Research Summary: **Dairy and Healthy Weight**

One of the most important public health concerns around the world is the increase in overweight and obese children and adults. Data from the National Health and Nutrition Examination Survey (NHANES) which assesses the health and nutritional status of adults and children in the United States shows that obesity continues to be a health concern with an estimated 66 percent of adults being classified as either overweight or obese. Alarmingly, the most recent NHANES survey indicated that an estimated 31.9 percent of children and adolescents aged 2 - 19 were at or above the 85th percentile of the BMI-for-age growth chart.

The rise of overweight and obese children and adults is of great concern, because excess body weight can significantly increase the risk of heart disease, hypertension, type 2 diabetes, certain types of cancer, and other diseases. Several scientific studies suggest that dairy foods (milk, yogurt, and cheese) play a beneficial role in maintaining a healthy weight. Solving the obesity crisis has become the number one public health issue for the U.S. population; therefore National Dairy Council® (NDC) has focused one area of its nutrition research on the role of dairy foods in a nutrient-rich diet to serve as part of the solution in addressing obesity and poor nutrition.

Today, many Americans are overweight and undernourished and are missing out on key essential nutrients because we are not choosing to eat nutrient-rich foods first. For example, many people fail to consume recommended amounts of calcium, mainly because of their low intake of dairy foods.

A growing body of research illustrates that enjoying three servings of milk, cheese or yogurt each day as part of a nutrient-rich, balanced diet may help maintain a healthy weight. Multiple observational studies show that people who consume more calcium and dairy foods weigh less and/or have less body fat than those who consume little or no dairy.

Scientific Support
Randomized Clinical Trials
Observational Studies
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Randomized Clinical Trials

Zemel and colleagues published the results from a multi-center study designed to determine the roles of supplemental calcium and dairy foods in augmenting fat and weight loss secondary to energy restriction (-500 kcal per day) in overweight and obese adults. One hundred and six otherwise healthy overweight and mildly obese adults (18-35 years of age) participated in a 12-week randomized, placebo-controlled trial. Among the compliant subjects (n=68), the consumption of an elemental calcium-rich diet (~1400 mg of calcium per day) exerted no significant effects on weight loss or body composition (i.e. fat mass and lean body mass) as compared to the consumption of a low calcium diet (~600 mg of calcium per day). Interestingly, a diet providing the equivalent amount of calcium (i.e. ~1400 mg per day) supplied from 3 servings per day of milk, cheese and/or yogurt resulted in a two-fold increase in fat loss as compared to the high- and low-calcium diets. In addition, the consumption of the high dairy diet resulted in significantly greater trunk fat loss and decreases in waist circumference as compared to the high- and low-calcium diets. Similar trends were noted among all subjects completing the study (n = 93) and in an intent-to-treat analysis (n = 106). The authors conclude that the results indicate that dairy-rich diets augment weight loss by targeting the fat compartment during energy restriction.

Zemel MB, Teegarden D, Van Loan M, Schoeller DA, Matkovic V, Lyle RM, Craig BA. Dairy-rich diets augment fat loss on an energy-restricted diet: a multi-center trial. Nutrients. 2009; 1(1): 83-100.

Manios et al. examined whether dietary changes and the consumption of dairy products fortified with calcium and vitamin D could affect anthropometric and body composition indices of postmenopausal women over a 12-month period. The women were randomly assigned to

either a dietary and lifestyle intervention group (1200 mg Ca and 7.5 µg of vitamin D via fortified dairy products), a calcium supplement group (1200 mg Ca), or a control group. The women in the dietary and lifestyle intervention group also attended biweekly sessions that discussed changes to lifestyle and dietary habits that could improve their health status. The authors reported that there were no significant differences in the mean 12-month change in body weight, BMI, total body fatness, or lean body mass between the groups. However, the dietary and lifestyle intervention group did have a lower decrease in mid-arm muscle circumference and a lower increase in the sum of skinfolds' thickness as compared to the other groups. In addition, the dietary and lifestyle intervention group had a greater decrease in the percentage of fat mass and a greater increase in the percentage of lean mass in as compared to the other two groups. The authors concluded that combining nutrition and lifestyle changes for 12 months had favorable changes in certain anthropometric and body composition indices in this population.

Manios Y, Moschonis G, Koutsikas K, Papoutsou S, Petraki I, Bellou E, Naoumi A, Kostea S, Tanagra S. Changes in body composition following a dietary and lifestyle intervention trial: The postmenopausal health study. Maturitas. 2009; 62(1): 58-65.

Yanovski and colleagues examined the effect of calcium carbonate supplementation on weight and body fat in the absence of caloric restriction in overweight and obese adults. The study was a single-center, randomized, double-blind, placebo-controlled trial that was conducted in overweight and obese individuals (BMI > 25 kg/m2). Three hundred and forty participants were randomly assigned to receive either elemental calcium (n = 170; 1500 mg/d) or placebo (n = 170) for two years. Baseline, mean total calcium intake was 878 and 887 mg/d in the calcium and control group, respectively. The measured change in body weight among all participants was +1.31 kg and fat mass increased by +0.82 kg over the 2-year period. After adjusting for age, race and sex, there were no statistically significant differences in change in body weight, BMI or body fat mass between the groups. In addition, there were no significant differences in abdominal circumference, hip circumference, triceps skinfold thickness, or serum 25-hydroxy vitamin D levels. Finally, analysis of weight change among those with lower initial dietary calcium intake (<1200 mg/d) found no significant difference in weight gain between calcium supplement group and placebo group. The authors conclude that calcium supplementation has limited efficacy for preventing weight gain among overweight and obese persons.

Yanovski JA, Parilkh SJ, Yanoff LB, Denkinger BI, Calis KA, Reynolds JC, Sebring NG, McHugh T. Effects of calcium supplementation on body weight and adiposity in overweight and obese adults. Ann Intern Med. 2009; 150(12):821-829.

Alonso et al. conducted a randomized crossover trial in 45 normotensive volunteers to examine the effects of low- and whole-fat dairy products on blood pressure and weight changes. Participants alternatively received 3.5 servings per day of whole-fat or low-fat dairy products (milk and yogurt) in addition to their usual diet during two 8-wk periods, with a 4-wk washout period between both interventions. The results showed that whole-fat dairy supplementation significantly increased systolic blood pressure and weight, whereas there was no change in weight and blood pressure in the low-fat dairy intervention. Based on these results, the authors concluded that supplementation with whole-fat dairy products, compared to low-fat dairy, was associated with weight gain. However, it should be noted that calories were not restricted in this study nor were any dietary changes made to reduce energy intake to compensate for the additional calories provided by the dairy products.

Alonso A, Zozaya C, Vazquez Z, Alfredo Martinez J, Martinez-Gonzalez MA. The effect of low-fat versus whole-fat dairy product intake on blood pressure and weight in young normotensive adults. J Hum Nutr Diet. 2009; 22(4):336-42.

Zemel and colleagues assessed the effects of recommended versus low dairy diets on weight maintenance following a weight loss program. The authors reported that, during the weight maintenance phase, there were no overall significant differences for body weight, BMI, body fat, or trunk fat between the recommended and low dairy groups. However, the authors noted that the recommended dairy group consumed significantly more calories as compared to the low dairy group. The authors conclude that diets with recommended levels of dairy do not enhance weight regain following a weight loss regimen despite containing higher energy content than diets with low dietary dairy.

Zemel MB, Donnelly JE, Smith BK, Sullivan DK, Richards J, Morgan-Hanusa D, Mayo MS, Sun X, Cook-Wiens G, Bailey BW, Van Walleghen EL, Washburn RA. Effects of dairy intake on weight maintenance. Nutr Metab (Lond). 2008; 5:28.

Wagner et al. examined the effects of increased calcium intake (either supplemental calcium or nonfat milk) on body weight, body fat, and markers of bone health in pre-menopausal adult women following consumption of a calorie-restricted diet for 12 wks. Calcium intake was approximately 788 mg/d in the control group, 1698 in the calcium-lactate group, 1566 in the calcium-phosphate group, and 1514 in the milk group. The authors reported no differences in body weight and body fat among the groups. Based on these results, they conclude that, under these experimental conditions, increasing calcium intake did not enhance weight or fat loss.

Wagner G, Kindrick S, Hertzler SM, DiSilvesto RA. Effects of various forms of calcium on body weight and bone turnover markers in women participating in a weight loss program. J Am Coll Nutr. 2007; 26(5):456-61.

Researchers examined the influence of dairy product consumption on appetite, satiety, and food intake in 58 overweight and obese adults. There were no reported significant differences in hunger, fullness, desire to eat, or preoccupation with foods when subjects consumed inadequate (<1 serving) vs. adequate (3 servings) dairy servings as part of their daily diet over the course of the 7-day treatment period. On average, when subjects consumed the adequate servings of dairy, they did increase overall calorie intake; however, there was partial compensation in some subjects for the dairy calories as they reduced calories from other foods. The authors note that the short-term nature of the study may not have provided enough time for compensating mechanisms to fully function. While this study was not designed to examine weight loss, the authors do note that increasing dairy consumption may lead to increased calorie intake, which could potentially cause weight gain. However, they also note that dairy consumption may offer a metabolic advantage based on other research and that further research is needed to understand if increased energy intake from dairy is offset by metabolic changes induced by dairy components.

Hollis JH, Mattes RD. Effect of increased dairy consumption on appetitive ratings and food intake Obesity. 2007;15:1520-1526.

Researchers aimed to determine the long-term consequences of milk or soy protein or equivalent energy consumption on training-induced muscle gains. This study examined the effects of consuming fat-free milk, soy or carbohydrate-based beverages on muscle fiber size, strength and body composition during a 12-week resistance training program on 56 healthy men (18-30 years of age). Participants consumed 500mL of one of the three beverages immediately post-exercise and then another 500mL of the same beverage again 1 hour following exercise. Results indicated all three groups increased muscle fiber size and muscle mass, but subjects in the milk group experienced the greatest gains in muscle fiber size and muscle mass. Despite similar dietary caloric intakes among participants over the course of the study, it was apparent through DEXA (dual-energy X-ray absorptiometry) measurements that participants in the milk group lost more body fat over the 12-week period than the soy group and carbohydrate group. Researchers concluded that the chronic consumption of fluid fat-free milk immediately and 1 hour after resistance exercise promotes greater body composition benefits (gains in lean body mass and reductions in body fat) compared to the consumption of a soy protein or carbohydrate beverage.

Hartman JW, Tang JE, Wilkinson SB, Tarnopolsky MA, Lawrence RL, Fullerton AV and Phillips SM. Consumption of fat-free fluid milk following resistance exercise promotes greater lean mass accretion than soy or carbohydrate consumption in young novice male weightlifters. American Journal of Clinical Nutrition August 2007:86:373– 81.

