Comparing weight loss of dieters who use and who don't use calcium supplementation

Kristi Diane Klein
Medical College of Ohio

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FINAL APPROVAL OF SCHOLARLY PROJECT
For the Degree of Master of Science in Biomedical Sciences
Concentration in Physician Assistant Studies

Student Name: Kristi Klein

Title of Scholarly Project: Comparing weight loss of dieters who use, and who
don't use calcium supplementation

APPROVED

<table>
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<tr>
<th>Name</th>
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<tr>
<td>Christopher Bork, PhD</td>
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<td>7/30/04</td>
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<td>Patricia Francis Hogue, MS, PA-C</td>
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<td>8/31/04</td>
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Date of Approval: ____________________________
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Kristi Diane Klein

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2004
Acknowledgements

This research project did have a lot of ups and downs but there are several people I would like to recognize that have helped me throughout my research, and to end up coming out on top. First is my advisor Dr. Christopher Bork. He helped keep me on track, and settled down when things would become hectic. I also thank him for his guidance through this entire experience, helping with statistical analysis, and proofreading my project.

I also thank Dan Cipriani. His involvement with the IRB and my project was a huge help with getting final IRB approval. I appreciate the personal time he took to help me, reading over my application several times, giving advice and suggestions to my IRB application where needed.

Largely involved and deserving acknowledgement is Physician’s Weight Loss Center and several of their personnel. Camille Farnam worked with me for several weeks speaking with several people to get permission from the National Headquarters, and to find a site to obtain subjects for the study. I thank Tim Sandvick, owner of the Solon satellite for allowing me to spend time at his site and use his participants in my study. I thank him and his staff for recording subjects’ data for my study, and recording it weekly on my database sheets.

I thank the SAH/SON Research Support Award Committee. I appreciate the time they took to review my application, and their decision to fund my study.

This research project had indeed been a lot of work. I am glad to have had this experience and the opportunity to create a research trial of my own. It took a lot of time, hard work and energy, but it all came together in the end. Again, I express gratitude to
all of those mentioned above for their help. My experience would not have been the same without the time and effort they all put in to aid this research.
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Introduction

The National Health and Nutrition Examination Survey (NHANES) took place from 1999-2000. According to the National Center for Health Statistics (2004), the results showed 64% of U.S. adults classified as either overweight (BMI 25-29.9) or obese (BMI greater or equal to 30). As shown in table one, this shows that the prevalence of overweight and obese has increased close to 8% from the NHANES III, which took place from 1988-1994.

Obesity contributes to a vast amount of health problems including diabetes, hyperlipidemia, and hypertension and appears to be increasing in prevalence. These conditions all contribute to coronary artery disease, and thus precipitate events such as myocardial infarction and strokes. Reducing obesity is an important component of disease prevention and health promotion.

There are many factors that contribute to obesity. Environmental factors that affect diet and exercise are closely linked to the increase in obesity (Parikh & Yanovski, 2003). It is well known that controlling caloric intake and exercise are essential for weight control. Many Americans struggle with weight and look for additional aid with weight loss. It was recently suggested that calcium may be such an option.

There is evidence that obesity is a disorder that has been associated with low calcium (Heaney, 2003). It is suggested that calcium works at the cellular level to increasing fat metabolism (Zemel, 2001). There are studies that have demonstrated that increasing dietary calcium does aid in weight loss (Parikh & Yanovski, 2003). The evidence for such a benefit with supplemental calcium is much weaker.
Literature Review

Calcium has recently been termed the “super nutrient” because of its many beneficial properties (Miller, Jarvis & McBean, 2001). These benefits include the prevention of osteoporosis, the ability to decrease blood pressure, and the potential to reduce the risk of stroke. Recently, a new additional benefit of calcium has been suggested (Miller et al., 2001). It is now proposed that calcium has a role in increasing weight loss.

