Progress in Nutrition 2018; Vol. 20, N. 2: 229-235 DOI: 10.23751/pn.v20i2.5839 © Mattioli 1885

Original Article

Effects of dairy and supplemental calcium on food intakes in a group of Jordanian females

Rula Amr[1], Khader Elmasri[2], Ala A.Qatatsheh[3], Amal Mayyas[4], Islam Hamad[5]

[1] Department of Human Nutrition and Dietetics, American University of Madaba , Jordan, Madaba- E-mail: r.amr@aum.edu.jo; [2]Food Science and Nutrition Department, Faculty of Agriculture, Jordan University, Jordan, Amman; [3]Department of Nursing, Princess Aisha Bint Al-Hussein Faculty of Nursing, Al-Hussein bin Talal University, Ma'an, Jordan and Department of Clinical Nutrition, Faculty of Applied Health Sciences, Qassim University, Arrass, Saudi Arabia; [4]Pharmacy Department, Faculty of Health Sciences. American University of Madaba, Jordan, Madaba; [5]Pharmacy Department, Faculty of Health Sciences. American University of Madaba, Jordan, Madaba

Summary. *Objective.* The effect of calcium intervention equivalent to three cups of milk/ day from dairy foods and 800 mg supplemental calcium as tablets, compared to a control group on normal diets with one cup of milk/ day, was studied on food and nutrient intakes. *Methods.* A group of 122 healthy adult Jordanian females, age 20-45 years, were recruited in the study during a period of 12 weeks. Study sample was divided into: dairy calcium group, supplemental calcium group, and control group. Intakes of main food groups, energy, carbohydrates, protein, fat, cholesterol, dietary fiber, calcium and vitamin D were evaluated, and their intake adequacies were assessed using the dietary reference intakes (DRIs) and food exchange system at the end of the study. *Results.* highly significant differences (P<0.001) were obtained between the different treatment groups regarding: (fats and oils), (meat, poultry, fish and eggs) and (bread, cereals, rice and pasta groups). The differences between the three groups took the same pattern. The control and supplemental calcium groups consumed significantly the highest amounts of fats, meats, bread and cereals, whereas the milk supplemental group consumed significantly the lowest amounts. No significant differences (P>0.05) were obtained between the different treatment groups regarding their intakes of fruits and vegetables. As for energy intakes, the control group exhibited a significantly (p <0.05) higher contribution of energy intake compared to the other intervention supplemented groups. *Conclusions.* It can be concluded that the postulation that the favorable effects of dairy components on food intake, subjective satiety and intake regulatory mechanisms have been usually observed in short term experiments where the components were consumed in amounts that found in usual serving sizes of dairy products, and in the current study, the milk intake of the milk group seemed to affect satiety and eating pattern of diet and nutrient intakes by lowering food and energy intakes.

Key words: Dietary calcium, Calcium supplements, Appetite, Dietary intakes, Jordanian females.

Introduction

The incidence of obesity has significantly increased in the last 20 years and has become a national and global epidemic. It is associated with many diseases such as heart disease, cancer, stroke and diabetes. Significant weight loss is known to reduce the risk for some of these diseases (1). According to the findings of obesity and diabetes from the Behavioral Risk Factors System, 21.1% of Jordanian men and 41.5% of Jordanian women suffer from obesity (2). On the other hand deficiencies of many important vitamins, such as vitamin A and vitamin D, and minerals such as iron, calcium, zinc and iodine are widespread in many parts of the world (3). According to the statistics of US Census Bureau, International Data Base (4), the extrapolated undiagnosed Prevalence of osteoporosis in Jordan due to calcium deficiency about 7%. Although big effort

has been made studying the effect of macronutrients on weight control, the role of micronutrients need to be more studied (5).

Despite the fact that energy balance is the one of the crucial factors in weight regulation, recent studies suggest that calcium metabolism and perhaps other components of dairy products may play a role in shifting the energy balance and have an effect on weight and appetite regulation process (6).

