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The Relationship between Dietary Calcium Intake and Serum Lipoprotein Levels and Anthropometric Measurements

Melek Oguzhan Gülmez[1], Neriman Inanc[2], Abdurrahman Oguzhan[3], Meltem Soylu[4], Gülsah Kaner[5] and Rusen Erez[6]

[1]Department of Dietetics, University of Erciyes, Yilmaz Mehmet Öztaskin Heart Hospital, 38039, Kayseri, Turkey
[2,4,5]Nuh Naci Yazgan University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Kayseri/Turkey
[3]Department of Cardiology, University of Erciyes, Yilmaz Mehmet Öztaskin Heart Hospital, 38039, Kayseri, Turkey
[6]University of Erciyes, Yilmaz Mehmet Özta°kin Heart Hospital, 38039, Kayseri, Turkey
Telephone: [1]<+905304167715>, [2]<+905324004004>, [3]<+905334185733>, [4]<+905464072717>, [5]<+905337750768>, [6]<+9005365708020>
Fax: [1]<+90 03524376327>, [2]<+90 0352 324 00 04>, [3]<+9003524376327>, [4]<+90 0352 324 00 04>, [5]<+90 0352 324 00 04>, [6]<+90 03524376327>
E-mail: [1]<meleksumer@hotmail.com>, [2]<nerimaninanc@gmail.com>, [3]<aoguzhan@erciyes.edu.tr>, [4]<msoylu@nny.edu.tr>, [5]<gkaner@nny.edu.tr>, [6]<rusenerez38@gmail.com>

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ABSTRACT This study was conducted to evaluate the association between daily calcium (Ca) consumption and serum lipid levels and some anthropometric measurements. Subjects were divided into 3 groups based on Ca consumption as Group 1 (<600 mg/d), Group 2 (600–1000 mg/d) and Group 3 (>1000 mg/d). A positive significant association was found between daily calcium consumption and body weight (BW), BMI and hip circumference (HC) of women in Group 1. BW, BMI, waist circumference (WC) and HC were negatively associated with daily Ca consumption of women in Group 3. Daily Ca consumption was correlated negatively with serum total cholesterol level in women of Group 2 whereas a significantly positive and strong association was found between Ca and HDL–C level in women of Group 3. The results of this study have shown that daily Ca consumption is of importance in protection of obesity and cardiovascular diseases, and it can be suggested that more related studies have to be conducted.

INTRODUCTION

The aim of this paper was to evaluate the relationship between daily Ca intake and serum lipid levels. High blood pressure and lipids as well as obesity are major risk factors in the development of cardiovascular diseases. Medical treatment of these conditions is expensive and the results obtained are not satisfactory. However, changes in dietary habits and increasing exercise are beneficial for almost everyone. Recent studies and public health research have emphasized the importance of adequate calcium intake through the use of fat-free and low-fat dairy products (Publication of T.C. Ministry of Health 2010; Asemi et al. 2015).

Inadequate calcium consumption has become a global problem and is associated with many medical problems such as osteoporosis, hypertension, colon and breast cancer, and kidney stones (Ward et al. 2012). Several studies have emphasized that the risk of many chronic diseases in the general population can be reduced by increasing dietary calcium intake (Asemi et al. 2015) Although up to1500 mg of calcium per day depending on age and gender has been recommended because of the many benefits of calcium on health (Vaskonen 2003), a daily intake of 800 mg of calcium is recommended by the Recommend Dietary Allowance (RDA).

Epidemiological studies investigating extraordinary increases in obesity, which is one of the major risk factors in formation of cardiovascular disease, have indicated that dietary calci-