In this study, researchers assessed the effects of calcium lactate, calcium phosphate, milk, or a placebo on body weight, body fat, and markers of bone turnover in 58 pre-menopausal overweight and obese women undergoing a 12-week weight loss program of diet and exercise. The background diets for all subjects included 750 mg calcium per day which came from milk, yogurt, cheese and other dietary calcium sources. In addition, the subjects were randomly assigned to receive either a placebo or 800 mg of calcium from calcium lactate, calcium phosphate, or 1percent milk. Therefore, the latter three groups consumed 1500-1700 mg of total calcium per day. Each group experienced statistically significant reductions in body weight and body fat over time; however, there were no significant differences in weight loss between groups. The milk group showed significantly less reduction of body fat than the placebo group. Only those who received calcium lactate had a significant decrease in bone resorption, indicating less bone breakdown. The authors state that one explanation for a lack of effect on weight loss between the groups may be that "an effect on weight loss requires a swing from a very low calcium intake, such as 400-500 mg/day, to a considerably higher calcium intake." The present study did not exclude subjects based on habitual calcium intakes and set the low calcium placebo group's intake at ~750 mg/day.

Wagner G, Kindrick S, Hertzler S, DiSilvestro RA. Effects of Various Forms of Calcium on Body Weight and Bone Turnover Markers in Women Participating in a Weight Loss Program. Journal of the American College Nutrition 2007;26(5):456-461.

Researchers administered four different isocaloric diets with various calcium intakes (400, 1200 or 2500 mg from dairy or 1200 mg from a supplement) in a crossover design to 10 healthy adults to study the effect of increased calcium intake on fecal fat and energy excretion over a 7-day period. A non-significant increase in fat excretion was found on the diet delivering 2500 mg calcium compared to 400 mg calcium diet. The authors speculate that the relatively high protein content of the high dairy diet (2500 mg calcium) may have increased calcium absorption thus decreasing the amount of calcium available for binding to fat for its subsequent excretion. The diet delivering 2500 mg of calcium from dairy did significantly reduce the expression of fatty acid synthase which is an indicator of decreased fat storage. The diet delivering 1200 mg of calcium as a supplement did significantly decrease serum triglycerides.

Boon N, Hul GBL, Stagen JHCH, Sluijsmans WEM, Valle C, Langin D, Vigueri N, Saris WHM. An intervention study of the effects of calcium intake on fecal fat excretion, energy metabolism and adipose tissue mRNA expression of lipid-metabolism related proteins. International Journal of Obesity 2007;31:1704-1712.

The acute effects of different sources of calcium (Ca) were examined in 8 adults (6 men and 2 postmenopausal women), aged 47-66 years in a 3-way cross-over study. Subjects were randomly provided breakfast meals of either low dairy Ca and low vitamin D (control), high non-dairy Ca (calcium citrate with orange juice) and low vitamin D, or high dairy Ca and high vitamin D. Measurements were taken hourly during the 6 hours following a meal. Regardless of source (dairy or non dairy), Ca intake acutely stimulated postprandial fat oxidation, suggesting Ca-rich meals appear to have beneficial effects on post-meal fat processing regardless of Ca source. Such an effect could help explain a potential link between Ca intake and body weight regulation.

Cummings NK, James AP, Soares MJ. The acute effects of different sources of dietary calcium on postprandial energy metabolism. British Journal of Nutrition 2006;96:138-144.

A 12-week study of 34 obese adults on a balanced, modestly reduced-calorie diet found that those who consumed a calcium-rich diet supplied by 3 servings of yogurt a day lost 22percent more weight, 66percent more body fat and 81 percent more trunk fat compared to those who simply reduced calories and consumed little or no dairy. The participants who ate 3 servings of yogurt also lost significantly more inches around the waist compared to those on the low-dairy diet.

Zemel MB, Richards J, Russel J, Milstead A, Gehardt L, Silva E. Dairy augmentation of total and central fat loss in obese subjects. International Journal of Obesity. 2005; 29(4):341-7.

Two randomized controlled studies were conducted in otherwise healthy obese African-American adults. The first clinical study, a 24-week study of 29 obese adults, found that those who consumed 3 servings of dairy per day on a balanced, modestly reduced-calorie diet lost twice as much weight and fat while preserving lean body mass compared to participants who consumed less than 1 serving of dairy per day. The second clinical study, a 24-week study of 34 obese adults, found that those who consumed 3 servings of dairy per day on a weight-maintenance diet (consumption of adequate calories to maintain weight) lost more total body fat and trunk fat and gained lean mass compared to participants who consumed less than 1 serving of dairy per day. In both studies, 3 servings of dairy a day decreased circulating insulin levels, suggesting an association between dairy intake and reduced risk of symptoms of type 2 diabetes. In addition, in the weight maintenance study, consuming 3 servings of dairy per day produced a significant decrease in blood pressure.

Zemel MB, Richards J, Milstead A, Campbell P. Effects of calcium and dairy on body composition and weight loss in African-American adults. Obesity Research. 2005 13(7): 1218-1225.

A 12-month study of 155 women (aged 18-30 years) found that normal weight subjects showed no effect on body composition under energy balance (study was not designed for weight loss). Women were randomly assigned to one of three groups: 1) control: women followed normal diet of less than 800 mg of calcium a day; 2) medium-dairy: women substituted dairy products to achieve intake of 1000-1100 mg of calcium a day and maintain their current calorie intake; and 3) high-dairy: women substituted dairy products to achieve intake of 1300-1400 mg of calcium and maintain their calorie intake. No significant differences were shown between the three groups in body weight fat mass, or lean mass after one year on non-calorie restricted diets. Throughout the intervention, the medium- and high-dairy groups had slightly higher (not statistically higher) mean calorie intakes than the control group, which may indicate a lack of appropriate substitution by the dairy groups. In contrast to weight loss studies in obese subjects using dairy within a detailed dietary prescription, this study was conducted in normal weight individuals who were simply instructed to substitute dairy into their diet for foods of equivalent caloric value.

Gunther CW, Legowski PA, Lyle RM, McCabe GP, Eagan MS, Peacock M, Teegarden D. Dairy products do not lead to alterations in body weight and fat mass in young women in a one year intervention. American Journal of Clinical Nutrition. 2005; 81(4): 751-6.

In a 12-month study of 19 normal-weight women (aged 18-30 years), the participants who consumed 3-4 servings of dairy each day burned more fat and calories from a meal compared to women who consumed a low-dairy diet (1-2 servings per day). The participants' ability to burn fat and calories after a meal was measured at the beginning and end of the trial to determine the impact of increasing dairy and calcium consumption during the one-year intervention. The researchers speculate that the potential mechanism for the increased fat burning is related to parathyroid hormone. They observed that increases in dairy consumption decreased parathyroid hormone, which was associated with an increase in fat burning. These findings build on other research demonstrating the role of calcium regulating hormones as potential mediators of the relationship between an increase in dietary calcium and greater fat burning.

Gunther CW, Lyle RM, Legowski PA, James JM, McCabe LD, McCabe GP, Peacock M, Teegarden D. Fat oxidation and its relation to serum parathyroid hormone in young women enrolled in a 1-y dairy calcium intervention. American Journal of Clinical Nutrition. 2005; 82: 1228-1234.

In a 48-week study, 72 obese adults followed three different balanced, modestly reduced-calorie diets: a "high-dairy" diet that included 4 servings of dairy (milk, yogurt or cheese) each day; a "high-dairy/high fiber/low glycemic index" diet that included 4 servings of dairy each day; and a "moderate-dairy" or standard diet that included 2 servings of dairy foods each day. While the groups lost similar amounts of weight and body fat, the participants in the high-dairy groups who most closely followed the prescribed diet and exercise plan consumed about 100 to 150 more calories each day. Even with the higher calorie intake, they lost the same amount of weight as the dieters who consumed 2 servings of dairy a day and fewer calories.

Thompson WG, Holdman NR, Janzow DJ, Slezak JM, Morris KL, Zemel MB. Effect of energy-reduced diets high in dairy products and fiber on weight loss in obese adults. Obesity Research. 2005; 13:1344-1353.

Researchers found that when exercising adults on a slightly reduced-calorie diet consumed 3-4 servings of dairy foods each day, their metabolism changed so that they burned more fat versus consuming one serving of dairy under the same conditions. The study included 19 overweight men and women (aged 20-50 years) who usually exercised less than three hours a week. Over the course of seven weeks, the subjects participated in four one-week periods in which they consumed either a low-dairy diet or a diet including 3-4 servings of dairy foods each day. Several times during the study, participants' rate of fat oxidation (burning) was measured over a 24-hour period in a room calorimeter. The researchers conclude that reducing calories and exercising while consuming adequate dairy foods can help improve the body's ability to burn fat, which may lead to the loss of body fat.

Melanson EL, Donahoo WT, Dong F, Ida T, Zemel MB. Effect of low- and high-calcium dairy-based diets on macronutrient oxidation in humans. Obesity Research. 2005;13:2102-12.

Twelve healthy, nonobese men were fed three diets of equal calorie levels: high-calcium/high-dairy, high-calcium/low-dairy and low-calcium/low-dairy. At the end of 7 days, there were no significant differences between the diets in 24-hour energy expenditure, fat oxidation or gene expression of proteins related to fat metabolism. However, the hormonal form of vitamin D (1,25-dihydroxyvitamin D3), which is involved in fat cell metabolism, was significantly lower after the high-calcium/high-dairy diet compared tot he low-calcium/low-dairy diet as expected, suggesting vitamin D may in fact play a role. The researchers conclude that beyond a vitamin D related mechanism, dairy/calcium intake may also affect dietary fat absorption, resulting in fecal fat and energy losses.

Boon N, Hul GBJ, Viguerie N, Sicard A, Langin D, Saris WHM. Effects of 3 diets with various calcium contents on 24-h energy expenditure, fat oxidation, and adipose tissue message RNA expression of lipid metabolism-related proteins. American Journal of Clinical Nutrition. 2005; 82: 1244-52.

Researchers monitored the diet progress of 44 study participants, who were either on a high-dairy, reduced-calorie diet (3-4 servings of dairy/1200-1400 mg calcium) or lower dairy, reduced-calorie diet (about 1 serving/400-500 mg calcium). Participants in both groups lost 20-24 pounds after 12 months. (Note: A post-hoc analysis indicated that there may not have been enough study completers to detect statistically-significant differences in weight loss between the two groups.)

Harvey-Berino J, et al. The impact of calcium and dairy product consumption on weight loss. Obesity Research. 2005; 13; 1720-1726.