Calcium intake is hypothesized to play a role in weight changes and weight maintenance; two proposed mechanisms for the association of body weight changes in conjunction with calcium intake (5, 7, 8, and 9). The proposed mechanisms involve either a decline in available energy or an increase in energy utilization. The decrease in available energy is proposed through two processes: increasing satiety or decreasing the absorption of fatty acids through the formation of calcium/fatty acid soaps in the intestine which reduces the absorption of energy related nutrients and increases fecal fatty acid loss (5, 7, 8, 10). The effects of calcium supplementation on appetite regulation have been less well studied, but most of these limited studies found that calcium significantly reduced hunger and food consumption (11). It has been found that people allocated to calcium plus vitamin D supplement had a significant decrease in fat consumption too (11). Food cravings are obvious in those suffering from premenstrual symptoms, calcium supplementation is found to play a role in attenuating these cravings as well (12).

The main target of this research is to study the effect of dairy calcium and supplemental calcium intake on food and nutrient intakes, eating behavior and appetite in a group of Jordanian females.

Materials and methods

Study design and sample

A convenient sample of 122 medically checked healthy adult Jordanian females aged 20 - 45 years, who lives in Jordan were recruited in the study. These women volunteered to participate in this study, and they were chosen from different institutions, companies, universities and even household women. This study was conducted over the period of three months. The following factors were assessed in the participants: personal information, weight and height, lifestyle, eating habits, health and nutritional status. Subjects who were pregnant or lactating or reported a known ill of chronic, inherited, endocrine or nutritional diseases or problems, on a special diet or taking nutrient supplements,contraceptives or medications, smoker, normotensive and alcohol drinkers, were all initially excluded. Eligible recruiters were clustered into one control group (C) and two experimental groups: milk (M) and tablet or calcium supplemented group (T).

Control Group: should follow their habitual active life style and their usual dietary patterns and habits, this group didn't drink milk at all, due to many reasons, including hating milk's taste or due to bloating from milk.

Tablet Group: should follow their habitual active life style and their usual dietary patterns and habits. Calcium supplement was given to each female in this group as two tablets daily of chocolate chews under the commercial name of "Ellactiva" for three months. Each tablet contains 400 mg elemental calcium this supplement dose covers the DRI and is without any side effects (13). These groups were instructed to take maximum one serving of dairy products per day, to cover the difference in calcium intake between them and the milk group. To ensure the safety of the calcium supplement, a specialized doctor was consulted along with the marketing company of the supplement.

Milk Group: should follow their habitual active life style and their usual dietary patterns and habits. Each female took three servings of milk on daily basis for three months (14).

Dietary assessment

Food consumed was measured using a dietary intake record method for three non consecutive days (two working days and one weekend day), including information about food measures and portion sizes, food ingredients, description of dishes, meals, frequency, snacking and food groupings. This method was the best accurate estimate of individual food consumption over a specific period of time (15). Food intake and adequacy were measured according to the five food groups system. Food intakes were convert-

ed to daily energy and nutrients including: energy, protein, carbohydrates, fat, cholesterol, dietary fiber, proteins, vitamin D and calcium. A special computer program based on food composition tables and available literature (ESHA, 2007) was used for nutrient evaluation. Adequacy of intakes was assessed by comparing intakes with the dietary reference intakes (DRI).

Statistical Analysis

Statistical analysis of the data was carried out using statistical analysis system (SAS). Factors showed significant (p<0.05) differences in the ANOVA table, their means were compared using Least Significance Difference (LSD) at (p <0.05).

