

The Effect of Cow's Milk Versus Calcium Supplement on the Components of Metabolic Syndrome in Overweight or Obese Women

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Abstract

Background: Obesity and metabolic syndrome are serious public health problems. It is suggested that high calcium diet can improve lipid profile, blood pressure and insulin resistance.

Methods: In this clinical trial, 75 healthy overweight or obese premenopausal women were randomly allocated to one of the following dietary regimens for 8 weeks: 1) a control diet 2) a calcium-supplemented diet containing 800mg/d calcium carbonate 3) a high milk diet containing three servings of low fat milk (all of them providing a 500kcal/day deficit). At baseline and after 8 weeks, waist circumference (WC), blood pressure, serum triglyceride (TG), fasting blood sugar (FBS), and high density lipoprotein cholesterol (HDL-C) were measured.

Results: After 8 weeks, WC, FBS and HDL-C decreased in all groups ($P < 0.001$), but there were no significant reduction in TG and blood pressure. Reduction of WC in the milk group was significantly higher than the controls ($P = 0.028$). Also, reduction of HDL-C in the calcium and milk groups was less than the controls ($P = 0.023$ and $P = 0.019$, respectively). Changes in FBS, TG and blood pressure were not significantly different among the 3 groups.

Conclusion: We found that increasing milk consumption led to more WC reduction. Milk or calcium intake caused less adverse effect on HDL-C, but has no effect on the blood pressure, FBS and TG. So increase in milk or calcium intake can reduce WC among the metabolic syndrome complications.

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Introduction

According to WHO report, obesity has more than doubled in the world since 1980. In 2008, 1.5 billion adults, 20 years and older, were overweight. Of these, over 200 million men and nearly 300 million women were obese.¹ Obesity is a risk factor for type 2 diabetes,

hypertension, dyslipidemia, and coronary heart diseases.² Also, the metabolic syndrome (MetS), a clustering of obesity, impaired glucose metabolism, hypertension, and dyslipidemia,^{3,4} is a serious public health problem.⁵ It is assumed that calcium and other components of dairy products may have an effect on energy balance and weight regulation.⁶⁻⁸ In fact, calcium and dairy

products inhibit lipogenesis and promote lipolysis via suppression of calcitriol.⁸ Moreover, several studies have shown an independent association between higher dairy consumption and a more favorable lipid profile,⁹ lower risk of hypertension,¹⁰ insulin resistance, and type 2 diabetes.¹¹⁻¹⁴

Calcium via dairy products consumption may be more potent than calcium supplement.¹⁵ It seems that bioactive compounds in dairy products are responsible for this effect.¹⁶ The effect of calcium intake on body weight, blood pressure, insulin resistance and lipid profile is still a controversial issue. The results of cross-sectional studies are indicative of the negative association between dairy products consumption and the risk of metabolic syndrome.^{17,18} But to the best of our knowledge there is no clinical trial on the effect of calcium or dairy consumption in premenopausal women. So, we decided to compare the effects of low fat cow's milk, and calcium supplement on components of metabolic syndrome in overweight or obese premenopausal women.

Material and Methods

Study Sample

Seventy five premenopausal overweight or obese women aged 20-50 years volunteered to participate in this randomized clinical trial and 64 completed the study. The study was performed in 2009. The study. Eleven participants dropped out for various reasons, including not consuming calcium supplement and unwillingness to continue participation. Inclusion criteria were as follows: body mass index (BMI) more than 25 kg/m², taking no medications or supplements which might affect metabolism of calcium, vitamin D or weight loss, absence of menopause, stable body weight (body weight change less than 3kg for the last 2 months), absence of diabetes, hypertension, coronary-artery, thyroid, and kidney diseases. The participants were non-pregnant and non-lactating with no allergy to milk or lactose intolerance. It was also ensured that the participants had not participated in any other studies within the last 6 months of screening. The study was approved by the ethics committee of National Nutrition and Food Technology Research Institute with the code number of 024342 and registered to IRCT with the ID of IRCT201304213080N1. Each participant was informed of the possible risks and benefits associated with this study and provided written signed consent.

Study Interventions

The participants were studied for a 2-week period for baseline dietary and physical activity assessment and then randomized to one of the following dietary regimens for 8 weeks: 1) a control diet providing a

500 kcal/day deficit, with 500-600 mg/day dietary calcium; 2) a calcium- supplemented diet identical to the control diet with 800mg/day of calcium (as calcium carbonate); 3) a milk diet providing a 500kcal/day deficit and containing three servings (220 ml) of low fat milk (1.5%). The total calcium of milk diet was between 1200-1300 mg/day.