Researchers in Denmark studied the short term effects of three diets, low calcium/normal protein, high calcium/normal protein, and high calcium/high protein on 24-hour energy expenditure, fat oxidation, and fecal fat excretion in 10 healthy, non-obese adults under energy balance conditions. The calcium level in the diets had no effect on 24-hour energy expenditure or fat oxidation, but fecal fat and energy excretion increased significantly during the high calcium/normal protein diet compared to the other two diets. The decreased fat and calorie absorption may explain one of the mechanisms by which high-calcium diets produce weight loss and suggests that dietary protein level may be important.

Jacobsen R, et al. Effect of short-term high dietary calcium intake on 24-h energy expenditure, fat oxidation, and fecal fat excretion. International Journal of Obesity. 2005; 29: 292-301.

In a study of 51 normal weight women who reduced their caloric intake and increased physical activity over four months, researchers found tha the women who also increased their milk intake by at least 200ml/day, nearly one cup, lost more body fat and gained more lean muscle mass compared to the women that did not increase milk intake.

Hirota T, Kawasaki I, Ikeda H, Aoe T, Hirota K. Intake of vitamin D and milk was associated with increase in muscle mass and decrease in body fat during dieting in young women. American Society for Bone and Mineral Research Annual Meeting. 2005. Abstract M272.

In a 48-week study of 44 obese postmenopausal women in Korea, researchers found that calcium supplementation induces body weight and fat loss with favorable changes in fat distribution, including reduced abdominal visceral fat. Subjects received a daily calcium supplement providing 300 mg calcium in addition to the average basal dietary calcium intake ~400 mg. Researchers compared the subjects with low (less than 400 mg per day) versus high (more than 400 mg per day) baseline dietary calcium intakes when analyzing the outcomes measures. Those subjects with low baseline calcium intakes were more obese than those with higher calcium intakes at the start of the study, but they achieved more weight and fat loss and improvement of insulin sensitivity after the 48-week calcium supplementation. The researchers conclude that obesity and calcium intake at baseline may partially determine the magnitude of the response to calcium supplementation.

Kim D, Rhee Y, Ahn C, Cha B, Kim K, Lee H, Lim S. Effects of calcium supplementation on body composition and fat distribution in Korean obese postmenopausal women. American Society for Bone and Mineral Research Annual Meeting. 2005. Abstract SA422.

To test effects of calcium and vitamin D on feelings of hunger and satiety and subsequent food intake, researchers fed 11 overweight adults a low-dairy calcium or high-dairy calcium breakfast and measured 24-hour food intake following the test breakfast. In this single blind, cross-over study, 24-hour food intake was significantly lower after the high-dairy calcium breakfast, demonstrating an effect of dairy calcium on subsequent energy intake.

Chan She Ping-Delfos W, Soares MJ, Cummings NK. Acute suppression of spontaneous food intake following dairy calcium and vitamin D. Nutrition Society of Australia Annual Conference. Asia Pacific Journal of Clinical Nutrition. 2004;13. Abstract.

In a 24-week study of 32 obese adults, those who consumed 3 servings of milk, yogurt or cheese a day while on a balanced, modestly reduced-calorie diet, lost significantly more weight and fat than those who consumed similar amounts of calcium through supplements or consumed little or no dairy. Participants on the high-dairy diet (1200-1300 mg calcium) lost 70 percent more body weight and 64 percent more body fat than those on the low-dairy diet.

Zemel MB, Thompson W, Milstead A, Morris K, Campbell P. Calcium and dairy acceleration of weight and fat loss during energy restriction in obese adults. Obesity Research. 2004; 12(4): 582-590.

In a 12-week multi-center trial of 68 overweight and obese adults consuming a reduced-calorie diet, the participants who consumed 3 servings of dairy a day lost more body fat compared to those who ate an equal amount of calcium through supplements or a low-dairy diet. All participants lost weight and body fat, but people on the high-dairy diet lost nearly twice as much body fat, more trunk fat and more inches around the waist compared to the other groups.

Zemel MB, Teegarden D, Van Loan M., Schoeller DA., Matkovic V., Lyle RM., Craig BA. Role of dairy products in modulating weight and fat loss: A multi-center trial. FASEB J. 2004; 18(5): A845. Abstract.

Observational Studies

Epidemiological, or observational, studies do not confirm a cause-and-effect relationship, but they are valuable in identifying associations and guiding researchers to investigate a connection further. Multiple observational studies show that people who consume more calcium and dairy foods weigh less and/or have less body fat than those who consume little or no dairy. Researchers speculate that a low calcium diet may be a risk factor for obesity. One expert suggested that correcting the country's calcium deficit may reduce the incidence of overweight and obesity by 60-80 percent.

Poddar et al. prospectively evaluated the association between dairy intake and changes in body weight and body composition over 8 months in 76 college students (19.2 ± 0.2 y/o). The authors reported that total dairy, low-fat dairy and calcium intakes were low among the students. Subjects who consumed a higher amount of low-fat dairy products had better diet quality, gained less body weight and had reductions in waist circumference, percent trunk fat, and percent total body fat as compared to those with lower intakes. The authors conclude that low-fat dairy intake may be associated with better diet quality and weight management in college students.

Poddar KH, Hosig KW, Nickols-Richardson SM, Anderson ES, Herbert WG, Duncan SE. Low-fat dairy intake and body weight and composition changes in college students. J Am Diet Assoc. 2009; 109(8):1433-8.

Daly and Nowson retrospectively examined the effects of calcium (1000 mg) and vitamin D3 (800 IU) fortified milk on blood pressure, lipid and lipoprotein concentrations in 167 men >50 years of age from a study originally designed to evaluate changes in bone mineral density, serum PTH and serum 25(OH) vitamin D¬3 over 2 years. The results indicated that the calcium and vitamin D fortified milk was not associated with changes in body weight, systolic or diastolic blood pressure, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol or triglyceride concentrations at any time point. The authors conclude that supplementation with reduced-fat calcium and vitamin D fortified milk did not have either a beneficial or detrimental effect on blood pressure or lipid profiles in healthy, older men.

Daly RM and Nowson CA. Long-term effect of calcium-vitamin D(3) fortified milk on blood pressure and serum lipid concentrations in healthy older men. Eur J Clin Nutr. 2009; 63(8):993-1000.

Bueno et al. performed a cross-sectional study to examine the association between dietary calcium intake and overweight in 1459 adults living in the municipality of Sao Paulo, Brazil. In energy-adjusted analyses that compared calcium intake levels to body weight, calcium intake was significantly and inversely associated with BMI. Additionally, when the subjects were grouped in quartiles based on calcium intake, it was observed that the prevalence of overweight decreased significantly in the highest calcium quartile.

Bueno MB, Galvao CL, Martini LA, Fisberg RM. Dietary calcium intake and overweight: An epidemiologic view. Nutrition. 2008; 24(11-12):1110-5.

O'Neil and colleagues conducted a cross-sectional study to assess the relationship between dairy product consumption on diet quality and BMI in low-income women. A non-probability sample of participants was recruited from 57 Head Start Centers, with a final sample size of 609 women. Three 24-hr dietary recalls were collected on each participant and the participants were divided into groups based on their dairy consumption: ≤1, >1 to ≤2, and >2 servings per day. The authors reported that women with higher intakes of dairy products had significantly higher intakes of nutrients, such as protein, vitamin D, riboflavin, phosphorus, calcium, magnesium, potassium and zinc. After controlling for confounding variables, there was no statistical difference among the dairy consumption groups for BMI. However, higher mean adjusted energy intakes were observed with greater consumption of dairy products and that energy intake was highest in those consuming >2 servings of dairy products per day. Thus, the consumption of >2 servings of dairy per day was not associated with additional weight despite the consumption of diets higher in energy and nutrient content.

O'Neil CE, Nicklas TA, Liu Y, Franklin FA. The impact of dairy product consumption on nutrient adequacy and weight of Head Start mothers. Public Health Nutr. 2008; Nov 12:1-9. 12(10):1693-701.

In a 6-year prospective study, Vergnaud et al. investigated the relationship between dairy and calcium intakes with changes in body weight and body fat distribution in 2,267 middle-aged French adults. The authors reported that the relationship between dairy and calcium intake with changes in weight and waist circumference differed according to sex, initial body weight status, and type of dairy products consumed. Specifically, in men who were overweight at baseline, 6-year changes in weight and waist circumference were inversely associated with the consumption of dairy products (milk and yogurt). Conversely, in women who were of normal weight at baseline, consumption of yogurt was significantly associated with weight gain. Also, in women who were overweight at baseline, positive relationships were found between milk consumption and change in waist circumference. Interestingly, calcium intake (total, dairy, and non-dairy) was not related to changes in weight or waist circumference.

Vergnaud AC, Péneau S, Chat-Yung S, Kesse E, Czernichow S, Galan P, Hercberg S, Bertrais S. Dairy consumption and 6-y changes in body weight and waist circumference in middle-aged French adults. Am J Clin Nutr. 2008; 88(5):1248-55.

Wyatt et al. reported that higher average dairy consumption was associated with enhanced weight loss and a greater decrease in waist circumference during a community-based weight loss program. The program, entitled "Calcium Weighs-In," placed equal emphasis on diet and physical activity on weight loss and was delivered within a community intervention context to promote dairy consumption (n = 116). The results are consistent with those from previous studies and suggest that the inclusion of low-fat dairy products, in conjunction with physical activity, during a weight loss program will enhance the loss of body weight and waist circumference.

Wyatt HR, Jortberg BT, Babbel C, Garner S, Dong F, Grunwald GK, Hill JO. Weight loss in a community initiative that promotes decreased energy intake and increased physical activity and dairy consumption: Calcium weighs-in. J Phys Act Health. 2008; 5(1):28-44.

This study retrospectively assessed the influence of calcium consumption on body weight and fat change as a result of a 9 month exercise trial in 50 previously sedentary overweight and obese adults who were not restricting calories. The supervised exercise trial included

moderate intensity for 45 minutes/day, 5 days/week. No associations between calcium consumption and body weight and fat change were observed in women, but calcium consumption was associated with weight loss in men. Researchers concluded that weight and fat loss as a result of exercise may be improved by increased calcium consumption in men.

Bailey BW, Sullivan DK, Kirk EP, Hall S, Donnelly JE. The Influence of Calcium Consumption on Weight and Fat Following 9 Months of Exercise in Men and Women. Journal of the American College of Nutrition 2007;26(4):350-355.

Using cross-sectional data from an elderly Dutch population (2064 adults, ages 50-74 years), the aim of this study was to evaluate associations of dairy consumption with body weight and other components of the metabolic syndrome. The median consumption of total dairy products was 4.1 servings/day. While higher intakes of most dairy products including dairy desserts, milk, and yogurt were associated with lower systolic and diastolic blood pressures, total dairy consumption was not significantly associated with other metabolic syndrome variables (including lipids, postprandial glucose or insulin), after adjustment for potential confounders.