Address for correspondence:
Dr. Neriman Inanc
Telephone: +905324004004
Fax: +90 0352 324 00 04
E-mail: nerimaninanc@gmail.com

um is inversely related to obesity (Dicker et al. 2008; Dougkas et al. 2011; Lee et al. 2014; Rozenberg et al. 2015). Body mass index (Samara et al. 2013), body weight (Eales et al. 2015), and fat mass (Tidwella et al. 2011; Eales et al. 2015) have all been affected by calcium consumption. Huang et al. (2011) reported negative associations between habitual dietary calcium intake and body composition and abdominal obesity in women. In a study evaluating the data obtained from the First National Health and Nutrition Examination Survey (NHANES 1), a significant negative correlation was found between calcium and body weight (Parikh et al. 2003). However, some studies revealed slight or no effect of calcium on body weight, body fat, and BMI (Zhang et al. 2004; Boon et al. 2005; Venti et al. 2005; Lorenzen et al. 2006; Murakami et al. 2006). A high dairy or calcium diet alone did not alter body composition or serum lipid profiles in Puerto Rican obese adults (Palacios et al. 2011). Recent meta-analysis demonstrated no significant associations between calcium supplements and body weight or body fat (Booth et al. 2015). There are studies indicating the beneficial effects of calcium on the prevention of hyperlipidemia, which is also a significant risk factor for cardiovascular diseases (Vaskonen 2003; Jacqmain et al. 2003; Lorenzen et al. 2006; Waldman et al. 2015). In several studies, calcium supplementation caused reductions in LDL cholesterol levels ranging from 4 percent to 15 percent in the in individuals with moderate hypercholesterolemia (Bostick et al. 2000; Shahhalili et al. 2001), whereas calcium supplementation had either no effect (Denke et al. 1993) or increased HDL cholesterol levels by 4.1 percent (Bell et al. 1992). Similar results were reported in a rat study by Vaskonen et al. (2002) who found dose dependent decreases in the concentrations of serum total cholesterol and triglycerides when dietary calcium was increased from 0.2 to 0.8 to 2.1 percent. These authors also determined increases in HDL cholesterol level and the ratios of HDL: total cholesterol and HDL:LDL. In a study performed by Jacqmain et al. (2003), it has been shown that plasma lipid and lipoprotein concentrations are strongly affected by calcium and that dietary calcium intake is inversely correlated to LDL-cholesterol, total cholesterol, and total cholesterol/HDL cholesterol ratio in men and women due to the lipogenesis and lipolysis balance. On the other hand, Entezari et al. (2003) reported no relation between additional elemental Ca and LDL-cholesterol and HDL-cholesterol in healthy women aged 18-30 years.

Dietary calcium may regulate body weight and fat mass through various mechanisms (Zemel et al. 2000; Gerstner 2005). However, both the mechanism and magnitude of the effect of calcium on body composition and lipid profile remain unclear (Shapses et al. 2004). This study was performed to evaluate the relationship between daily dietary calcium intake and serum lipid levels and some anthropometric measurements, which had not been investigated in our country so far.

MATERIAL AND METHOD

Experimental Design

This study is a randomized, cross-sectional study that was performed to evaluate the relationship between daily calcium intake and serum lipid levels as well as some anthropometric measurements in randomly selected subjects (100 men and 100 women) from November 2010 to April 2011.

Sample size was calculated by taking into account the data previously indicated in literature (Jacqmain et al. 2003). One hundred adult men and 100 adult women between 19 and 65 years old who did not receive vitamin/mineral-supplements or lipid-lowering medication were included in the study. Individuals were grouped concerning the calculated daily calcium intake of <600 mg/day (Group 1), 600 to 1000 mg/day (Group 2), and >1000 mg/day (Group 3) according to the data obtained from their daily food consumption. This study was approved by The Ethics Committee of Erciyes University, Faculty of Medicine (Ethics Committee Approval No: 2010/134). Written informed consent was obtained from all individual participants included in the study.

Anthropometric Measurements

Body weight, height, waist circumference, and hip circumference of the individuals were measured, and body mass index (BMI) values were calculated through dividing the weight (kg) by height (m^2) square. The height of individuals was measured while the person was standing without shoes, feet together, and head was maintained in the Frankfort Horizontal Plane position (triangle of eyes in alignment with the upper side of auricle). The body weight and height of individuals without shoes and with light clothing were measured with the weight-height scale (Nan, IB 150 models that can measure a minimum of 1000 g, a maximum of 150 kg with 50 grams sensitivity) in the morning after overnight fasting at Yilmaz Mehmet Öztaskin Heart Hospital Diet Clinic.

