milk products, in the context of a healthier dietary pattern that also includes increased consumption of fruit, is associated with better body weight and adiposity measures.^{8,9,44} Although one cannot isolate the effect of dairy products per se from these studies, it is clear that increased milk product consumption is an important aspect of this healthy dietary pattern.

A recent study demonstrated that inclusion of low-fat dairy products in a dietary pattern that also included consumption of whole-grain cereals is positively associated with plasma adiponectin levels in healthy women.⁴⁵ Adiponectin, a hormone secreted by adipocytes (fat cells), has been shown to improve insulin action as well as glucose and lipid metabolism and is associated with a reduced risk of developing type 2 diabetes (reviewed by Yannakoulia et al 2008).⁴⁵

Bottom line: *Milk products are an integral part of a dietary pattern that appears to be beneficial for achieving and maintaining a healthy weight.*

Calcium Supplements vs. Milk Products

Almost all the studies to date on the effect of calcium or milk products on weight have examined the influence of either milk products or calcium supplements on measures of body weight.

Only one head-to-head study has been conducted to compare the role of milk products with that of calcium supplements.²⁷ In this randomized, placebo-controlled trial, both the calcium supplement and dairy groups lost more weight and fat than those subjects on a control diet (low dairy, low calcium). However, the dairy group had more favourable outcomes with respect to body weight and fat loss compared to the supplement group.²⁷

This study was the first to suggest that milk products may have a role in weight regulation beyond the role for calcium. Although more research is needed to confirm this finding, several studies indicate the beneficial effect of various dairy components in weight management, as described in the next section.



Biological Plausibility and Potential Mechanisms

Although the impact of calcium and milk products on energy metabolism and adiposity is still the topic of ongoing research, several studies have confirmed the theory's biological plausibility, including animal studies, epidemiological studies and clinical trials.⁴⁶

Two main physiological mechanisms have been proposed to explain how calcium intake can affect body weight: 1) the effect of dietary calcium on intracellular calcium levels and 2) the effect of dietary calcium on fatty acid absorption from the gastrointestinal tract.

Effect of Dietary Calcium on Intracellular Calcium Levels

Low dietary calcium intake stimulates high levels of parathyroid hormone (PTH) and 1,25-dihydroxyvitamin D, which in turn stimulates high levels of intracellular calcium. High levels of intracellular calcium in adipocytes stimulate lipogenesis and inhibit lipolysis. Support for this mechanism is derived from studies conducted in transgenic mice (reviewed by Zemel 2005),⁴⁷ in vitro studies with human adipocytes⁴⁸⁻⁵⁰ and a recent randomized, controlled trial in humans.⁵¹

Effect of Dietary Calcium on Fat Absorption from the Gastrointestinal Tract

Increased dietary calcium seems to bind more fatty acids in the colon, thereby inhibiting fat absorption. Support for this mechanism is derived from several studies conducted in animals and humans (reviewed by Major et al 2008a).⁴³

The Whole Is Greater than the Sum of the Parts!

Data from several lines of evidence demonstrate that milk products have a greater effect on weight management than does calcium from supplements.²⁷ It has therefore been proposed that other bioactive components in milk products, which may act either independently or synergistically with dietary calcium, may also play an important role in energy metabolism (reviewed by Zemel 2005).⁴⁷

Other bioactive components that may play a role in body weight regulation include:

- Protein composition, especially high levels of branched-chain amino acids (BCAAs)
- Other properties of whey protein, such as the presence of angiotensin converting enzyme (ACE) inhibitor peptides
- Vitamin D
- Carbohydrate quality (as defined by glycemic index)

Branched-chain amino acids, and in particular leucine, which is abundant in milk products, may have a positive effect on protein synthesis and maintenance of lean mass.⁵²

In addition to BCAAs, whey contains many bioactive compounds that may act either independently or synergistically to affect lipogenesis, lipolysis, lipid oxidation and energy partitioning.⁴⁶

The ACE inhibitory activity of whey protein may be relevant to adipocyte lipid metabolism. Angiotensin II upregulates adipocyte fatty acid synthase expression, and ACE inhibition mildly attenuates obesity in both mice and hypertensive humans (reviewed by Zemel 2005).⁴⁷ The ACE inhibitory effect of milk products may also explain their significant antihypertensive properties, as demonstrated in several studies, including the landmark DASH diet study.⁵³

The role of vitamin D has become the subject of intense interest. A recent study demonstrated that in addition to calcium, adequate vitamin D status may enhance fat oxidation and the thermic effect of a meal.⁵¹

Another potential mechanism by which milk products may modulate weight is through their

low glycemic index. A recent Cochrane Systematic Review concluded that low-glycemic-index and low-glycemic-load diets were more effective than high-glycemic-index or conventional low-fat diets in inducing weight and fat-mass loss and produced more favourable lipid profiles.⁵⁴

In Brief

Benefits Beyond Weight

The benefits of milk products extend far beyond their role in weight and fat loss. Perhaps even more important than losing weight or fat is achieving optimal body composition. Because weight-loss strategies often lead to loss of lean tissue such as muscle and bone, preservation of lean tissue is of the utmost importance.