Daily caloric requirements were calculated using the Harris-Benedict equation.¹⁹ After multiplying it by physical activity level, meal schedules were given to each individual based on a 500 kcal/day deficit from estimated caloric requirements.²⁰ The diets for all groups were designed to provide comparable levels of macronutrients as follows: 55% carbohydrate, 18% protein and 27% fat. At baseline and at two-week intervals, the weight, height, waist circumference, and blood pressure were measured and 24h-dietary records,²¹ as well as physical activity records (2 week days and 1 weekend) were taken. Waist circumference was measured on the narrowest area of the waist below the rib cage and above the umbilicus with the use of a non-stretchable tape measure.²²

At baseline and after 8 weeks, fasting blood samples (10 ml) were obtained in the morning. The plasma was separated and frozen at -80°C for later analysis. Serum Glucose and TG were measured using enzymatic chromatography (Pars azmoon, Tehran, Iran). Serum HDL-C was measured by direct Turbidimetry method (Pars azmoon, Tehran, Iran).

Statistical Analysis

Dietary records were analyzed using Nutritionist 4 (N IV). Statistical analyses were performed using SPSS software, version 16. One way ANOVA was used to compare the characteristics of subjects in three groups at baseline, also to compare the mean differences of FBS, HDL-C, TG, blood pressure and waist circumference among 3 groups. We used LSD post hoc test to find the two by two between groups' differences. P<0.05 was considered significant.

Results

Of the 75 women meeting the general eligibility criteria, 11 dropped out before completing the weight-loss period (5, 3, and 3 persons in control, calcium supplement, and milk groups, respectively).

Baseline characteristics of the participants are shown in Table 1. It is apparent that there were no significant differences between the age, BMI, WC, serum HDL-C, TG, Glucose and energy and calcium intake of the participants in the 3 groups.

Table 2 indicates that there were no differences in the energy, macronutrients, fiber and cholesterol intakes among the 3 groups during the study. Also,

Table 1: Baseline characteristics of the subjects under the study

Variables	Control (n=20)	Ca group (n=22)	High milk (n=22)	P*
Age (year)	38.25±9.49	35.77±8.70	38.27±10.43	0.61
BMI (kg/m ²)	30.78±3.13	31.54±4.12	30.01±3.55	0.39
WC (Cm)	90.57±7.63	90.81±9.79	86.88±8.46	0.09
FBS (mg/dl)	84.5±7.66	85.22±8.36	83.86±5.75	0.82
TG (mg/dl)	125.25±48.19	118.90±54.85	122.04±54.22	0.92
HDL-C (mg/dl)	43.75±5.26	40.95±3.67	42.90±3.86	0.10
Systolic BP (mmHg)	107.25±9.10	102.50±8.96	104.00±9.11	0.22
Diastolic BP (mmHg)	67.00±8.64	65.68±7.28	67.75±7.69	0.75
Energy (kcal/d)	1839.35±169.54	1870.77±201.79	1937.26±177.79	0.25
Calcium (mg/d)	512.85±172.71	532.29±149.77	484.58±131.07	0.64

All values are mean±standard deviation, *One way ANOVA

Table 2: Intake of energy, macronutrients, calcium, fiber and cholesterol of the subjects during the study period

Variables	Control (n=20)	Ca group (n=22)	High milk (n=22)	P*
Energy (kcal/d)	1221.21±153.73	1239.60±180.09	1297.89±137.83	0.25
Fat (%)	27.21±3.77	26.45±2.80	27.36±3.25	0.64
Protein (%)	17.63±1.34	17.40±2.78	17.59±2.21	0.90
Carbohydrate (%)	54.78±3.58	56.04±2.78	55.04±4.12	0.46
Cholesterol (mg/d)	143.12±60.32	138.98±30.24	144.19±41.81	0.92
Fiber (g/d)	14.34±3.76	14.37±4.11	13.77±2.35	0.80
Calcium (mg/d)	495.46±163.87	1320.53±219.36	1302.00±107.56	<0.001

All values are mean±standard deviation, *One way ANOVA

Table 3: Between groups' differences of metabolic syndrome components of the subjects under the study

Variables	Control ²⁰	Calcium group ²²	High milk group ²²	P*
	Before-After	Before-After	Before-After	
WC (cm)	3.98±0.62 ^a	5.13±0.68	6.32±0.54 ^a	0.036
SBP (mmHg)	1.00±1.52	-0.68±1.24	0.50±1.53	NS
DBP (mmHg)	0.25±1.22	1.13±1.27	2.25±1.28	NS
FBS (mg/dl)	8.50±1.97	8.95±1.21	6.90±1.92	NS
TG (mg/dl)	3.40±7.01	4.95±7.42	14.81±11.04	NS
HDL-C (mg/dl)	5.60±1.22 ^{ab}	1.95±0.71 ^a	1.86±0.86 ^b	0.010

All values are mean±standard error, NS: not significant, *Between groups differences (One way ANOVA). The same letters in a row shows significant differences, P<0.05 for all (LSD post hoc test)

it was shown that the percentages of carbohydrate, protein and fat intake were very close to the recommended amounts of 55%, 18%, and 27%, respectively.