Waist and hip circumferences were measured while the individuals were standing, arms were open on both sides and feet were together. Waist circumference was measured with a tape measure between the iliac crest and the lowest rib (mid-point crossing circumference) when the individual exhaled. The tape measure was positioned horizontally, parallel to the floor, and measurement was carried out with attention paid to applying no pressure to the skin. Hip circumference was determined from the highest point of the side of the hip (Pekcan 2002). Waist/hip ratio was calculated from the values of waist and hip circumferences.

Food Consumption Records

Preliminary information about the amount of food and portion sizes was given to individuals one day prior to participating in the study by using the food and nutrition photograph catalog (Rakicioglu et al. 2006) and food models that had been purchased for the research project. The next day, authors used these tools during the questionnaires for the 24-hour food consumption of individuals using the backward reminder method. Daily dietary calcium intakes of individuals were determined by evaluating the food consumption data with BeBis (Nutrition Information Program-Full 7 version). Calcium content of black tea was determined as described by Nas et al. (1993).

Biochemical Measurements

Blood samples of 4 mL were collected after 12 hours of fasting for serum lipid profiles and centrifuged at 3000 rpm for 15 minutes, then the sera were kept at -70 ºC. Serum triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and Ca levels were analyzed with commercially available kits by Architect/Aeroset 16000 auto analyzer at Erciyes University, Medical Faculty Hospital, Dr. Mustafa Gündogdu Central Laboratory. Blood lipid levels were evaluated according to the classification of ATP 3 (Adult Treatment 3) (National Cholesterol Education Program 2001). VLDL cholesterol was calculated by dividing the triglycerides values by five (Güvener 2000). Reference values of the Erciyes University Medical Faculty Hospital, Dr. Mustafa Gündoggdu Central Laboratory were used for the evaluation of serum calcium levels.

Statistical Analysis of Data

Stastical Package for Social Sciences for Windows version 16.0 (SPSS Inc., Chicago, IL, USA) was used for statistical evaluation of the data. The distribution of the quantitative data was defined as X±SE. Differences between groups were analyzed by one-way ANOVA. When the differences determined Scheffe' test was used. Correlation was evaluated by the Pearson's correlation analysis. The distribution of qualitative data was defined as percentage, and the differences between the groups were analyzed by the chi-square test. The significance was set at $p<0.05$.

RESULTS

Sixty-three percent of the women and 61.0 percent of the men were between 19-30 years of age and 37.0 percent of the women and 39.0 percent of the men were 31-50 years old. In Group 1, the percentage of the participants aged 19-30 years (60.4 % of women and 60.6 % of the men) was higher than the other groups. In Group 2, 33.3 percent of the individuals were women and 36.1 percent were men, whereas in Group 3, the percentage of the women was 6.3 and the percentage of the men was 3.3. There were no statistically significant differences between the groups concerning the age distribution of women and men ($p> 0.05$) (Table 1).

There were no statistically significant differences between groups concerning the mean values of anthropometric measurements in women or men ($p>0.05$) (Table 2). A significant positive relationship between daily calcium intake and body weight ($r = 0.313$, $p \leq 0.01$), BMI ($r = 0.285$, $p <0.05$), and hip circumference ($r = 0.271$, $p <0.05$) was determined in the women in Group 1. There was no significant relationship between women's daily calcium intake and any anthro-

Table 1: Socio-demographic features of women and men with low, moderate and high calcium intake

Age (year)		*Group 1 (<600 mg Ca)*		*Group 2 (600-1000 mg Ca)*		*Group 3 (>1000 mg Ca)*		*Total*	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Women	19-30	38	60.4	21	33.3	4	6.3	63	100.0
	31-50	21	56.8	15	40.5	1	2.7	37	100.0
				χ^2=1.0, p=0.60					
Men	19-30	37	60.6	22	36.1	2	3.3	61	100.0
	31-50	26	66.6	12	30.8	1	2.6	39	100.0
				χ^2=0.3, p=0.83					

pometric measurements in Group 2. A significant negative correlation was determined between daily calcium intake and body weight (r = -0.891, p <0.05), BMI (r = -0.875, p≤0.05), waist circumference (r = -0.934, p ≤0.05) and hip circumference (r = -0.997, p≤0.01) in the women in Group 3. No significant relationship was determined between daily calcium consumption and anthropometric measurements in men in all groups (p> 0.05) (Table 3).