Snijder MB, van der Heijden AA, van Dam RM, Stehouwer CD, Hiddink GJ, Nijpels G, Heine RJ, Bouter LM, Dekker JM. Is higher dairy consumption associated with lower body weight and fewer metabolic disturbances? The Hoorn Study. American Journal of Clinical Nutrition 2007;85:989-995.

This intervention used the existing Women's Health Initiative study population to perform a secondary study testing the effects of calcium plus vitamin D supplementation on body weight gain. In this double-blinded, placebo-controlled trial on 36,282 postmenopausal women (ages 50 - 79 years), subjects were randomized to receive a dose of 1000 mg of calcium carbonate plus 400 IU of cholecalciferol (vitamin D) or placebo daily with meals for 7 years. The overall mean weight change difference between the groups was small (-0.13 kg) over the 7-year duration. After 3 years of follow-up, women with baseline calcium-deficient diets (<1200 mg/d) who were randomized to supplements were 11 percent less likely to experience small weight gains (1-3 kg) and 11 percent less likely to gain more moderate amounts of weight (>3 kg). The authors acknowledge that the effect size was small; however, they assert that one explanation for the small effect observed may have been because the source of calcium supplementation was from nondairy products.

Caan B, Neuhouser M, Aragaki A, Lewis CB, Jackson R, LeBoff MS, Margolis KL, Powell L, Uwaifo G, Whitlock E, Wylie-Rosett J, LaCroix A. Calcium plus vitamin D supplementation and the risk of postmenopausal weight gain. Archives of Internal Medicine. 2007;167:893-902.

Researchers found that women who eat yogurt frequently are less likely to be overweight and have higher daily intakes of calcium, phosphorus, magnesium and vitamins A, D and B12. Data was collected from 14 days of diet records from a nationally represented sample of 3,000 women ages 19 and older. The data indicates that regular consumption of yogurt may play a role in healthy body weight and contribute to more favorable micronutrient intakes in adult women.

Campbell J, Albertson A, Holschuh N, Bell E, Eldridge A. Yogurt Consumption: Influence on nutrient intake and body weight status in US adult women. NAASO abstract presented 2007.

Researchers retrospectively analyzed data to evaluate the interaction of dietary calcium and calorie intake as predictors of body weight regain following a weight loss diet in 103 overweight and obese women. After controlling for changes in energy intake, data collected between 6 to18 months post-intervention demonstrated that a 100 mg increase in dietary calcium (amount found in 1/3 cup of low-fat or fat-free milk) intake was associated with approximately 3.5 pounds less weight regain, when energy intake was held constant. The authors concluded that these data lend support for the hypothesis that dietary calcium may be inversely related to weight regain following a weight loss diet.

Ochner CN, Lowe MR. Self-reported changes in dietary calcium and energy intake predict weight regain following a weight loss diet in obese women. Journal of Nutrition 2007;137:2324-2328.

In a cross-sectional population study (NHANES III) comparing American Indians (ages 47-79 years) to the general U.S. population, researchers found a higher percent body fat (PBF) and body mass index (BMI) and lower calcium intake in American Indian men and women compared with the general U.S. population. After adjustment for potential confounders, PBF and BMI were lower (by 1.28 percent and 0.80 kg/m2 respectively) in the American Indians with higher Ca intakes (≥873 mg/d) compared to those with lower intakes (<313 mg/d). In contrast, no relation between calcium intake and PBF or BMI was observed in the general U.S. population.

Eilat-Adar S, Xu J, Loria C, Mattil C, Goldbourt U, Howard BV, Resnick HE. Dietary calcium is associated with body mass index and body fat in American Indians. Journal of Nutrition 2007;137:1955-1960.

This population-based cross-sectional survey evaluated the effect of diet and physical activity with age-associated changes in body composition among people 53 years and older living in Taiwan. Milk consumption was associated with a lower BMI. The authors believe the association of milk consumption with lower BMI could be the result of reverse bias as older women are not in the habit of drinking milk, but may begin to do so when they are told they have low bone density or are in a frail condition.

Tsai AC, et al. Influence of diet and physical activity on aging-associated body fatness and anthropometric changes in older Taiwanese. Nutrition Research 2007;27:245-251.

This study examined the association between calcium intake and dairy product consumption with overweight and obesity in young adults, utilizing a sample of 1306 participants in the 1995-1996 young adult survey of the Bogalusa Heart Study. Age range was 19-38; 505 males, 801 females; 952 whites (72.9 percent) and 354 blacks (27.1 percent). No significant association was found between dairy product consumption, calcium intake and overweight, as defined by body mass index or waist circumference (WC). However, there was a significant inverse association between calcium intake, low-fat dairy product consumption and waist-to-hip ratio in white males. The results are generally consistent with others reported in human studies. However, in this study, low-fat dairy and calcium intake were significantly higher in normal weight white males compared to their overweight counterparts when using waist-to-hip ratio to define overweight status. This correlation did not exist when researchers used WC or BMI as markers for overweight. This result (in white males) contrasts with other studies, where calcium-adiposity associations were found mainly in women.

Note: Waist-to-hip ratio has been referred to as an indicator of fat distribution and reported to be a better predictor than WC or BMI of coronary heart disease risk factors and increased risk of non-insulin dependent diabetes. Conclusion: Increasing intake of calcium and low-fat dairy products may be associated with lower abdominal adiposity, particularly in young adult white males. Authors note that the results need to be interpreted with caution until large clinical trials confirm a cause-and-effect association between the intake of calcium and dairy products and body fat distribution.

Brooks BM, Rajeshwari R, Nicklas TA, Yang SJ, Berenson GS. Association of calcium intake, dairy product consumption with overweight status in young adults (1995-1996): the Bogalusa Heart Study. Journal of the American College of Nutrition 2006;25:523-532.

A cross-sectional study from Iran found that people who ate more dairy foods including milk, yogurt and cheese were less likely to be overweight or obese than those who consumed fewer dairy foods.

Mirmiran P, et al. Dairy consumption and body mass index: An inverse relationship. International Journal of Obesity. 2005; 29:115-121.

In this cross-sectional study of 827 men and women in Tehran (aged 18-74 years), researchers found that higher intakes of dairy products were associated with a lower prevalence of metabolic syndrome. Additionally, a higher intake of dairy was associated with a healthier diet, lower waist circumference and lower blood pressure.

Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi F. Dairy consumption is inversely associated with the prevalence of the metabolic syndrome in Tehranian adults. American Journal of Clinical Nutrition. 2005; 82: 523–530.

In the Amsterdam Growth and Health Longitudinal Study, researchers in the Netherlands followed a cohort of men and women from ages 13 to 36 years to investigate the longitudinal relationship between health and lifestyles considering physical activity, diet, smoking and alcohol consumption. The data indicate a weak inverse relation of calcium intake and BMI. The authors conclude that the findings may be in contrast with previous investigations (where stronger inverse relationships were found) because the average calcium intake is much higher in this Dutch population than in subjects assessed in other studies. They suggest there may be a threshold for calcium intake above which no additive beneficial effect exists. The calcium intake threshold in the Dutch study was about 800 mg per day.

Boon N, Koppes LLJ, Saris WHM, Van Mechelen W. The relation between calcium intake and body composition in a Dutch population. American Journal of Epidemiology. 2005; 162:27-32.

Researchers analyzed data from 10,066 women (aged 45 years and older) participating in the Women's Health Study who were free of cardiovascular disease, cancer and diabetes. Results indicate that higher intakes of calcium and dairy products were significantly associated with a lower prevalence of metabolic syndrome.

Liu S, Song Y, Ford ES, Manson JE, Buring JE, Ridker PM. Dietary calcium, vitamin D, and the prevalence of metabolic syndrome in middle-aged and older U.S. women. Diabetes Care. 2005; 28: 2926-2932.

A study that used data from the Quebec Family Study investigated weight/fat changes in relation to participants' consumption of foods from various food groups. Only participants who ate more from the dairy group and from the fruit group (but not in combination) gained less weight over time.

Drapeau G, et al. Modifications in food-group consumption are related to long-term body-weight changes. American Journal of Clinical Nutrition. 2004; 80: 29-37.

Following an analysis of food patterns consumed by 459 healthy adults participating in the Baltimore Longitudinal Study of Aging, researchers at Tufts University suggest that a diet rich in reduced-fat dairy products and high-fiber foods may lead to smaller gains in BMI in women and smaller gains in waist circumference in both women and men. Diet was assessed by using 7-day dietary records, from which 40 food groups were formed and entered into a factor analysis.

Newby PK, et al. Food patterns measured by factor analysis and anthropometric changes in adults. American Journal of Clinical Nutrition. 2004; 80: 504-513.

In a cross-sectional study of 582 men and women, people who consumed more calcium had a lower percent of body fat and trunk fat than individuals who consumed less calcium.

Martin G, et al. Calcium intake is correlated with percent body fat and percent trunk fat, but not serum lipids, in the Newfoundland population. Obesity Research. 2004; 12(10): A217; 851-P. Abstract.

A study of overweight, previously sedentary adults showed that weight and fat loss, resulting from a 9-month exercise intervention program without dietary restriction, was associated with increased calcium consumption in men.

Bailey B, et al. The influence of calcium consumption on weight and fat alterations following 9 months of exercise in men and women. Obesity Research. 2004; 12(10S): A34; 133-OR. Abstract.

A study involving 175 pre-menopausal and 70 postmenopausal women indicates that calcium intake is associated with the maintenance of normal body weight, the prevention of visceral fat gain (the fat that surrounds internal organs) and insulin sensitivity.

Choquette S, et al. The effect of calcium intake on body weight, weight regain and insulin resistance. Obesity Research. 2004; 12(10): A170; 667-P. Abstract.

A study originally designed to look at blood pressure found that when individuals consumed a diet high in dairy foods, fruits and vegetables they had a significantly higher resting metabolic rate and utilized more fat for energy than when they consumed a diet high in only fruits and vegetables. As these subjects were not restricting their caloric intakes, this suggests a positive role for dairy foods in weight maintenance.

De Jonge L, et al. Increased resting metabolic rate and fat oxidation after a diet rich in dairy products. Obesity Research. 2004; 12(10): A127; 496-P. Abstract.

Men and women in Israel with the highest calcium and milk intakes were the most likely to have a BMI in the normal range. Women with the highest calcium intakes had the smallest waist circumference.

Dicker D, et al. On the relationship between dietary calcium intake, body mass index and waist size. Presented at the 13th European Congress on Obesity. International Journal of Obesity and Related Metabolic Disorders. 2004; Supplement 1(28): S59. Abstract.

A report from the Czech Republic found that adults on a balanced, modestly reduced-calorie diet lost more weight when their diet included more calcium and more protein.