It is shown in Table 3 that after 8 weeks, changes of dependent variables were significant among groups just for WC and HDL-C. LSD post hoc test showed that reduction in WC was more in the milk group compared to the controls (P=0.028). Also, reduction in HDL-C levels of calcium supplement and milk groups were less than the controls (P=0.023 and P=0.019, respectively).

Discussion

Results of this study indicated that among the components of metabolic syndrome, calcium supplement or milk consumption only affected the waist circumference and HDL-C level. We found that milk intake led to more reduction in WC than the controls. Besides, although not statistically significant, reduction in WC of the calcium

supplement group was greater than the controls, too. In agreement with our findings, Zemel and colleagues showed that daily consumption of 3 cups of yogurt can cause more reduction in WC than the controls (3.99 cm Vs 0.58 cm).²¹ High dietary calcium intake reduces 1, 25-vitamin D levels which decreases the calcium influx into the cell; thus, the intracellular levels of the ionic calcium stimulate lipolysis and inhibit lipogenesis in the adipocyte. Milk is rich in bioactive compounds as angiotensin converting enzyme inhibitors that increase lipolysis, too.^{8,21} It is suggested that bioactive peptides and branched chain amino acids content of dairy products are responsible for their more potent effect on WC, compared with calcium supplement.^{8,15}

After following limited energy diet, there was a reduction in serum HDL-C of all groups, but comparing the controls, it was less in the calcium and milk groups. Major and colleagues found that after 15 weeks intake of 1200 mg/d calcium plus 400 IU/d vitamin D, there was a tendency for more beneficial changes in HDL-C in the Ca+vitamin D group.²³

Also, Reid and colleagues showed that consumption of 1 gr/d calcium supplement for 1 year led to more serum HDL-C increase in Ca group than the control group.²⁴ In contrast, Daly and Nowson reported that consumption of far-reduced calcium-vitamin D fortified milk did not have beneficial effects on HDL-C in healthy older men.²⁵ Also, Bostik and coworkers found that 1 or 2 gr/d of calcium carbonate for 6 months could not increase the HDL-c significantly.²⁶ It seems that inconsistency of the results is due to the amount of calcium or milk, length of the study and characteristics of the participants.²⁷ HDL-C reduction following energy limited diets has been shown in other studies, too. Reducing fat intake and increasing carbohydrate consumption are the main reasons of this event.²⁶

We found no beneficial effects on TG, FBS and blood pressure. It is assumed that using overweight or obese otherwise healthy subjects is the main reason of these outcomes. Despite the cohort studies such as Women's Health Study,²⁸ CARDIA,²⁹ and SUN,³⁰ which showed high calcium intake was related to less blood pressure, results of clinical trials are not consistent.^{21, 25, 26} On the other hand, the results of DASH diet on 500 subjects with normal blood pressure or mild hypertension showed that the effect of milk consumption on blood pressure reduction was more pronounced in hypertensive subjects.³¹

Related to the effect of calcium intake on FBS, the results of Thompson and colleagues³² and Major and coworkers²³ are in agreement with the findings of our study. Pittas and colleagues reported that Ca+vitamin D supplementation could improve insulin resistance in subjects with FBS>126mg/dl but not in those with FBS<126mg/dl,³³ so it is assumed that having mean FBS of 84mg/dl can be a justification for our results.

Also, we did not find any significant differences in serum TG reduction among the 3 groups, which is consistent with other studies' results.^{21, 24, 25}

Short duration and using overweight or obese otherwise healthy persons are the limitations of our study. We guess that using hypertensive, insulin resistant, hyperlipidemic subjects or patients with MetS would result in more obvious outcomes. So, it merits further studies with different participants and longer periods.

In conclusion, we found that increasing milk consumption led to more WC reduction. Milk or calcium intake caused less adverse effect on HDL-C, but it showed no effects on blood pressure, FBS, and TG. So, increasing milk or calcium intake can reduce WC among the metabolic syndrome complications.

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