According to the ATP III cholesterol classification and diagnostic criteria of hyperlipidemia, 1.0 percent of the women and 14.0 percent of the men were found to be hypertriglyceridemic (>200 mg/dL). Hypercholesterolemia (>200 mg/dL) in men (15.0 percent) was higher than in women

Table 4: Distribution of serum lipids and Ca levels of individuals according to ATP III Cholesterol Classification and Hyperlipidemia Diagnostic Criteria

Serum lipids (mg/dL)		*Group 1 (<600 mg Ca)*		*Group 2 (600-1000 mg Ca)*		*Group 3 (>1000 mg Ca)*		*Total*	
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Triglycerides									
Women	< 150	54	58.7	33	35.9	5	5.4	92	100.0
	150-199.9	4	57.1	3	42.9	-	-	7	100.0
	200–499.9	1	100.0	-	-	-	-	1	100.0
	≥ 500	-	-	-	-	-	-	-	-
				÷^{2}=1.1, p =0.88					
Men	< 150	42	61.8	23	33.8	3	4.4	68	100.0
	150-199.9	12	66.7	6	33.3	-	-	18	100.0
	200–499.9	7	58.3	5	41.7	-	-	12	100.0
	≥ 500	2	100.0	-	-	-	-	2	100.0
				÷^{2}=2.8, p =0.82					
Total Cholesterol									
Women	< 200	55	58.5	34	36.2	5	5.3	94	100.0
	200-239	3	75.0	1	25.0	-	-	4	100.0
	≥ 240	1	50.0	1	50.0	-	-	2	100.0
				÷^{2}=0.7, p =0.94					
Men	< 200	51	60.0	31	36.5	3	3.5	85	100.0
	200-239	9	75.0	3	25.0	-	-	12	100.0
	≥ 240	3	100.0	-	-	-	-	3	100.0
				÷ ^{2}=3.0, p =0.55					
HDL- C									
Women	< 40	11	57.9	8	42.1	-	-	19	100.0
	40-59.9	36	60.0	20	33.3	4	6.7	60	100.0
	≥ 60	12	57.1	8	38.1	1	4.8	21	100.0
				÷ ^{2}=1.6, p =0.79					
Men	< 40	31	57.4	20	37.0	3	5.6	54	100.0
	40-59.9	31	70.5	13	29.5	-	-	44	100.0
	≥ 60	1	50.0	1	50.0	-	-	2	100.0
				÷ ^{2}=3.8, p =0.43					

Table 2: Anthropometric measurements of women and men with low, moderate and high calcium intake

Anthropometric measurements	*Women*				*Men*			
	Group 1 (<600 mg Ca)	*Group 2 (600-1000 mg Ca)*	*Group 3 (>1000 mg Ca)*	*p*	*Group 1 (<600 mg Ca)*	*Group 2 (600-1000 mg Ca)*	*Group 3 (>1000 mg Ca)*	*p*
	n=59	*n=36*	*n=5*		*n=63*	*n=34*	*n=3*	
	X±S	*X*±S	*X*±S		*X*±S	*X*±S	*X*±S	
Height (cm)	160.4± 5.5	159.5± 7.4	165.6± 5.5	0.13	173.9± 6.8	173.8± 7.4	176.6± 8.6	0.80
Body weight (kg)	63.7± 13.7	62.5± 9.4	68.6± 18.2	0.59	79.3± 17.2	77.7± 11.6	76.6± 4.1	0.86
BMI (kg/m²)	24.7± 4.5	24.6± 4.0	24.8± 5.8	0.99	26.1± 4.9	25.7± 3.6	24.6± 2.9	0.80
Waist circumference (cm)	76.6± 10.8	76.0± 9.3	76.0± 11.4	0.96	89.3± 12.8	89.7± 9.0	86.3± 0.5	0.88
Hip circumference (cm)	97.8± 9.4	97.9± 7.4	103.6± 10.0	0.36	99.5± 8.9	100.5± 7.0	110.0± 2.6	0.85
Waist/Hip Ratio	0.780± 0.06	0.775± 0.07	0.730± 0.05	0.26	0.895± 0.05	0.891± 0.04	0.863± 0.02	0.57

