Calcium from dairy products, vitamin D intake, and blood pressure: the Tromsø study[1–3]

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ABSTRACT
Background: The present epidemiologic study was conducted in Tromsø, Northern Norway, in 1994–1995.
Objective: The objective was to evaluate the relation between calcium intake from dairy products and the intake of vitamin D on systolic and diastolic blood pressure.
Design: Subjects who were taking drugs for hypertension or heart disease, those taking calcium tablets, subjects reporting cardiovascular disease, and pregnant women were excluded, leaving 7543 men and 8053 women aged 25–69 y for analysis. Calcium and vitamin D intakes were calculated from a food-frequency questionnaire.
Results: After correction for age, body mass index, alcohol and coffee consumption, physical activity, cigarette smoking, and vitamin D intake, there was a significant linear decrease in systolic and diastolic blood pressure with increasing dairy calcium intake in both sexes ($P < 0.05$). However, the difference in blood pressure between subjects with the highest and those with the lowest calcium intake was ≤1–3 mm Hg. Similarly, with increasing blood pressure there was a significant ($P < 0.001$) linear decrease in age-adjusted calcium intake from dairy sources; the difference between the highest and the lowest blood pressure groups was 3–10%. Vitamin D intake had no significant effect on blood pressure.
Conclusions: There is a negative association between calcium intake from dairy products and blood pressure. However, although the effect of calcium on blood pressure appears to be small, calcium could have a significant effect on primary prevention of cardiovascular diseases. *Am J Clin Nutr* 2000;71:1530–5.

KEY WORDS Calcium intake, vitamin D intake, systolic blood pressure, diastolic blood pressure, hypertension, milk intake, Norway

INTRODUCTION

There has been considerable interest in the role of dietary factors in hypertension (1). In several (2–4), but not all (5), epidemiologic studies, hypertensive subjects had a lower calcium intake, particularly from milk and other dairy products, than did nonhypertensive subjects (6–9). In agreement with this, calcium supplementation has been reported to lower blood pressure (10). Thus, an adequate calcium intake to prevent not only osteoporosis but also hypertension has been advocated (11).

In a health survey in Tromsø during 1994 and 1995, >27 000 subjects were examined. The primary focus was on cardiovascular risk factors but subjects were also asked about consumption of milk, cheese, and yogurt, which are the main calcium sources in the Norwegian diet (12). The purpose of the present study was therefore to use this database to evaluate possible relations between intake of calcium from dairy sources and blood pressure. Because the absorption of calcium is highly dependent on vitamin D status (13), intake of vitamin D was also included in the analyses.

SUBJECTS AND METHODS

Subjects

In 1994–1995 all men and women aged >24 y who were living in the municipality of Tromsø, in the northern part of Norway, were invited to participate in a health survey carried out by the National Health Screening Service in cooperation with the University of Tromsø and local health authorities. This health survey was the fourth since 1974 and was conducted similarly to the previous ones (14). The study was approved by the Regional Committee for Medical Research Ethics, Health Region V, and all subjects gave their written, informed consent to participate.

Questionnaires

The letter of invitation to participate in the study contained questions on cardiovascular diseases; number of cigarettes smoked daily; number of cups of coffee drunk daily; number of hours of moderate and hard weekly physical activity; number of glasses of beer, wine, and spirits (eg, vodka) drunk per 2 wk; and whether the subjects put butter on their bread. The participants brought the completed questionnaires with them to the examination, where the responses were checked for logistics. A physical

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TABLE 1
Calcium and vitamin D contents in foods and calcium and vitamin D intakes from each food

	Calcium content	Vitamin D content[1]	Calcium intake[2]		Vitamin D intake[2]	
			Men	Women	Men	Women
	mg/g	*ng/g*	*mg/d*		*μg/d*	
Milk[3]	1.0	0.5	402.1 ± 270.8	269.7 ± 206.3	0.1 ± 0.1	0.0 ± 0.1
Yogurt	1.1	0.5	12.5 ± 20.5	15.2 ± 23.0	0.0 ± 0.0	0.0 ± 0.0
Cheese	5–7.5	1.5	149.2 ± 117.1	159.5 ± 103.5	0.0 ± 0.0	0.0 ± 0.0
Butter	—	80	—	—	1.8 ± 1.2	1.3 ± 0.9
Cod liver oil	—	2160	—	—	2.6 ± 3.6	2.5 ± 3.6
Vitamin D tablets[4]	—	100	—	—	0.3 ± 1.4	0.3 ± 1.6
Fatty fish topping	—	100	—	—	0.7 ± 1.1	0.5 ± 0.8
Fatty fish dinner	—	75	—	—	1.1 ± 1.2	1.0 ± 1.1
Egg	—	16	—	—	0.2 ± 0.1	0.1 ± 0.1
Total	—	—	563.8 ± 305.0[5]	444.4 ± 236.0	6.8 ± 4.7[5]	5.8 ± 4.6