A Calcium Summit held in Washington, D.C., came to the conclusion that the calcium intake in the United States had reached a crisis level in 1999 (Miller et al., 2001). The current RDA is 1000mg for adults 19 to 50, and 1200mg for adults 51 and older (Miller et al., 2001). The recommended amount is a little higher for adolescents, young adults, pregnant, and lactating women. Data collected from the Continuing Survey of Food Intakes by Individuals (CSFII) in 1994-96 demonstrated that 12% of females age 12-19 and 32% of males of the same age group met the recommended intake calcium. Sixteen percent of females 20 to 29, 14% 30 to 39, and 11.5% of women 40 to 49 are meeting the recommended amount (Miller et al., 2001).

Obesity is a growing epidemic leading to a decrease in the quality of life and increased medical costs (Teegarden, 2003). Between 1980 and 1990, there was an increase of 40% in the prevalence of obesity in U.S. adults (Nicklas, Baranowski & Cullen, 2001). This is a major concern because obesity contributes to various health problems including atherosclerotic cardiovascular disease, type 2 diabetes, dyslipidemia, hypertension, and is associated with insulin resistance (Nicklas et al., 2001). There is also a link between obesity and sleep apnea, pseudotumor cerebri, and polycystic ovary
Since obesity is increasing in such huge proportions, it is imperative to find methods to intervene and decrease the occurrence of obese Americans. The addition of calcium to the diet may be such a solution to help decrease this incidence.

The exact amount of calcium suggested to aid in weight loss is not yet certain, but it has been suggested that there may be an increase in weight loss when reaching a daily allowance of 1000-1600mg daily (Tice, n.d.). Data from six observational studies and three controlled trials were reanalyzed, and there was a consistent effect size noted (Heaney, 2002). Each 300 mg increase in calcium intake was associated with about 1 kg less body fat in children, and 2.5-3 kg lower body weight in adults (Heaney, 2002). Data was also published that described the relationship between calcium intake and weight of 564 women. Fifteen percent of women were overweight at the 25th percentile of calcium intake, and that number fell to only 4% when calcium intake reached recommended intake values (Heaney, 2003).

Individuals may be concerned of adverse effects with increasing calcium intake over the RDA, but levels of 2,000mg/day appear to be safe and effective. Although there is a possibility of calcium supplementation causing adverse effects and imbalance with other medications if it is taken in excess, generally the upper tolerable limit is a total of 2500mg/day, which includes diet and supplementation (Ilich & Kerstetter, 2000). This quantity should not be exceeded for long periods of time in order to help decrease the possibility of side effects.

Calcium can be obtained in the diet in many ways. Most calcium is found in dairy products including milk, yogurt and cheese. Single servings of dairy, such as a glass of milk, cup of yogurt or serving of cheese contain about 300mg of calcium, so
three simple servings of dairy can provide the recommended amount. Other sources include dark-green leafy vegetables such as broccoli, collards, kale, mustard greens, turnip greens, and fish with edible bones (Roberts, 2003). If calcium obtained from the diet does not meet the recommended amount, various supplements are available including calcium carbonate, which has 40% elemental calcium, the highest of all calcium supplements (Miller et al., 2001).

It was proposed that the addition of calcium to the diet helps decrease weight by increasing fat metabolism at the cellular level. Agouti is an obesity gene that is expressed in human adipocytes. Recent studies have demonstrated that this protein stimulates calcium influx, and promotes energy storage by the stimulation of fatty acid synthase (FAS), an enzyme in de novo lipogenesis, and inhibition of lipolysis (Zemel, 2001) (fig. 1). This action was reproduced by calcium channel agonists and inhibited by calcium channel antagonists. A study was performed using rats with over expression of the agouti gene. They were treated with calcium channel antagonists, and there was a significant decrease in lipogenesis and adipose tissue mass (Zemel, 2001).