Table 3: Relationship between daily calcium intake and some anthropometric measurements of women and men

Anthropometric measurements	*Women*						*Men*					
	Group 1 (<600 mg Ca)		*Group 2 (600-1000 mg Ca)*		*Group 3 (>1000 mg Ca)*		*Group 1 (<600 mg Ca)*		*Group 2 (600-1000 mg Ca)*		*Group 3 (>1000 mg Ca)*	
	n=59		*n=36*		*n=5*		*n=63*		*n=34*		*n=3*	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Height (cm)	0.184	0.16	0.280	0.09	-0.488	0.40	-0.014	0.91	-0.071	0.69	0.042	0.97
Body weight (kg)	0.313	0.01	0.106	0.53	-0.891	0.04	0.035	0.78	0.165	0.35	0.993	0.07
BMI (kg/m²)	0.285	0.02	-0.026	0.88	-0.875	0.05	0.041	0.74	0.231	0.8	0.465	0.69
Waist circumference (cm)	0.221	0.09	-0.168	0.32	-0.934	0.02	0.017	0.89	0.113	0.52	-0.992	0.08
Hip circumference (cm)	0.271	0.03	0.045	0.79	-0.997	0.01	-0.045	0.72	0.129	0.46	-0.444	0.70
Waist/Hip Ratio	0.071	0.59	-0.268	0.11	-0.602	0.28	0.085	0.50	0.058	0.74	0.218	0.86

Table 5: Serum lipid and calcium concentrations of women and men with low, moderate and high calcium intake

Serum lipids (mg/dL)	Women				Men			
	Group 1 (<600 mg Ca)	Group 2 (600-1000 mg Ca)	Group 3 (>1000 mg Ca)	p	Group 1 (<600 mg Ca)	Group 2 (600-1000 mg Ca)	Group 3 (>1000 mg Ca)	p
	n=59	n=36	n=5		n=63	n=34	n=3	
	$\overline{X}$±S	$\overline{X}$±S	$\overline{X}$±S		$\overline{X}$±S	$\overline{X}$±S	$\overline{X}$±S	
Triglycerides	77.0± 39.8	80.9± 41.0	64.6± 22.8	0.67	145.8±103.2	128.0± 72.4	73.3± 17.0	0.32
Total Cholesterol	156.2± 28.6	165.0± 26.6	161.2± 10.6	0.31	175.6± 39.7	158.8± 26.1	145.6± 17.2	0.04
HDL –C	51.8± 11.6	50.7± 10.7	53.2± 7.0	0.85	40.8± 8.5	39.8± 8.7	37.3± 1.1	0.70
LDL –C	89.0± 25.0	98.0± 22.7	95.0± 10.8	0.20	105.3± 27.3	93.4± 21.4	93.7± 15.9	0.08
VLDL –C	15.6± 8.2	16.2± 8.1	12.9± 4.5	0.68	29.1± 20.6	25.6± 14.4	14.6± 3.4	0.32
Serum Ca (mg/dL)	9.761± 0.88	9.907± 0.77	9.808± 1.07	0.72	9.975± 0.76	9.929± 0.65	9.813± 0.20	0.90

Table 6: Relationship between daily calcium intake and serum lipids and calcium of women and men

Serum lipids (mg / dL)	Women						Men					
	Group 1 (<600 mg Ca)		Group 2 (600-1000 mg Ca)		Group 3 (>1000 mg Ca)		Group 1 (<600 mg Ca)		Group 2 (600-1000 mg Ca)		Group 3 (>1000 mg Ca)	
	n=59		n=36		n=5		n=63		n=34		n=3	
	r	p	r	p	r	p	r	p	r	p	r	p
Triglycerides	0.068	0.60	-0.280	0.09	-0.512	0.37	-0.052	0.68	0.176	0.32	0.414	0.72
Total Cholesterol	0.171	0.19	-0.333	0.04	0.337	0.57	0.030	0.81	0.279	0.11	-0.844	0.36
HDL –C	-0.022	0.86	0.049	0.77	0.956	0.01	0.172	0.17	-0.132	0.45	-0.814	0.39
LDL –C	0.186	0.15	-0.311	0.06	-0.073	0.90	0.050	0.69	0.276	0.11	-0.940	0.22
VLDL -C	0.071	0.59	-0.285	0.09	-0.512	0.37	-0.052	0.68	0.176	0.32	0.414	0.72
Serum Ca (mg/dL)	0.055	0.67	0.322	0.05	0.156	0.80	0.274	0.03	-0.154	0.38	0.933	0.23