Kabrnova K, et al. Association of changes in macronutrient and calcium intakes with body weight change in obese subjects. Presented at the 13th European Congress on Obesity. International Journal of Obesity and Related Metabolic Disorders. 2004; Supplement 1(28): S138. Abstract.

In a study involving 103 women and the effect of calorie and calcium intake on weight regain after weight loss, researchers found that high dietary calcium intake led to less weight regain during a year follow-up.

Ochner, C and Lowe, M.R. Opposing effects of calcium and caloric intake on weight regain after diet. Presented at the 13th European Congress on Obesity. International Journal of Obesity and Related Metabolic Disorders. 2004; Supplement 1(28): S143. Abstract.

Data from more than 550 women were reevaluated to assess the effects of calcium on weight gain. While calcium is only one factor that potentially affects obesity, findings from this reanalysis indicate that increasing calcium intakes to recommended levels may reduce the incidence of overweight and obesity by 60-80 percent in a population. This estimate and conclusion are based on data projection.

Heaney RP. Normalizing calcium intake: projected population effects for body weight. Journal of Nutrition. 2003; 133:268S-270S.

Using data from adults in the Quebec Family Study, researchers found that a higher calcium intake was significantly associated with lower body weight and fat in women and found a similar trend in men. Women in the study who consumed inadequate amounts of calcium were more likely to be overweight. After controlling for age, energy intake, percent dietary fat and protein, and sociol economic status, women consuming less than 600 mg of calcium a day had greater body weight, BMI, percentage body fat, fat mass, waist circumference and abdominal fat tissue compared to those consuming 600 mg of calcium or more. Dairy foods provided about 60 percent of the calcium in the study subjects' diets.

Jacqmain M, Doucet E, Despres JP, Bouchard C, Tremblay A. Calcium intake, body composition, and lipoprotein-lipid concentrations in adults. American Journal of Clinical Nutrition. 2003; 77:1448-1452.

Data from more than 800 adults enrolled in the HERITAGE Family Study was evaluated and found that high daily calcium intake (including from dairy foods) is associated with lower weight.

Loos R, et al. Calcium intake and body composition in the HERITAGE Family Study. Obesity Research. 2003; 11(S): 597-P.

Researchers at the University of Colorado measured whole-body fat oxidation during a 24-hour period in 35 non-obese healthy adults. In their retrospective analysis of data from these subjects, a higher dietary calcium intake over the 24-hour period was associated with burning significantly more body fat, even during sleep.

Melanson EL, Sharp TA, Schneider J, Donahoo WT, Grunwald GK, Hill JO. Relation between calcium intake and fat oxidation in adult humans. International Journal of Obesity. 2003; 27: 196-203.

Researchers at Tufts University found that a diet high in fruit, vegetables, reduced-fat dairy and whole grains, and low in red and processed meat, fast food and soda, was associated with smaller gains in BMI and waist circumference in adults.

Newby PK, et al. Dietary patterns and changes in body mass index and waist circumference in adults. American Journal of Clinical Nutrition. 2003; 77:1417-1425.

Results from the CARDIA study indicate that increased dairy consumption may protect overweight individuals from becoming obese or developing insulin resistance syndrome (also known as metabolic syndrome), which is associated with increased abdominal fat. Obesity and insulin resistance syndrome are major risk factors for type 2 diabetes and cardiovascular disease. This 10-year prospective study examined the dietary habits of more than 3,000 adults aged 18 to 30 years. Increased dairy consumption was equally beneficial to African Americans and Caucasians, and both reduced-fat and full-fat dairy products were effective.

Pereira MA, Jacobs JD, Van Horn L, Slattery ML, Kartashov AI, Ludwig DS. Dairy consumption, obesity, and the insulin resistance syndrome in young adults: The CARDIA Study. Journal of the American Medical Association. 2002; 287:2081-2089.

Researchers tracked the lifestyle habits of nearly 150 middle-aged, premenopausal women as part of the Healthy Transitions Study and found that body fat was inversely associated with calcium intake, in both white and African-American subjects. This correlation was stronger for white subjects compared to African-American subjects, who also had lower intakes of calcium.

Lovejoy JC, Champagne CM, Smith SR, de Jonge L, Xie H. Ethic differences in dietary intakes, physical activity, and energy expenditure in middle-aged, premenopausal women: the Healthy Transitions Study. American Journal of Clinical Nutrition. 2001; 74:90-95.

A controlled, clinical trial of young women designed to investigate the effects of calcium on bone health demonstrated that calcium supplementation (1500 mg/day) resulted in less gain in fat mass over a three-year period, compared to a lower-calcium control group.

Barger-Lux MJ, et al. Calcium supplementation may attenuate accumulation of fat in young women. Journal of Bone Mineral Research. 2001; 16:S219. Abstract.

In this reevaluation of five clinical studies originally designed to measure bone health, researchers found that a higher intake of calcium (primarily from dairy foods) was associated with a lower BMI and body weight. Results from this study indicate that women weighed an average of 18 pounds less for every 1,000 mg of calcium consumed.

Davies KM, Heaney RP, Recker RR, et al. Calcium intake and body weight. Journal of Clinical Endocrinology & Metabolism. 2000; 85(12): 4635-4638.

In young adult women (aged 18 to 31 years) enrolled in a two-year exercise program, calcium from dairy foods was associated with lower body weight and body fat in women consuming fewer than 1900 calories per day. The researchers concluded that the effect of calcium was specific to dairy calcium because total calcium and dairy, when adjusted for calories, predicted changes on body weight and body fat, whereas non-dairy calcium did not.

Lin YC, Lyle RM, McCabe LD, McCabe GP, Weaver CM, Teegarden D. Dairy calcium is related to changes in body composition during a two-year exercise intervention in young women. Journal of the American College of Nutrition. 2000; 19(6):754-760.

Researchers studied the relationship between consumption of specific types of food, e.g., meat, fish, bread and dairy and metabolic syndrome via food frequency questionnaires in nearly 5,000 men and women. Metabolic syndrome is a condition characterized by insulin resistance, central obesity, high blood pressure, high blood glucose and triglycerides, and low HDL cholesterol. Dairy product consumption was associated with lower diastolic blood pressure in both men and women. The consumption of 1-4 portions per day of dairy was related to lower serum triglycerides, fasting blood glucose and lower incidence of metabolic syndrome in men.

Mennen LI, Lafay L, Feskens EJM, Novak M, Lepinay P, Balkau B. Possible protective effect of bread and dairy products on the risk of the metabolic syndrome. Nutrition Research. 2000; 20:335-347.

Researchers analyzing data from NHANES III found that in men and women, increased calcium intake is associated with lower body fat. These data are consistent with animal studies that suggest increased dietary calcium may affect the rate of energy metabolism and reduce the risk of obesity.

Zemel MB, et al. Regulation of adiposity by dietary calcium. FASEB Journal. 2000; 14:1132-1138.

Animal and In Vitro Studies

Bruckbauer et al. investigated the effects of specific dairy components (branched-chain amino acids and angiotensin-converting enzyme inhibitors) on adipose cell and muscle metabolism in an animal model of diet-induced obesity. The results of the study showed that genes involved in lipogenesis were downregulated in the adipose tissue, while genes involved in fatty acid oxidation were up-regulated in the muscle of aP2-agouti mice consuming nonfat dry milk. In addition, genes involved in protein synthesis were up-regulated in the muscle of mice consuming either branched-chain amino acids or angiotensin-converting enzyme inhibitors. Finally, several pathways involved in inflammation were down-regulated by the consumption of nonfat dry milk, branched-chain amino acids and angiotensin-converting enzyme inhibitors. Overall, the results of this study provide further evidence that, independent of calcium, certain dairy components can play a role in energy metabolism and inflammation.

Bruckbauer A, Gouffon J, Rekapalli B, Zemel MB. The effect of dairy components on energy partitioning and metabolic risk in mice: a microarray study. J Nutrigenet Nutrigenomics. 2009; 2:64-77.

DeAngel et al. evaluated the effects of different calcium sources on obesity in a postmenopausal mouse model. Ovariectomized mice were randomized to either low-fat or high-fat diets containing either calcium phosphate from nonfat dry milk (dairy) or calcium carbonate supplements. The results of the study showed that dairy but not supplemental calcium, decreased weight gain and percent body fat in high-fat fed mice, with no effect on food consumption. In addition, dairy improved insulin resistance and glucose tolerance. Thus, the authors conclude that dairy calcium may be more beneficial on body weight and bone health after menopause as compared to calcium supplements.

DeAngel RE, Berrigan D, Nunez NP, Hursting SD, Perkins SN. Dietary calcium source influences body composition, glucose metabolism and hormone level in a mouse model of postmenopausal obesity. In Vivo. 2009; 23(4):527-35.

Eller and Reimer examined the effect of different calcium-enriched dairy protein sources on the prevention of weight gain in diet-induced, obese rats. Twelve week old, obese rats were fed one of eight ad libitum diets that varied in protein source (casein, whey or complete dairy), calcium content (0.67% or 2.4%) and energy level (high fat/high sucrose or normal calorie). After 8 weeks, all rats consuming diets containing 2.4% calcium (irrespective of protein source) as well as those consuming the dairy/high fat/0.67% calcium diets had significantly lower body weight than the rats consuming the other high fat/high sucrose diets. In addition, the dairy/high fat/0.67% and 2.4% calcium groups had significantly lower body fat and greater lean body mass as compared to the other high fat/high sucrose groups. Insulin resistance was lowest for the dairy/high fat/0.67% calcium group and significantly different from the whey/high fat/0.67% calcium and whey/high fat/2.4% calcium groups. Moreover, the high calcium diets resulted in decreased plasma insulin (independent of protein source) as compared to the low calcium diets. Thus, the authors conclude that complete dairy protein improves body composition and insulin sensitivity to a greater extent than whey or casein alone.

Eller LK and Reimer RA. Dairy protein attenuates weight gain in obese rats better than whey or casein alone. Obesity (Silver Spring). 2009. Epub ahead of print.

Chen and Reimer examined the effects of branch-chain amino acids (leucine, isoleucine, and valine) and dairy proteins (casein and whey) on the secretion of satiety hormones and the regulation of genes involved in fatty acid and cholesterol metabolism in the human intestinal cell line NCI-H716. A dose-response test (0.5% - 3.0%) was conducted to study the effects of different dairy-related proteins on glucagon-like peptide-1 (GLP-1) release and the expression of select genes. The results of the study indicated that leucine, isoleucine, skim milk and casein stimulated GLP-1 releases. Additionally, isoleucine and whey downregulated the mRNA expression of various genes involved in fatty acid metabolism including intestinal-type fatty acid binding protein, fatty acid transport protein 4, fatty acid synthase, and sterol regulatory element-binding protein-2. Based on these results, the authors conclude that the anti-obesity effect of dairy may be mediated by a coordinated increase in GLP-1 secretion and reduction in the expression of genes involved in intestinal fatty acid absorption and synthesis in enterocytes.