Dietary calcium also helps decrease the amount of 1,25-dihydroxyvitamin D that gets into the cell. 1,25-dihydroxyvitamin D is responsible for the promotion of the influx of calcium into adipocytes (Zemel, 2002). This influx increases lipogenesis, inhibits lipolysis, and expands triglyceride stores (Zemel, 2001). Therefore the addition of dietary calcium will decrease the amount of 1,25-dehydroxyvitamin D influx, and therefore decrease lipogenesis, and promote lipolysis (fig. 2). It was also recently demonstrated that increased levels of calcitriol stimulates calcium influx into adipocytes, thus promoting adiposity. It is a low level of calcium in the diet that causes an increase
in calcitriol (Zemel, 2002). By increasing consumption of calcium, there would be a decrease in the calcitriol level.

All of the above methods demonstrate that the influx of intracellular calcium leads to the stimulation of lipogenesis, and the inhibition of lipolysis, thus increasing triglyceride stores. Increasing dietary calcium would thus decrease the activity of agouti, decrease calcitriol levels and 1,25-dihydroxyvitamin D, which all decrease the level of intracellular calcium.

An article in the Journal of Nutrition commented on these demonstrations, but the studies presented show no such evidence of weight loss with the addition of calcium. In eight studies, no significant changes in weight, height, fat mass or lean mass were noted between groups (Barr, 2003). These findings may be due to the fact that caloric intake was not regulated in these groups. Similarly, several trials were conducted on groups that added calcium supplements to their diet. In most of the trials, there was no difference in body weight or composition between calcium and placebo or untreated groups (Barr, 2003). It is important to note that many of these studies did not restrict caloric intake, and varying amounts and types of calcium supplementation were used.

Although there is evidence of dietary calcium reducing lipogenesis and promoting lipolysis, thus supporting a decrease in obesity, it is not clear if calcium supplements also support a decrease in obesity. The purpose of this study was to ascertain whether dieters taking a calcium supplement would demonstrate an increase in weight loss.
Methods

The study protocol was reviewed and approved by the Institutional Review Board of the Medical College of Ohio.

Sample

This study was designed to see if adding supplemental calcium would aid weight loss. Nineteen females from Physicians Weight Loss Center in Solon, Ohio participated. They were randomly placed one of two groups. One following the Physicians Weight loss diet as directed, and the second also following the diet and adding 1000mg of calcium a day. Volunteers with kidney disease, thyroid disorders, those who are pregnant or lactating were not allowed to participate in this study.

Qualified subjects were randomly split into two groups. One group stayed on their diet as directed by Physician’s Weight Loss Center and the other group followed the Physician’s Weight Loss Center diet and, in addition, took 1000mg of Calcium daily. No subjects were required to stop taking a multivitamin if they currently did so. Participants who took a daily multivitamin took the calcium in addition to the vitamin because daily vitamins contain substantially less calcium than is needed for weight loss.

Data Collection

Volunteers that read, agreed and signed the consent form were able to participate in the trial. Information collected included subjects’ height and weight. A baseline weight was recorded at the initiation of the trial. Physician’s Weight Loss Center recorded the participants' weight. The weights recorded in Physician’s Weight Loss Center records were transferred to a database form containing a subject's name, weight,
height, group number, and activity level. Activity was measured via a point system. Subjects gave themselves one point for every half hour of activity performed. The Physician’s Weight Loss Center personnel then detached the names of the subjects prior to giving the forms to the investigator. Subjects’ body mass index (B.M.I) were calculated from the weights obtained, and their height.

Data Analyses

In addition to demographic variables such as age, height, weight at baseline and BMI, statistical analyses were performed to determine if there were differences in weight loss between dieters who took calcium and those who did not. A two-way analysis of variance with one repeated measure was used to determine if there was a significant difference in BMI between the groups and over time. The major outcomes being measured were: 1. a difference in weight loss between the group adding the calcium compared to the group not taking the calcium; 2. a difference in BMI over time (the trial variable); and, 3. the interaction of trial and group. The statistical hypotheses tested were that there would be no statistically significant differences in BMI ($\alpha=0.05$):

1. between the group adding the calcium compared to the group not taking the calcium
2. between the two trials
3. among the interactions
Results

Of the nineteen females that began the trial, only 13 of them completed the entire six weeks for the study. The complete list of demographics are shown in table 2. Heights ranged from 5’1/2” to 5’8”. Weight loss varied between the weeks. Although there was occasionally weight gain between weeks, overall, all subjects lost weight with the exception of one participant. The same is true with BMI. All subjects had a decline with the exception of two participants.