(6.0 percent). The percentage of men having low HDL levels (<40 mg/dL) was higher (54.0 percent) than women (19.0 percent). Only one man (1.0 percent) in Group 1 had excessive (≥190 mg/dL) LDL-C level whereas there were no women with excessive LDL-cholesterol in any groups (Table 4). In both women and men, serum triglycerides were slightly lower in the moderate and high calcium groups (p>0.05). Total cholesterol levels were significantly lower in moderate and high calcium consuming men (p< 0.05) whereas no difference was observed in women (Table 5). No significant differences were determined between the groups regarding the serum concentrations of Ca, HDL-C, LDL-C and VLDL-C in men and women (Table 5). There were a negative correlation between dietary Ca and total cholesterol levels (r=-0.333, p<0.05) of women in group 2 and a positive correlation between Ca intake and serum Ca levels of women in group 2 and of men in group 1 (p<0.05) (Table 6).

DISCUSSION

According to the STANISLAS study, higher dietary calcium consumption was associated with a lower 5-year increase of the BMI and waist circumference (Samara et al. 2013). Heaney et al. (2003) reported that the women who had consumed the recommended levels of calcium gained 400 grams less weight per year. The weight, height, body fat and the amount of daily calcium consumption of 110 girls consuming moderate (1000-1304 mg/day) and low levels (<713 mg/day) of Ca were measured before and after supplementation of 500 mg of Ca daily in a study by Lorenzen et al. (2006). These authors observed a significant negative correlation between calcium intake and body fat at the beginning of their study whereas they detected no influence of calcium on height, body weight and body fat percentage. They suggested that calcium may exert its effect when consumed as the part of the diet, and the effects of calcium may be due to some component of dairy products (Lorenzen et al. 2006). Some other studies have also shown no effects of additional calcium on body composition (Palacios et al. 2011; Booth et al. 2015).

In another study in American Indian adults, lack of significant association between calcium intake and body weight, body fat mass and BMI was attributed to the consumption of high fat and energy diets (Venti et al. 2005). On the other hand, a significant reduction in body fat of obese African American men was determined by increasing calcium intake from 400 mg/day to 1000 mg/day for 12 months (Zemel et al. 2000). In a later study, Zemel et al. (2004) also determined significant weight loss and decreased fat mass in obese adults consuming an energy-restricted diet that had 800 mg of additional Ca, and they claimed that an energy-restricted diet may facilitate beneficial effects of calcium on energy balance. The present paper examines the relationship between daily calcium consumption and anthropometric measurements. A significant positive association was determined between dietary calcium intake and anthropometric measurements except waist circumference and waist/hip ratio of women in low calcium group. On the other hand, a significant inverse relation concerning body weight, BMI, waist and hip circumferences (p<0.05) were found in high calcium group indicating that lower body weight is associated with higher calcium intake. These findings are consistent with the previous studies indicating an inverse correlation between calcium intake and body fat (Dicker et al. 2008; Heiss et al. 2008; Tidwella et al. 2011). Jacqmain et al. (2003) found greater body weight, BMI, fat percentage, fat mass, waist circumference and abdominal adipose tissue area in women whose daily calcium intake was lower than 600 mg.