Chen Q and Reimer RA. Dairy protein and leucine alter GLP-1 release and mRNA of genes involved in intestinal lipid metabolism in vitro. Nutrition. 2009 (3); 25:340-9.

Parra et al. examined the effects of calcium on body weight and fat in wild-type, male mice. In experiment 1, the mice consumed a high-fat diet (43%) with or without supplemental calcium for 2 months. In experiment 2, the mice consumed the high-fat diet for 86 d followed by the normal-fat diet (12%) with or without supplemental calcium for 2 months. The results showed that calcium intake was able to attenuate body weight and body fat gain under the high-fat diet condition (experiment 1). Additionally, following weight gain, the increased calcium accelerated weight loss in the mice consuming the normal-fat diet (experiment 2). In both instances, there was no difference in food intake. Overall, the results support the role of dairy calcium in enhancing weight and fat loss.

Parra P, Bruni G, Palou A, Serra F. Dietary calcium attenuation of body fat during high-fat feeding in mice. J Nutr Biochem. 2008; 19(2): 109-17.

Mechanistic Support

Researchers have conducted cellular, animal and human studies to better understand the specific mechanism responsible for dairy's impact on body weight and fat. While more research is needed to understand all the mechanisms that may be involved in the dairy-weight relationship observed in human studies, current scientific evidence suggests that a combination of calcium and other dairy components may participate in the body's natural regulatory system for burning fat to support weight management. Preliminary studies indicate five plausible mechanisms including vitamin D-related regulation of fat burning in fat cells and decreased fat storage, parathyroid hormone effects on fat burning, increased satiety, decreased fat (and calorie) absorption and branch chain amino acids and inhibition of fat synthesis.

Buchowski and colleagues conducted a randomized cross-over study to determine the effects of dairy and non-dairy dietary calcium on fecal fat excretion in lactose digesters and maldigesters during moderate energy restriction (12 wks at -30% kcals). Weight loss was not significantly different between the groups following 12 weeks on energy restriction. Fecal fat loss, expressed as percent of fat intake, was

significantly higher with high calcium consumption (1500 mg/d) as compared to low calcium consumption (500 mg/d), independent of calcium source and lactose digestion status. The authors reported that the difference in fecal fat excretion between the groups could produce 63 – 125 kJ per day of fecal energy loss, which could correspond to 0.4 – 0.7 kg body fat loss per year. The authors conclude that during moderate energy restriction, a high calcium diet causes an increase in fecal fat excretion in both lactose digesters and maldigesters.

Buchowski MS, Aslam M, Dossett C, Dorminy C, Choi L, Acra S. Effect of dairy and non-dairy calcium on fecal fat excretion in lactose digester and maldigester obese adults. Int J Obese (Lond.). 2010; 34(1):127-35.

Bortolotti and colleagues conducted a double-blind, placebo-controlled, randomized crossover trial that examined the effect of calcium supplementation on energy expenditure and markers of fat metabolism in the absence of energy restriction in a group of overweight individuals who habitually consumed a low-calcium diet. The results showed that there was no significant difference in resting energy expenditure, fat oxidation, and glycerol turnover following calcium supplementation. Also, calcium supplementation did not significantly change the expression of genes in subcutaneous adipose tissue that are involved in fat metabolism.

Bortolotti M, Rudelle S, Schneiter P, Vidal H, Loizon E, Tappy L, Acheson KJ. Dairy calcium supplementation in overweight or obese persons: its effect on markers of fat metabolism. Am J Clin Nutr. 2008; 88(4):877-85.

Teegarden et al. investigated the impact of dietary calcium or dairy product consumption on total energy expenditure, fat oxidation, and thermic effect of a meal during moderate caloric restriction (500 kcal deficit per day). This study was a sub-study of a multisite trial completed at four sites that investigated the impact of dietary calcium or dairy products in modulating weight loss (Zemel et al., 2009). Twenty-four overweight women (age 18 – 31 y/o) were placed on a calorie-restricted diet and randomized into one of three groups for the 12 week intervention: (1) control (500 mg total calcium/day), (2) calcium supplement (900 mg calcium supplement; total calcium 1400 mg/day), and (3) high dairy (3 servings of dairy per day; total calcium 1400 mg/day). There was no difference in total energy expenditure between the groups. Increased fat oxidation was observed in the calcium supplemented group, but not in the dairy or control groups. Additionally, baseline 25-hydroxyvitamin D was positively correlated with the thermic effect of meal and trended toward a correlation with fat oxidation. The authors conclude that the results suggest calcium intake, but not dairy intake, increases fatty acid oxidation during weight loss. Moreover, the results suggest that vitamin D status is associated with the thermic effect of meal regardless of calcium intakes.

Teegarden D, White KM, Lyle RM, Zemel MB, Van Loan MD, Matkovic V, Craig BA, Schoeller DA. Calcium and dairy product modulation of lipid utilization and energy expenditure. Obesity (Silver Spring). 2008; 16(7):1566-72.

Bendsen et al. recently reported results from a randomized crossover trial that compared a diet high in calcium from low-fat dairy to one low in calcium. The results showed that the high calcium diet significantly increased total fat excretion as compared to the low calcium diet. Moreover, fecal energy excretion increased in a corresponding manner. Taken together, these results suggest that high intakes of calcium, either supplemental or from dairy products, can decrease intestinal fat absorption which may explain why a high-calcium diet can enhance weight loss.

Bendsen NT, Hother AL, Jensen SK, Lorenzen JK, Astrup A. Effect of dairy calcium on fecal fat excretion: a randomized crossover trial. Int J Obes (Lond). 2008; 32(12):1816-24.

Sampath et al. examined the effects of supplemental calcium on rates of lipid oxidation and lipolysis in women. Fifteen overweight, premenopausal women were supplemented with 1500 mg of calcium per day for 3 months while maintaining their usual diets and activity levels. While serum calcitriol levels significantly decreased, body weight and body fat, as well as rates of lipid oxidation and lipolysis were not altered by calcium supplementation. Thus, the authors concluded that calcium supplementation decreased circulating levels of calcitriol, but had no effect on rates of lipid oxidation or lipolysis, in these overweight women.

Sampath V, Havel PJ, King JC. Calcium supplementation does not alter lipid oxidation or lipolysis in overweight/obese women. Obesity. 2008; 16(11):2400-4.

Researchers assessed both mice and human plasma samples to study the effect of a high dairy, high calcium, or suboptimal calcium diet on oxidative and inflammatory stress. Thirty overweight aP2-agouti transgenic mice were fed a diet of either low calcium, high calcium from non-dairy supplements, or high dairy. The food intake/spillage, body weight, and plasma/adipose tissue measurements were recorded for three weeks. Results showed that the high dairy diet suppressed weight gain in mice compared to both the control and the high-calcium non-dairy supplement diets. Expression of an inflammatory cytokine gene in mouse adipose tissue was decreased in both the high-calcium and high-dairy diet. In addition, human plasma samples from two previous studies were analyzed. Thirty study subjects from one study

were on hypocaloric (reduced-calorie) diets with high dairy (yogurt) or control (calcium deficient). Thirty-one study subjects from the other study were on eucaloric (no calorie change) diets with high dairy (3 servings) or low dairy (less than 1 serving). Plasma concentrations of a low-grade inflammation marker called CRP were significantly lower in study subjects on a high dairy diet from both studies. Authors state that their findings support the role that calcium plays in oxidative and inflammatory stress, and state that dairy products further affect oxidative stress when compared with a calcium carbonate supplement.

Zemel MB, Sun X. Dietary Calcium and Dairy products Modulate Oxidative and Inflammatory Stress in Mice and Humans. Journal of Nutrition 2008;138:1047-1052.

This mechanistic study performed in transgenic mice was designed to compare the weight loss effects of angiotensin converting enzyme inhibitors (ACEi), branched chain amino acids (BCAA) and calcium (Ca). Transgenic mice were maintained for 6 weeks on an obesigenic, soy-based diet and then randomized to an ad libitum control group or energy-restricted diet for 6 more weeks. The energy-restricted diet (70 percent of ad libitum) contained soy protein (0.4 percent Ca), non-fat dry milk (1.2 percent Ca) or Ca-depleted non-fat dry milk (0.4 percent Ca). The non-fat dry milk group exhibited about a 2-fold greater reduction in body weight and fat than the energy restricted group, and the Ca-depleted milk group exerted 60 percent of the effect of intact milk. Overall, the Ca, BCAA and ACEi content of the milk accounted for 90 percent of its "anti-obesity" activity including weight and fat loss and protection against muscle loss, with about 40 percent of the effect attributable to Ca alone.

Zemel MB, Herweyer A. Role of branched chain amino acids and ACE inhibition in the anti-obesity effect of milk. FASEB Journal. 2007;21:538.11.Abstract.

Mice fed yogurt experienced less weight and fat gain versus mice fed a control diet, without a decrease in food intake, over four weeks.

Johnson M, Watts A, Allison D, Nagy T. Effect of dairy supplementation on body composition in mice. North American Society for the Study of Obesity Annual Conference. 2005. Abstract 197-P.

Mice allowed free access to diets high in calcium, specifically from dairy foods, had less fat and weight regain after a period of weight loss. An increase in proteins measured in the fat tissue (UCP2) and skeletal muscle (UCP3 and PPAR) suggests an upregulation of fat burning in the animals consuming calcium-rich dairy diets.

Sun X, et al. Calcium and dairy products inhibit weight and fat regain during ad libitum consumption following energy restriction in Ap2-Agouti transgenic mice. Journal of Nutrition. 2004; 134:3054-3060.

Preliminary findings demonstrate that calcium from dairy foods increases the rate of weight loss in mice fed a low-fat diet and slows the rate of weight gain in mice fed a high-fat diet.

Serra F, et al. Dietary calcium helps to counteract obesity. Presented at the 13th European Congress on Obesity. International Journal of Obesity and Related Metabolic Disorders. 2004; Supplement 1 (28):S146. Abstract.

Rats fed high-calcium, high-dairy protein diets gained significantly less weight than controls and had 29 percent less carcass fat, while consuming the same amount of energy. Additionally, researchers found that rats fed the high-calcium, high-dairy protein diet had increased fecal excretion of dietary lipid and lower levels of serum 1,25-dihydroxyvitamin D -- offering clues to potential mechanisms for the dairy-calcium effect on weight.

Papakonstantinou E, Flatt WP, Huth PJ, Harris RBS. High dietary calcium reduces body fat content, digestibility of fat, and serum vitamin D in rats. Obesity Research. 2003;11:387-394.