Results

Dietary Intake and Adequacy

Daily intakes of the individual foods were measured and collected into the five food groups and evaluated according to the food guide system in the following manner (Table 2):

Table 1. Sample Characteristics

	Sample number	Age (years)	Weight (Kg)	BMI (Kg/m^2)
		**	NS	NS
CN	14	22.1±1.2 b	55.3±1.7	21.3±0.5
MN	16	23.8±1.1 b	55.0±1.6	21.0±0.5
TN	15	28.3±1.1 a	59.7±1.6	22.3±0.5
		NS	NS	NS
CO	26	29.0±1.4	87.0±3.1	33.2±1.1
MO	26	32.0±1.4	88.9±3.1	33.7±1.1
TO	25	30.2±1.4	86.3±3.2	33.1±1.2

1- Values are given as Means ± SEM.
2- Groupings are based on: type of treatment: Control group (C), Milk group (M), Tablet group (T) and on body mass index: Normal weights (N) and Obese (O).
3- Means with similar letters in their superscripts within the same column are not significantly different (p >0.05). Letters were written in a descending order of mean values.
*4- * p <0.05 ** p <0.01 *** p <0.001 NS: Not Significant p >0.05.*

Table 2. Intakes of Five Groups Food System

	Subgroup	Fats & Oils	Meat,poultry, fish & eggs	Fruits	Vegetables	Bread,cereals, rice & pasta
Treatment		***	***	NS	NS	***
	C	21.22±1.47a	2.66±0.20b	1.21±0.17	6.37±0.51	4.89±0.27a
	M	12.44±1.41b	2.40±0.19b	1.17±0.17	5.56±0.49	4.53±0.26b
	T	19.11±1.45a	3.91±0.20a	1.04±0.17	6.00±0.50	6.39±0.27a

1- Values are given as Means ± SEM.
2- Groupings are based on type of treatment: Control (C), Milk (M), Tablet (T)
3- Means with similar letters in their superscripts within the same column are not significantly different (p >0.05). Letters were written in a descending order of mean values.
*4- * p <0.05 ** p <0.01 *** p <0.001 NS: Not Significant p >0.05.*
5- Data are presented as number of servings.

Fats and Oils: A highly significant difference (p <0.001) was noted between the different treatment groups regarding their fats and oils intakes. The control and supplemental calcium groups' intakes were the highest, whereas the milk supplemental groups' intakes were the lowest.

Meat, Poultry, Fish and Eggs: The difference in the intakes between the different treatment groups were highly significant (p <0.001). It can be noted that the calcium supplemental group intakes of meat were the highest compared to the other groups. Meat group intakes were sufficient in all the treatment groups according to the food pyramid recommendations.

Fruits: Insufficient intakes of fruits were noticed in all the treatment groups with around one serving of fruits per day. The difference in the intakes were nearly equal between the different treatment groups with no significant differences between them (p >0.05)**.**

Vegetables: The control and supplemental calcium groups consumed insignificantly the highest number of servings from vegetables, while the milk supplemented groups consumed the least. Vegetable intakes were sufficient in all the treatment groups according to the food pyramid recommendations.

Bread, Cereals, Rice and Pasta: The differences in the intakes between the different treatment groups were highly significant (p <0.001). The milk supplemented group intakes of bread, cereals, rice and pasta were significantly lower than the control and the calcium supplemented groups.

Nutrient Intakes and Adequacy

Food intakes were analyzed for energy, carbohydrate, animal and plant protein, fat, cholesterol, dietary fiber, calcium and vitamin D. Adequacy of energy and nutrient intakes were assessed by comparing intakes with the dietary reference intake (DRI).

Energy: The differences in energy intake between the different treatment groups of the study were significant (p <0.05) (Table 3). However, these values represented 2426.9±46.2, 2258.3±44.3, 2297.4±45.5 for the control, milk supplemented and calcium supplemented groups respectively. The control group exhibited a significant (p <0.05) higher contribution of energy intake compared to the other intervention supplemented groups.

Carbohydrates (CHO): Daily Carbohydrate intakes of the different treatment groups did not differ significantly (p >0.05) (Table 3). The control group consumed the highest amounts of CHO followed by the milk supplemented group then the calcium supplemented group. The percentage contribution of CHO intake from the DRI between the different treatment groups did not also differ significantly (p >0.05) (Table 3).