Abdominal obesity is highly associated with dyslipidemia. The waist/hip ratio, an indicator of abdominal obesity, is also a clear marker of cardiovascular disease (Grasso 2010). A study conducted in Australia investigated the relationship between dietary calcium and obesity in male and female adults with 18.5 BMI who consumed low (<600 mg/day), moderate (600-1000 mg/day) and high (>1000 mg/day) Ca in diet. Total dairy food intake was inversely associated with the likelihood of global and abdominal obesity (waist circumference >102 cm for men and >88 cm for women). In contrast, Booth et al. (2015) found no association between supplementation of calcium and body weight or body fat. In the present study, a slight decline was determined only in waist/hip ratio with the increasing calcium intake in women. Also in men, a slight but not statistically significant decrease was observed in BMI, waist circumference and waist/hip ratio with high Ca intake (Table 2). However, determination of inverse associations between high calcium greater than 1000 mg/day and body weight, BMI, waist and hip circumferences in women and lack of any correlation in antropometric measurements of men (Table 3) were consistent with the results of the other studies (Dicker et al. 2008; Huang et al. 2011). In our study, observations of the reductions in waist and hip circumferences with the increased Ca intake in women may lead to the development of new strategies for healthy nutrition and for prevention of cardiovascular disease in our country.

In this study, seven percent of the women and three percent of the men were grade 1 obese and 3 percent of the women and men were grade 2. Although statistically insignificant, the ratio of obese women with grade 1 obesity (85.7%) was higher in the low-calcium consumed group, and there were no women with grade 2 obesity in high calcium consumed group. In men, all of the individuals with grade 2 obesity were found in the low-calcium group ($p>0.05$). This study's results were supported by a one-year food consumption survey performed in America by the Ministry of Agriculture. This survey revealed the highest obesity prevalence in black Hispanics on a low (592 mg/day) calcium diet (Xue et al. 2001). Similarly, the HERITAGE family study evaluating the relationship between obesity/abdominal obesity and calcium intake of 362 men and 462 women, demonstrated that calcium has anti-obesity effect in both genders in black and white people, but the effect was more pronounced in black men and white women (Loos et al. 2004).

The triglycerides level of $\leq$150 mg/dL is considered as normal according to ATP III classification and hyperlipidemia diagnostic criteria in both men and women (National Cholesterol Education Program 2001). In this study, mean triglycerides concentrations ranged from 64.6 ± 22.8 to 77.8 ± 39.8 mg/dL in women and from 73.3 ± 17.0 to 145.8 ± 103.2 mg/dL in men, which is lower than the level accepted as normal. Although not significant, the highest level of serum triglycerides was determined in men consuming low calcium (Table 5) whereas the highest serum triglycerides concentration was found in women consuming moderate level of Ca (600-1000 mg/day). Total cholesterol levels were lower in moderate and high calcium consumed men ($p<0.05$) whereas no difference was observed in women (Table 5). When the total cholesterol level of >200 mg/dL is considered as hypercholesterolemia according to the ATP III cholesterol classification (National Cholesterol Education Program 2001), the prevalence of hypercholesterolemia in the adult age group in our country is approximately 1/4 (Mahley et al. 1995). In this study, 6 percent of women and 15 percent of the men were found to be hypercholesterolemic (Table 4) according to the ATP III cholesterol classification and diagnostic criteria for hyperlipidemia.