Changes in BMI were analyzed using a two-way analysis of variance with one repeated measure. Changes over time (baseline BMI and BMI end) were assessed by tests of within-subjects contrasts (n=13). There was a statistical difference in BMI over the trial (F=4.80, df=1, p=0.05). When analyzed for between groups changes in BMI due to treatment (calcium supplement or not) no statistically significant differences were found. (F=0.51, df=1, p=0.49).

Recognizing that exercise can be a confounding variable a second analysis was then performed using a 2-way ANOVA with one repeated measure with only subjects that exercised (n=9). A t-test examining mean activity between the group that received calcium supplements and the group that did not indicated there was no significant statistical difference so there was no basis for using exercise as a covariate.

The ANOVA revealed once again that for subjects who exercised their BMI changed over the trial (F=6.50, df=1, p=0.04) but that there were no SSD’s between the group that took calcium supplements and the group that did not (F=0.62, df=1, p=0.46).
Discussion

The analyses indicate that the decline in BMI cannot be explained by calcium. These results suggest that subjects would decrease their BMI as a result of the diet, regardless of adding exercise or calcium. Repeating the 2-way ANOVA with only those subjects who exercised demonstrated similar results indicating that exercising did not affect the groups differently. Apparently, the subjects’ BMI changed as a result of their diet.

One explanation for lack of differences between the groups may be the fact that the sample size may not have been large enough to demonstrate an effect. A second alternative may be that the activity was insufficient to result in substantial caloric expenditure. Finally, the length of the study may have been too short to obtain appreciable differences between the groups.
**Conclusion**

Although no significant decline in BMI could be attributed to the addition of calcium, the fact that there was a decrease in BMI is promising. These results may be attributed to several things, including the small sample size available to participate, length of the trial, compliance, exercise, age, and how long each individual has been on the diet.

Since this trial leaves it inconclusive as to whether adding calcium can be attributed to weight loss, this study should be repeated with several changes. A similar study with larger samples, and an extended trial period should be conducted. It would also benefit to have a closer monitor on exercise. Obtaining type (aerobic versus anaerobic) and frequency of exercise would help clarify results. Investigators should also record how long each participant has been on the diet, due to the fact that those just beginning a diet will lose weight more quickly than those who have been on a particular diet for some period of time.
Reference List


Table 1


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Demographics obtained from subjects

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Figure 1. The role of agouti on adipocytes (M. Zemel, 2001, Journal of the American College of Nutrition, 20, 428S-435S)
Figure 2. The role of calcium and 1,25-dihydroxyvitamin D on lipid metabolism (M. Zemel, 2001, Journal of the American College of Nutrition, 20, 428S-435S)
Comparing weight loss of dieters who use, and who don't use calcium supplementation

Objective: The objective of this study was to see if the addition of 1000mg of supplemental calcium to a calorie restricted diet would increase weight loss compared to individuals not adding calcium to their diet. Methods: Nineteen subjects were recruited from Physician’s Weight Loss Center in Solon, Ohio. Individuals were randomly placed into one of two groups. One to stay on their diet as directed by Physician’s Weight Loss Center and the other to follow the diet and take 1000mg of calcium supplements daily. Results: There was weight loss between both groups but no significant statistical difference between the group that added and did not add calcium. Conclusion: Weight loss did occur in this trial, but it remains unclear if it was related to the addition of calcium. This may have been due to sample size, and length of trial. The study should be conducted with larger samples, and exercise closely monitored.