Dietary Fiber: Highly significant differences in dietary fiber intakes were observed between the different treatment groups as grams and as percentage contribution of the DRI. The control group consumed higher amounts of dietary fiber compared to the milk and calcium supplemented groups (Table 3).

Protein: Differences in protein intakes expressed as grams and as percentage of the DRI were insig-

Table 3. Intakes of Energy, Carbohydrates & Dietary Fiber in values and as % of the DRI

	Subgroup	Energy (kcal)	Energy % DRI	CHO(gm)	CHO % DRI	Dietary Fiber (gm)	Dietary Fiber % DRI
Treatment		*	***	**NS**	**NS**	***	***
	C	2426.9±46.2a	104.1±0.6a	293.11±8.37	86.42±1.73	28.78±1.19a	108.84±4.17a
	M	2258.3±44.3b	98.8±0.6b	281.39±8.03	85.18±1.65	20.70±1.14b	78.55±4.00b
	T	2297.4±45.5b	98.4±0.6b	278.55±8.25	82.14±1.70	23.43±1.17b	87.61±4.11b

1. *Values are given as Means ± SEM.*
2. *Groupings are based on: type of treatment: Control group (C), Milk group (M), Tablet group (T)*
3. *Means with similar letters in their superscripts within the same column are not significantly different (p >0.05).*
4. *Letters were written in a descending order of mean values.*
5. *p <0.05 ** p <0.01 *** p <0.001 NS: Not Significant p >0.05.*

nificant (p >0.05) between the different treatment groups. The calcium supplemented group consumed higher amounts of protein, followed by the milk supplemented group, while the control group intakes were the least (Table 4).

Fat: The differences in fat intakes between the different treatment groups were of high significant differences (P<0.001) (Table 4). The control group consumed the highest amounts of fat than the other two treatment groups. The milk and calcium supplemented groups' intakes of fat were nearly the same. The differences in the mean values of fat intakes as percentage coverage of the DRI were also highly significant (p <0.001).

Cholesterol: Cholesterol intakes were not significantly different between the different treatment groups (p >0.05) neither as grams, nor as percentage coverage from the DRI (Table 4).

Vitamin D and Calcium (Ca): An apparent highly significant (p <0.001) increase in the intakes were noticed in the milk group, followed by the calcium supplemented group. The control group intakes of vitamin D and calcium were the lowest. The same goes for the percentage coverage of vitamin D and calcium intakes from the DRI (Table 5).

Discussion

The studied sample consisted of 122 healthy women. The sample was divided into the three treatment groups: control (C), milk (M) and calcium tablet (T) groups.

The results of the current study showed that there were highly significant differences in fats and oils, bread, cereals, rice and pasta intakes between the different treatment groups. The milk group exhibited

Table 4. Intakes of Total Protein, Animal Protein and Plant Protein as grams and as % of the DRI

	Subgroup	Total Protein (gm)	Total Protein% DRI	Fat (gm)	Fat % DRI	Cholesterol (mg)	Cholesterol % DRI
Treatment		**NS**	**NS**	***	***	**NS**	**NS**
	C	90.43±3.60	131.07±5.17	106.12±3.40a	136.08±3.25a	269.64±15.34	89.86±5.10
	M	97.41±3.45	142.19±4.95	84.55±3.26b	110.32±3.11b	229.72±14.70	76.63±4.89
	T	98.46±3.54	140.69±5.09	91.54±3.35b	117.67±3.20b	276.81±15.11	92.27±5.03

1. *Values are given as Means ± SEM.*
2. *Groupings are based on type of treatment: Control (C), Milk (M), Tablet (T)*
3. *Means with similar letters in their superscripts within the same column are not significantly different (p >0.05). Letters were written in a descending order of mean values.*
4. ** p <0.05 ** p <0.01 *** p <0.001 NS: Not Significant p >0.05.*