The HDL-cholesterol levels were significantly lower in approximately half of the Turkish coronary disease patients when compared to European mean levels, according to results for Turkey from EUROASPIRE III: Survey on the Lifestyle, Risk Factors and Use of Cardio protective Drug Therapies in Coronary Patients From 22 European Countries (Tokgözoglu et al. 2010), the first Turkish heart disease study (Mahley et al. 1995). However, Turkey is third after Romania and Cyprus among 22 European countries concerning low HDL-cholesterol (Tokgözoglu et al. 2010). In this study, although not statistically significant, the highest HDL-cholesterol level (53.2 ± 7.0 mg/dL) in women was found in the high calcium group. In men, the highest HDL cholesterol (40.8 ± 8.5 mg/dL), which was also insignificant ($p>0.05$), was observed in the low calcium group (Table 5). HDL-cholesterol levels were lower than 40 mg/dL in 57.9 percent of women and 57.4 percent of men who consumed low levels of calcium, but this finding was not statistically significant (Table 3). The HDL cholesterol levels determined in the present study were consistent with the study of Kozan et al. (2007), who reported HDL-cholesterol levels as 46.3 mg/dL in men and 52 mg/dL in women. The HDL cholesterol levels in Turkish population were reported as 38.3 mg/dL in men and 45.5 mg/dL in women by Abaci (2011), who showed that low HDL cholesterol level is associated with smoking, physical inactivity, insulin and CRP levels, and waist circumference rather than a genetic predisposition. In the present study, although not statistically significant, the highest LDL-cholesterol level (105.3 ± 27.3 mg/dL) was determined in men receiving low calcium. On the other hand, women who consumed 600-1000 mg/kg calcium showed the highest levels of LDL-cholesterol (98.0 ± 22.7) (Table 5). When the association between serum lipids and dietary calcium was evaluated, an inverse relation was determined between dietary calcium and total cholesterol ($p<0.05$) in women whose calcium intake was between 600-1000 mg/day while a positive correlation was observed between Ca intake and HDL cholesterol levels ($p \leq 0.01$) in the women receiving >1000 mg Ca daily. A slight but not significant inverse correlation was observed between dietary calcium consumption and LDL cholesterol concentrations of women receiving over than 600 mg Ca/day (Table 6). These findings confirm the results of Jacqmain et al. (2003) who reported that total cholesterol, LDL cholesterol, and total cholesterol: HDL cholesterol ratio is negatively associated with increased calcium intake after adjustment of some co-variations in men and women. On the other hand, in the present study, no significant relation was observed between the dietary calcium and serum concentrations of total, HDL, LDL and VLDL cholesterols in men (Table 6). The influence of dietary calcium on either anthropometric measurements or serum lipid profiles is more pronounced in women as in the study of Jacqmain et al. (2003). Entezari et al. (2003) also reported no relation between additional 1000 mg elemental Ca (625 mg calcium carbonate) and LDL-cholesterol, HDL-cholesterol and Apo A1 in 53 healthy women aged 18-30. However, the additional calcium reduced concentration of Apo B but increased Apo A1: Apo B ratio and triglyceride levels. This finding may indicate the influence of calcium on lipolysis and lipogenesis (Jacqmain et al. 2003), and calcium supplementation may exert its beneficial effects when the calcium intake is lower than the requirements (Entezar et al. 2003).

Precipitation of dietary calcium and phosphate results in the formation of insoluble amorphous calcium phosphate (ACP) compounds in the intestine. The positively charged calcium ions in the ACP are thought to bind to the negatively charged carboxyl moiety of unconjugated bile acids that increases the conversion of cholesterol to bile acids in the liver. These compounds are taken from the enterohepatic circulation and excreted in the feces. Calcium can also form insoluble soaps with fatty acids in the intestine that prevent the absorption of dietary fat. Decreased absorption of saturated fatty acids results in a decline in serum cholesterol, and may cause an increase in LDL uptake by the liver thus diminishing the LDL in serum (Vaskonen 2003; Vaskonen et al. 2002; Ditscheid et al. 2005).

Elevation of serum Ca levels is effective in the emergence of severe coronary risk factors such as hypertension, hyperlipidemia, obesity, diabetes and hyperinsulinemia (Lind et al. 1997; Jorde et al. 1999). In a study conducted on 2183 male patients for 18 years, serum calcium was found to be an independent risk factor for myocardial infarction (Lind et al. 1997). In this study, a significant positive relation ($p<0.05$) was found between daily Ca consumption and serum Ca level in women consuming 600-1000 mg Ca and in men consuming less than 600 mg Ca (Table 6). This difference may result from parathyroid hormone activity and different mechanisms in hormonal pathways relating to gender.

The results of the present study have shown that a high calcium diet reduces body weight, abdominal obesity and serum cholesterol especially in women. This study has also shown the need to develop new strategies for healthy nutrition and for prevention of cardiovascular disease in Turkey.

CONCLUSION

The results of the presented study have shown that high calcium diet reduces body weight, abdominal obesity and serum cholesterol especially in women.

RECOMMENDATIONS

This study has also showed the need to develop the new strategies for healthy nutrition and for prevention of cardiovascular disease in Turkey.

LIMITATIONS OF THE STUDY

Because the food consumptions were recorded by the researchers with face to face interviews, it is thought that daily calcium intake might be affected due to the exaggerated or missing information given by the participants.

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