A review of studies of both human and animal fat cells helped demonstrate that the calcium in these cells plays a key role in regulating fat metabolism and storage. Specifically, increased calcitriol (the active form of vitamin D) increases in response to low calcium diets and has been shown to promote the influx of calcium into fat cells, which in turn inhibits fat breakdown and promotes fat storage.

Zemel MB. Mechanisms of dairy modulation of adiposity. Journal of Nutrition. 2003; 133:252S-256S.

This research review concluded that dietary calcium may play an important role in the regulation of energy metabolism and may result in a reduction of body fat and an acceleration of weight and fat loss during caloric restriction. This review also concluded that dairy sources of calcium demonstrate substantially greater effects than supplemental or fortified sources. Suppression of the active form of vitamin D with

high-calcium diets may reduce calcium in the fat cell, inhibit fat storage and increase fat breakdown.

Zemel, MB. Role of dietary calcium and dairy products in modulating adiposity. Lipids. 2003; 38(2):139-146.

A study demonstrated that 1α,25-dihydroxyvitamin D3 (the active form of vitamin D) has an inhibitory effect on uncoupling protein 2 (UCP2), a protein found in fat cells that helps the body "burn energy." The researchers concluded that suppression of 1α,25-dihydroxyvitamin D3 via a high-calcium diet may result in up-regulation of UCP2, and therefore may contribute to the anti-obesity effect of dietary calcium.

Shi H, et al. 1 alpha, 25-dihydroxyvitamin D3 inhibits uncoupling protein 2 expression in human adipocytes. FASEB J. 2002; 16(13):1808-10.

Data from this in vitro study indicate that 1α,25-dihydroxyvitamin D3 (the active form of vitamin D) allows the influx of calcium into human fat cells, which in turn stimulates the storage of fat and inhibits the breakdown of fat. The researchers conclude that intake of dietary calcium may directly inhibit this mechanism, and therefore may contribute to dietary calcium's anti-obesity effect.

Shi H, et al. 1,25 Dihydroxyvitamin D3 modulates human adipocyte metabolism via nongenomic action. FASEB J. 2001; 15:2751-3.E19.

A study found that calcium, particularly calcium from dairy foods, maintains weight and fat loss in calorie-restricted mice by adjusting energy metabolism. More specifically, the study found that the high-calcium diet suppressed the influx of calcium into fat cells, which stimulated fat breakdown, inhibited fat storage and increased energy wasting through body heat.

Shi H, et al. Effects of dietary calcium on adipocyte lipid metabolism and body weight regulation in energy-restricted aP2-agouti transgenic mice. FASEB J. 2001; 15:291-293.

Research Reviews

Scientists have reviewed the body of literature on dairy and weight and concluded that getting 3 servings of dairy foods each day has the potential to impact weight loss and body composition.

A recent systematic review and meta-analysis by Christensen et al. examined the effect of calcium from dietary supplements or dairy products on quantitative fecal fat excretion. Analysis of 15 sub-studies showed that increased calcium intake resulted in increased fecal fat excretion, corresponding to about 2 g of fecal fat per day. Moreover, the authors estimated that increasing dairy calcium intake by 1241 mg per day resulted in an increase in fecal fat of 5.2 g per day (range 1.6 – 8.8 g per day). Thus, the authors conclude that the dietary calcium has the potential to increase fecal fat excretion to an extent that could be relevant for prevention of weight gain or weight regain.

Christensen R, Lorenzen JK, Svith CR, Bartels EM, Melanson EL, Saris WH, Tremblay A, Astrup A. Effect of calcium from dairy and dietary supplements on fecal fat excretion: a meta-analysis of randomized controlled trials. Obes Reviews. 2009; 10(4):475-86.

This paper summarizes the findings of a symposium that was organized to assess the role of calcium and dairy food on energy balance and body composition. Experts discussed 13 proposition statements during the symposium and reviewed 165 studies to explain them. The effects of calcium and dairy consumption on body weight and adiposity level, appetite, weight loss intervention outcome, lipid-lipoprotein profile and the risk to develop metabolic syndrome were discussed together with the metabolic mechanisms proposed to explain these effects. Taken together, the observations presented in the manuscript suggest that calcium and dairy food intake can influence many components of energy and fat balance, indicating that inadequate calcium/dairy intake may increase the risk of weight gain and other health problems.

Major GC, Chaput JP, Ledoux M, St-Pierre S, Anderson GH, Zemel MB, Tremblay A. Recent developments in calcium-related obesity research. Obesity Reviews. 2008; 9(5): 428-445.

Researchers reviewed 124 studies (observational and clinical trials) to determine the association between vitamin D and calcium or dairy consumption and type 2 diabetes. In observational studies, authors found an inverse association between both prevalence and incidence of

type 2 diabetes and vitamin D status. This association was also been seen for metabolic syndrome. Observational studies reviewed also point to an inverse association between type 2 diabetes or metabolic syndrome and dairy intake; authors note that this may be due to the many nutrients in dairy, not just calcium and vitamin D. From clinical intervention studies, authors found mixed results due to the design of the studies (being short in duration and including few study subjects). They concluded that vitamin D, by itself, may not have a significant effect on type 2 diabetes status in healthy individuals, but the combination of vitamin D and calcium supplementation may help in the prevention of type II diabetes, especially in at-risk populations.

Pittas AG, Lau J, Hu FB, Dawson-Hughes B. The role of vitamin D and calcium in type 2 diabetes. A systematic review and meta-analysis. Journal of Clinical Endocrinology & Metabolism. 2007 Jun;92(6):2017-29.

This review article presents the evidence for the connection between dairy consumption and a healthy weight discussing supportive cellular, animal, and human epidemiological and clinical studies. The modulation of the hormonal form of vitamin D (calcitriol) by dietary calcium which regulates intracellular calcium thereby affecting fat metabolism in human fat cells is one of the possible mechanisms to explain the relationship between dairy consumption and a healthy weight. Cellular and animal research indicates that reducing calcitriol levels by increasing dietary calcium results in reduction of body fat in the absence of caloric restriction, substantially increases body weight and fat loss during caloric restriction and reduces weight and fat regain following successful weight loss. Both animal and human studies have demonstrated that dairy sources of calcium are more effective than supplemental calcium in reducing body weight and body fat during caloric restriction and incorporation of dairy into weight management regimens is associated with preservation of lean body mass. A portion of this additional anti-obesity bioactivity may be attributable to the whey fraction of dairy which has ACE-inhibitory activity and a high concentration of branched chain amino acids. Finally, habitual intakes of calcium and dairy are critical as increasing human consumption from inadequate to adequate recommended intakes seems to be necessary in order to observe an impact on body weight and fat.

Zemel MB. The role of dairy foods in weight management. Journal of the American College of Nutrition. 2005 Dec;24(6 Suppl):537S-46S.

This research review examined epidemiologic and clinical data supporting a relationship between dietary calcium intake and obesity. The author concluded that MDs and other primary care providers should include recommendations about adequate calcium intake in standard dietary counseling about weight management.

Schrager S. Dietary calcium intake and obesity. Journal of the American Board of Family Practice. 2005; 18:205-210.

A review article concluded that dairy products, specifically milk, may be potential functional foods for enhancing weight loss or preventing weight gain. The author notes that weight control effects of milk could be even greater in a healthy, balanced diet that combines other possible functional foods such as tea and nuts along with energy restriction and increased physical activity.

St-Onge, MP. Dietary fats, teas, dairy, and nuts: potential functional foods for weight control? American Journal of Clinical Nutrition. 2005; 81:7-15.

This review of observational and intervention studies concluded that substantial evidence exists for an association between dietary calcium or dairy product intakes and lower body fat or waist circumference. Specifically, the results of randomized clinical trials support the role of dairy foods in enhancing weight and fat mass loss, while the results for calcium are contradictory. The results of the individual studies are impacted by multiple factors, such as total energy intake, protein amount and source, and/or vitamin D status. These factors may act synergistically to regulate energy balance or promote reduction or prevent gain of body fat. The author points out that if current recommendations for calcium intake were met through food sources in the promotion of optimal bone health, this might also help to reduce the incidence and development of overweight and obesity.

Teegarden D. The influence of dairy product consumption on body composition. Journal of Nutrition. 2005; 135:2749-2752.

A review article of selected randomized trials that were originally designed to primarily explore the relationship between dairy consumption or calcium intake and bone health, could not identify a clear pattern between body weight and dairy foods nor calcium. However, these studies were not specifically designed or powered to examine the dairy/weight relationship, and factors that can affect the dairy/weight relationship were not well controlled.

Barr SI. Increased dairy product or calcium intake: Is body weight or composition affected in humans? Journal of Nutrition. 2003; 133: 245S-48S.

Dietary calcium may play a role in regulating body weight, supporting the hypothesis that increasing dietary calcium or dairy intake may reduce future weight gain.

Parikh SJ, et al. Calcium intake and adiposity. American Journal of Clinical Nutrition. 2003; 77:281-287.

A review of data from six observational and three controlled trials revealed a consistent effect of higher calcium intake with lower body fat and/or weight and reduced weight gain at midlife. The data also suggest that increasing calcium intake by the equivalent of two dairy servings per day could reduce the risk of overweight substantially, possibly by as much as 70 percent.

Heaney RP, et al. Calcium and weight: clinical studies. Journal of the American College of Nutrition. 2002; 21(2): 152S-155S.

A research review of laboratory, clinical and population data concluded that increasing dietary calcium intakes may result in reductions in fat mass and blood pressure.

Zemel MB. Calcium modulation of hypertension and obesity: mechanisms and implications. Journal of the American College of Nutrition. 2001; 20:428S-35S.

Studies of Children and Adolescents

While the majority of dairy/weight management studies have been conducted with adults, researchers have found that dairy may play a role in maintaining a healthy weight and body composition or preventing an unhealthy weight gain among children and adolescents. Some studies have shown that a higher intake of dairy foods is associated with a lower percentage of body fat among children and teenagers.

Using data previously collected from a randomized controlled trial that examined the effect of calcium supplementation and physical activity in preschool children, researchers found that among the groups of children receiving either a calcium supplement or placebo, there were no significant changes or correlations in fat mass or percent body fat. Among children with the lowest intake of dietary calcium (<821 mg/day), fat mass gain was lower in the calcium group than in the placebo group but was not correlated with mean total calcium intake. Overall, the authors conclude that these findings support a weak relation between changes in fat mass gain and calcium intake in preschool children who typically consume below the recommended amount of dietary calcium.

DeJongh ED, Binkley TL, Specker BL. Fat mass gain is lower in calcium-supplemented than in unsupplemented preschool children with low dietary calcium intakes. American Journal of Clinical Nutrition 2006;84:1123-7.