A recent study demonstrated the important role of increased milk product intake in preserving lean tissue, such as bone and muscle, in the context of a weight-loss strategy.⁶¹ A recent review paper concurs that results from randomized, controlled trials indicate that milk product intake has been shown to protect muscle mass during energy restriction and to increase muscle mass on eucaloric diets.⁴³

Furthermore individuals who are overweight or obese are at risk for a number of health problems, including hypertension, metabolic syndrome, cardiovascular disease and type 2 diabetes. Increased milk product intake has demonstrated a beneficial role in reducing that risk.^{7,39,53,62-64}

What's New?

Emerging research points to a connection between bone and energy metabolism.^{55,56} The role of calcium and milk product intake in bone health is very well established, adding further support to the biological plausibility of milk's role in weight management. Of interest is the role of osteocalcin, a hormone produced by bone cells (osteoblasts). Osteocalcin has been shown to be involved in endocrine regulation of energy metabolism via effects on insulin secretion and action and through adiponectin expression.⁵⁵

Recent genomic and metabolomic research has added further support for the biological plausibility of a role for milk products in weight management. A recent study demonstrated that a high-calcium diet that included whey protein affected the expression of more than 129 genes in adipose tissue, including genes involved in insulin, adipocytokine and fatty acid metabolism.⁵⁷ Another study by the same group demonstrated that the impact of energy restriction was enhanced by whey and calcium with respect to fat accumulation in the liver (fatty liver), which may be a key mechanism in the development of metabolic syndrome and associated complications.⁵⁸

Another study has demonstrated a role for dairy product consumption in reducing oxidative stress and inflammation in both animals and humans.⁵⁰ Both oxidative stress and inflammation are believed to play a key role in obesity-associated metabolic complications.⁵⁰

Recent research also points to regulation of appetite by certain vitamins and minerals,⁵⁹ including calcium.⁶⁰

A recent review paper provides strong evidence that dairy products and calcium may influence several components of energy balance, including energy intake and energy expenditure.⁴³

Conclusions

Data from landmark epidemiological studies and randomized, controlled trials have demonstrated either a slower rate of weight gain in groups at risk of gaining weight (such as postmenopausal women and growing children) or augmentation of weight or fat-mass loss under conditions of caloric restriction in overweight or obese individuals. This improved weight control is particularly evident in people whose habitual calcium or milk product consumption is below recommended levels. These findings have been confirmed in adults, children, adolescents and special subgroups, such as individuals with type 2 diabetes. Furthermore, these findings have been substantiated by evidence from studies (including studies conducted in humans) that demonstrates several potential biological mechanisms for this benefit.

Although many factors influence the development of overweight and obesity, it is clear from the evidence to date that milk products play an important role in their own right and also as an integral part of a healthy dietary pattern that can help ensure a healthy weight and, more importantly, ensure overall health.

Future Directions

We need large, long-term, randomized controlled trials to find out more about milk product consumption for prevention of weight gain in at-risk groups (such as children, adolescents and postmenopausal women). We also need similar trials of milk product consumption in the context of weight loss with body composition and metabolic endpoints. More mechanistic studies are needed in humans to elucidate the role of several constituents in milk products with respect to body weight management.

In Your Practice

Here are some tips to help your clients maintain a healthy body weight:

- Encourage consumption of a healthy diet based on *Canada's Food Guide*. Emphasize the need to meet the recommendations for intake of vegetables and fruit and milk products.
- For children, adolescents and postmenopausal women, encourage consumption of at least the recommended number of servings per day of milk products.

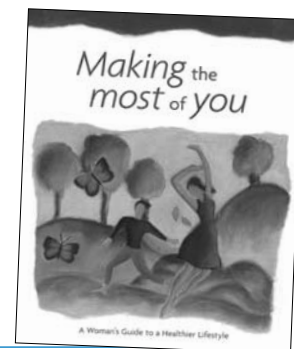
- Emphasize consumption of the recommended number of servings of milk products for overweight and obese individuals who are following an energy-restricted diet.
- Encourage consumption of the recommended number of servings of milk products in high-risk individuals (such as those with hypertension, type 2 diabetes or cardiovascular risk factors).
- Encourage a healthy lifestyle that includes regular physical activity.
- Give the accompanying Fact Sheet (10 Steps Toward a Healthy Weight) to your clients.

Resources for Your Clients

Making the Most of You (MMY) is a client resource designed for women trying to achieve a healthy

weight. First produced in 2002, this popular resource has now been updated to meet the 2007 *Food Guide* recommendations. This free resource includes sound information and tips on the *Food Guide*, physical activity and serving sizes and includes tracking charts for multiple weeks. Women who have used MMY have found it engaging and motivational. MMY is available in Ontario, Quebec and the Maritimes by using our online order form under “nutrition education” at www.dairynutrition.ca.

At www.yourhealthyweight.ca, experts will answer your clients’ questions about weight.



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