Table 5. Intakes of vitamin D and Calcium in values and as % of the DRI

	Subgroup	Vitamin D (mcg)	Vitamin D % DRI	Calcium (mg)	Calcium % DRI
Treatment		***	***	***	***
	C	3.05±0.06c	60.95±1.24c	793.27±20.49c	79.28±2.05c
	M	7.75±0.06a	155.10±1.18a	1335.26±19.64a	133.47±1.97a
	T	5.83±0.06b	116.50±1.22b	1184.04±20.18b	118.39±2.02b

1. *Values are given as Means ± SEM.*
2. *Groupings are based on type of treatment: Control (C), Milk (M), Tablet (T)*
3. *Means with similar letters in their superscripts within the same column are not significantly different (p >0.05). Letters were written in a descending order of mean values.*
4. *p <0.05 ** p <0.01 *** p <0.001 NS: Not Significant p >0.05.*

the lowest significant intakes of fats and oils, bread, cereals, rice and pasta compared to the control and calcium tablet groups.

It can be observed that the milk and tablet groups' intakes of energy and macronutrients were less than the control group, except for the protein. Accordingly, this indicates that the appetite of the milk and tablet groups were less than that of the control group. These findings go along with the proposition of Major *et al* (16); he proposed that that an inadequate calcium intake negatively influences appetite control. From another perspective, Tordoff described several arguments in favor of the existence of a sensory and behavioral regulation of body calcium (17), which underlies the existence of a taste and an appetite for calcium (18). The calcium appetite, defined by Tordoff (17) as the motivation to seek out or choose calcium containing items, is a phenomenon that has been observed for other minerals in vertebrates (18). Several studies have shown that rats fed with a diet with a low content of a specific mineral developed a preference for substances with higher concentration in the minerals they had been deprived of. This is the case for calcium, sodium and magnesium (19). The existence of a phosphorus, iron, zinc and copper specific appetite in response to their specific deficient state in rats has also been suggested Troiano *et al* (20), these findings can explain the results of this current study; when the control group were deprived from calcium rich foods, they developed cravings to other types of food like fatty food, rice pasta and noodles.

This current study, demonstrated that calcium found in milk exhibited significantly a high effect in appetite suppression. Schneeman results were also consistent with the results of this current study (21); Schneeman studied the effects of dairy product intake on Cholecystokinin (CCK) in a randomized crossover design study. The study found that the intake of meals that contain dairy products raised CCK levels within 6-hours more than the intake of non-dairy meals in women but not in men. These proposed mechanisms of the effect of calcium and dairy products on appetite, supports our results.

The existence of calcium specific appetite in humans has never been directly assessed. The only indication for a behavioral control for calcium homeostasis in humans is anecdotal observations that have reported preference for calcium-rich edible substances (water with high millimolar quantities of calcium), or craving for nonedible substances with a high-calcium content (animal bones, powdered rock, ashes stalks, clay, chalk, plaster) under different calcium deficiency circumstances (18). However, it has been suggested that if an innate behavioral mechanism to respond to calcium deficiency is found in humans, it would be associated with the complex flavor profile that characterizes the most appreciable source of calcium (18). This makes the identification of a calcium appetite behavior in human much complex and implies that in calcium deficient people, such behavior could result in an increased energy intake. Therefore, additional research in the future studying the effect of dietary calcium on appetite and food intake is needed.

Recommendations, Future Research and Application

Obesity and related diseases is extensively impacting children, adolescents, and adults in developed and developing countries. Attention should be given to attenuate this problem. We should encourage the intakes of milk and dairy products, as an alternative solution for calcium drugs as an attempt to attenuate obesity and increased appetite. It is also important to interpret the findings of the anti-obesity effect of dietary calcium and dairy foods within the context of optimal calcium and dairy intake. The available data indicate that substantial improvements in adiposity are unlikely to result from increasing dairy intake beyond an optimal range (approximately three daily servings).

Acknowledgments

The authors express their gratitude to the deanship of academic research, University of Jordan, Amman for sponsoring this research.