Researchers from Boston University conducted a prospective study using data from the Framingham Children's Study. They found that consumption of fewer than 1.25 servings of dairy per day in girls and fewer than 1.70 servings of dairy per day in boys during early childhood was associated with increased risk of excessive amounts of body fat by early adolescence. Specifically, girls that consumed the lowest level of calcium gained an extra 25 mm of subcutaneous (belly) fat by early adolescence. The protective effect of dairy was not explained by calcium or magnesium intake.

Moore LL, Bradlee ML, Gao D, Singer MR. Low dairy intake in early childhood predicts excess body fat gain. Obesity 2006;14:1010-18.

Researchers found that a diet rich in calcium and dairy products was linked to lower body fat, yet calcium supplements had no effect on body weight or body fat during the one-year intervention. This randomized, double-blind intervention study looked at the impact of calcium supplementation on body weight and body fat in young girls. The 110 subjects (12-year-old girls) were randomly assigned to receive 500 mg of calcium carbonate or a placebo for one year. Food frequency questionnaires were used to assess habitual intake of dietary calcium. While the low-dose calcium supplementation had no effect on body weight or body fat, the habitual intake of dietary calcium (from milk and dairy products) was associated with lower body fat. In their analysis of the results, the researchers suggest that the effect of calcium on body weight may only be exerted if it is consumed as part of a meal. Additionally, they speculate that the weight management effect may be due to other ingredients in dairy products, and calcium may simply be a marker for a high dairy intake.

Lorenzen JK, Molgaard C, Michaelsen KF, Astrup A. Calcium supplementation for 1-y does not reduce body weight or fat mass in young girls. American Journal of Clinical Nutrition. 2006;83:18-23.

In a two-year prospective study of young girls (initially 10 years old), total calcium intake and dairy intake was associated with lower percent body fat and percent trunk fat in peripubertal girls, but did not predict change in percent body fat over two years.

Barr, S. Calcium intake is associated with percent body fat in peripubertal girls, but does not predict change in percent body fat over two years. North American Society for the Study of Obesity Annual conference. 2005. Abstract 68-OR.

Using baseline data from the Youth and Adolescents Osteo Outcomes Study, researchers analyzed calcium intake and body composition of 280 Caucasian and African American adolescents (aged 8-18 years). The results revealed that less than 15 percent of adolescent girls and 37 percent adolescent boys get the recommended amounts of calcium. Low calcium intakes were associated with a higher body fat.

Lucchesi M, McClanahan B, Ward K, Lanctot J, Clemens L. Calcium intake and body composition in children. North American Society for the Study of Obesity Annual Conference. 2005. Abstract 234-P.

Using data from the Framingham Children's Study, researchers found that children with the lowest intakes of fruit and dairy products had the greatest yearly gains in waist circumference from preschool to early adolescence.

Moore, L, Qureshi MM, Bradlee ML, Singer M. Early childhood food pyramid intake and change in central adiposity. North American Society for the Study of Obesity Annual Conference. 2005. Abstract 69-OR.

In this randomized, cross-over study, six children (ages 9-10 years) were given either 3 servings per day of milk or a sweetened fruit drink – referred to as a "single-nutrient beverage" – for one week. After the one-week supplementation period, the post-meal energy expenditure and the thermic effect of food were higher with the consumption of milk compared to the sweetened fruit drink. While the authors acknowledge that these results are preliminary, they comment that the findings suggest a metabolic adjustment induced by milk and a potential long-term effect of milk consumption on energy balance.

St-Onge MP, Claps N, Kostelli A, Heymsfield S. A mixed nutrient beverage leads to greater thermic effect of food compared to a single nutrient beverage after one week of supplementation. FASEB Journal. 2005; 971.5. Abstract.

In a two-year observational study of 46 New Zealand children (ages 3-10 years) who were "milk avoiders," researchers found that low calcium intakes at baseline were associated with an elevated BMI, short stature and low bone mineral density compared to a reference population of milk drinkers. Increasing milk intake resulted in some catch-up in height at the two-year follow-up for the milk avoiders, but the group remained short in stature, with BMI values that were higher than the reference population.

Rockell JEP, Williams SM, Taylor RW, Grant AM, Jones IE, Goulding A. Two-year changes in bone and body composition in young children with a history of prolonged milk avoidance. Osteoporosis International. 2005; (16)9: 1016-1023.

A study in Italy evaluated the relationship between milk consumption and body mass in nearly 900 children ages 5-11 years. The researchers found an association between higher milk consumption and lower BMI z-scores, when controlling for sex, age, physical activity, birth weight, parental overweight and education.

Barba G, Troiano E, Russo P, Venezia A, Siani A. Inverse association between body mass and frequency of milk consumption in children. British Journal of Nutrition. 2005; 93(1):15-19.

Researchers followed 12,829 children ages 9 to 14 from the Growing Up Today Study from 1996 to 1999. Using food frequency questionnaires and self-reported height and weight, they found that children who consumed more than 3 servings of milk per day gained significantly more in BMI than those who drank fewer servings. However, when the analysis was adjusted for energy, milk intake had no significant effect on increase in BMI and total energy was found to be the most important predictor of increase in BMI. The authors concluded that milk itself was not responsible for the weight gain in this cohort, but rather added calories. In a previous report of the Growing Up Today Study by the same researchers (Rockett HR, Berkey CS, Field AE, Colditz GA. Cross-sectional measurement of nutrient intake among adolescents in 1996. Preventive Medicine. 2001; 33:27-37), the same researchers reported that overweight participants consumed fewer dairy products than non-overweight youths.

Berkey CS, Helain RS, Willett WC, Colditz GA. Milk, dairy fat, dietary calcium, and weight gain: A longitudinal study of adolescents. Archives of Adolescent and Pediatric Medicine. 2005; 159:543-550.

In this review, the authors examined the current evidence exploring the role of dairy intake in relation to obesity and metabolic syndrome in children and adolescents. They found that there is some biological evidence for a beneficial role of dairy, but these physiological pathways have not been examined in children and adolescents. They concluded that more research is needed to determine whether any effects of dairy are independent of other eating patterns, such as intake of sweetened beverages or overall energy intake.

Huang TK, McCrory, MA. Dairy intake, obesity, and metabolic health in children and adolescents: knowledge and gaps. Nutrition Reviews. 2005; 63:71-80.

A study of 3,044 Portuguese children (ages 7-9 years) found an inverse relationship between calcium intake and BMI in girls.

Moreira P, Padez C, Mourao I, Rosado V. Dietary calcium and body mass index in Portuguese children. European Journal of Nutrition. 2005; 59:861-867.

Researchers at Creighton University evaluated the influence of diet on weight gain during 2 years of a study originally designed to investigate the effects of a calcium-rich diet on bone health. Participants were randomly assigned to a calcium-rich diet supplying at least 1,500 mg of calcium per day (primarily from dairy foods) or their usual diet. While the girls on the calcium-rich diet consumed about 150 more calories per day, they did not have greater increases in body weight, BMI or fat mass compared to girls consuming their usual diets at approximately 900 mg of calcium per day.

Lappe JM, Rafferty KA, Davies KM, Lypaczewski G. Girls on a high-calcium diet gain weight at the same rate as girls on a normal diet: A pilot study. Journal of the American Dietetic Association. 2004; 104:1361-1367.

Children who ate more dairy foods and had moderate intake of dietary fat gained less weight and fat than children who ate fewer dairy foods and had low or high intakes of dietary fat.

Moore LL, Singer MR, Bradlee ML, Ellison RC. Dietary predictors of excess body fat acquisition during childhood. Circulation. 2004; 109(7):5, No. 3.

In adolescent Asian and Caucasian girls ages 9-14, total and dairy calcium intake, but not non-dairy calcium, was associated with lower body fat. One milk serving was associated with decreased body fat measured by skinfold thickness while soda intake was associated with greater body weight. Researchers concluded that decreasing soda and increasing dairy consumption among girls, particularly Asians, may help maintain body fat and weight during adolescence.

Novotny R, Daida YG, Acharya S, Grove JS, Vogt TM. Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls. Journal of Nutrition. 2004; 134(8):1905-1909.

A study of 1701 children from 3rd to 7th grade in nine schools in Chile found a significant association between obesity and low intake of dairy products. While intake of energy-dense foods and TV watching time appeared as risk factors, only dairy consumption was associated with a significant inverse association with obesity.

Olivares S, Kain J, Lera L, Pizarro F, Vio F, Moro'n C. Nutritional status, food consumption and physical activity among Chilean school children: A descriptive study. European Journal of Clinical Nutrition. 2004; 58:1278-1285.

By reviewing diet questionnaires of overweight and normal-weight 10- to 14- year-old students, Hungarian researchers found that the heaviest children had the lowest intake of calcium from dairy foods.

Lelovics, Z and Tarnavolgyi, G. Relation between calcium intake and obesity. Presented at the 13th European Congress on Obesity. International Journal of Obesity and Related Metabolic Disorders. 2004; Supplement 1(28): S169. Abstract.

Obese Greek adolescents 11, 13, and 15 years were found to skip breakfast more and eat less fruits and milk than normal weight Greek students.

Tsakalou Z, et al. Prevalence of obesity/overweight and eating habits in Greek adolescents. Presented at the 13th European Congress on Obesity. International Journal of Obesity and Related Metabolic Disorders. 2004; Supplement 1(28): S203. Abstract.

Researchers evaluated dairy intake in relation to changes in body fat in 99 children followed over 12 years from ages 2-3 to 12-13 in the Framingham Children's Study. Children who consumed the fewest dairy servings per day had statistically greater gains in BMI and body

fat than those who consumed more dairy from childhood to early adolescence. The researchers concluded that low levels of dairy may be associated with a greater acquisition of body fat during childhood.

Moore LL, Singer MR, Bradlee ML, Gao DI, Hood M, Ellison RC. Low intakes of dairy products in early childhood may increase body fat acquisition. Obesity Research. 2003; 11(S): 130-OR.

Researchers followed 196 non-obese 8-12 year-old girls for 10 years. They found no evidence that dairy food or calcium consumption is associated with changes in BMI or body fat during adolescence. The researchers concluded that there is no scientific basis for teenagers who are concerned about weight gain or body fat levels to exclude the recommended amounts of dairy foods from their diets.

Phillips SM, et al. Dairy food consumption and body weight and fatness studied longitudinally over the adolescent period. International Journal of Obesity. 2003; 27:1106-13.

In children followed from ages 2 to 8, a higher dietary calcium intake from calcium-rich foods like milk, cheese and yogurt was associated with a lower percentage of body fat.

Skinner JD, Bonds W, Carruth BR, Ziegler P. Longitudinal calcium intake is negatively related to children's body fat indexes. Journal of the American Dietetic Association. 2003; 103: 1626-1631.

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