Bibliografia

1. World Health Organization (WHO). Obesity and Overweight, Geneva: World Health Organization. 2nd ed. Geneva: World Health Organization; 2008.
2. Zindah M, Belbeisi A, Walke H, Mokdad AH. Obesity and

diabetes in Jordan: findings from the behavioral risk factor surveillance system, 2004. Prev Chronic Dis 2008; 5:A17.
3. World Health Organization (WHO). Fortifying the Fight against Poverty. Strategic Plan 2004–2007, Geneva, Global Alliance for Improved Nutrition, Geneva: World Health Organization; 2004.
4. United State Census Bureau, International Data Base, 2004. http://www.wrongdiagnosis.com/o/osteoporosis/basics.htm
5. Teegarden D. Calcium intake and reduction in weight or fat mass. J. Nutr 2003; 133:249S-51S.
6. Zemel MB. Regulation of adiposity and obesity risk by dietary calcium: mechanisms and implications. J Am Coll Nutr 2002; 21:146S-51S.
7. Heaney RP. Low calcium intake among African Americans: effects on bones and body weight. J. Nutr 2006; 136:1095-8.
8. Teegarden D. The influence of dairy product consumption on body composition. J. Nutr 2005; 135:2749-52.
9. Zemel MB, Shi H, Greer B, Dirienzo D, Zemel PC. Regulation of adiposity by dietary calcium. The FASEB Journal 2000; 14:1132-8.
10. Zemel MB, Miller SL. Dietary calcium and dairy modulation of adiposity and obesity risk. NUTR REV 2004; 62:125-31.
11. Major GC, Alarie F, Dore J, Phouttama S, Tremblay A. Calcium+ Vitamin D supplementation and weight loss in women who are low calcium consumers: Is there a role for a calcium–specific appetite control. Obesity 2006; 14: A93.
12. Thys-Jacobs S, Starkey P, Bernstein D, Tian J, Premenstrual Syndrome Study Group. Calcium carbonate and the premenstrual syndrome: effects on premenstrual and menstrual symptoms. Am J Obstet Gynecol 1998; 179:444-52.
13. Straub DA. Calcium supplementation in clinical practice: a review of forms, doses, and indications. Nutr Clin Pract 2007; 22:286-96.
14. United State Department of Agriculture, Center for Nutrition Policy and Promotion. MyPyramid, 2005. http://www.mypyramid.gov/.
15. Lee R, Nieman D. (2010). Nutritional Assessment, 5th ed; New York: McGraw-Hill.
16. Major GC, Chaput JP, Ledoux M, St-Pierre S, Anderson GH, Zemel MB, Tremblay A. Recent developments in calcium -related obesity research. Obes Rev 2008; 9:428-45.
17. Tordoff MG. Calcium: taste, intake, and appetite. Physiol Rev 2001; 81:1567-97.
18. Striegel-Moore RH, Thompson D, Affenito SG, Franko DL, Obarzanek E, Barton BA, Schreiber GB, Daniels SR, Schmidt M, Crawford PB. Correlates of beverage intake in adolescent girls: the National Heart, Lung, and Blood Institute Growth and Health Study. J. Pediatr 2006; 148:183-7.
19. Nielsen SJ, Popkin BM. Changes in beverage intake between 1977 and 2001. Am. J. Prev.Med 2004; 27:205-10.
20. Troiano RP, Briefel RR, Carroll MD, Bialostosky K. Energy and fat intakes of children and adolescents in the United States: data from the National Health and Nutrition Examination Surveys. Am J Clin Nutr 2000; 72:1343s-53s.
21. Schneeman BO, Burton-Freeman B, Davis P. Incorporating dairy foods into low and high fat diets increases the postprandial cholecystokinin response in men and women. . J. Nutr 2003; 133:4124-8.

Correspondence:
Rula Amr
Department of Human Nutrition and Dietetics,
American University of Madaba, Jordan, Madaba
E-mail: r.amr@aum.edu.jo