[1] To convert to IU, multiply by 0.04.
[2] $\bar{x}$ ± SD; n = 7543 men, 8053 women.
[3] 100 g whole milk, light milk, or nonfat milk contains 0.05, 0.02, or 0 μg vitamin D and 3.9, 1.5, or 0.1 g fat, respectively.
[4] Per tablet.
[5] Significantly different from women, $P < 0.01$.

activity score was calculated by adding the hours of moderate and hard physical activity together (giving the hours with hard activity double weight). An alcohol intake score was calculated by adding together the number of glasses of beer, wine, and spirits (assuming an equal amount of alcohol in one glass of each type).

A second questionnaire that included questions about medical history, pregnancy, past and present medication use, and dietary habits was filled out by the subjects at home and returned by mail. For subjects aged <70 y, the questionnaire on dietary habits included questions on the type of milk and number of glasses drunk daily, the number of slices of bread eaten daily and how many of these slices had a topping containing fatty fish (eg, mackerel or sardines) or different types of cheese, how many times weekly yogurt and egg (boiled or fried) were eaten, and how many times weekly fatty fish (eg, salmon) was eaten for dinner. Furthermore, the subjects were asked about their daily use of calcium and vitamin D tablets and cod liver oil supplementation.

Each portion of butter the subjects put on their bread was assumed to be 6 g, each glass of milk was assumed to be 150 mL, each topping with cheese was 10 g, each topping with fatty fish was 20 g, each portion of yogurt was 100 mL, each egg was 60 g, and the amount of fatty fish in a dinner portion was 200 g. These portions are usual Norwegian servings (15). Each tablet of vitamin D was assumed to contain 10 μg vitamin D and each portion of cod liver oil supplementation was assumed to be 10 mL. On the basis of a Norwegian food table (16), the daily intake of calcium from dairy products and daily intake of vitamin D were calculated (**Table 1**). Unless otherwise specified, "calcium intake" throughout this article refers to intake from dairy sources.

Measurements

The subjects were not asked to fast. Height and weight were measured while the subjects wore light clothing and no shoes. Body mass index (BMI; in kg/m^2) was calculated. Blood pressure was measured as described in detail previously (14) with an automatic device (Dinamap Vital Signs Monitor 1846; Critikon Inc, Tampa, FL). In brief, the subjects were seated for 2 min. Three recordings were made at 2-min intervals, and the lowest value was used.

Statistical analyses

To enable main effects and interactions to be identified, the data were evaluated initially with a 3-factor analysis of variance (ANOVA) with sex, calcium intake, and vitamin D intake as fixed factors; systolic and diastolic blood pressure as dependent variables; and age, BMI, alcohol and coffee consumption, physical activity, and number of cigarettes smoked daily as independent variables. Associations were evaluated with Pearson correlation coefficients. Differences between men and women were evaluated with ANOVA. Linear trends were evaluated with linear regression. Comparisons of calcium intakes between subjects with and without hypertension were done with multiple linear regression, with calcium intake as a dependent variable; systolic or diastolic hypertension as fixed factor; and age, BMI, alcohol and coffee consumption, physical activity, number of cigarettes smoked daily, and daily intake of vitamin D as independent variables. Systolic hypertension was defined as systolic blood pressure ≥160 mm Hg, and diastolic hypertension was defined as diastolic blood pressure ≥100 mm Hg. All tests were done two-sided, and the Bonferroni correction was used as a post hoc test. Significance was set at $P < 0.05$. The data were analyzed with SPSS for WINDOWS, version 8.0 (SPSS Inc, Chicago).

RESULTS

Subjects

A total of 12 866 men and 14 293 women were examined, corresponding to 74.2% and 79.0%, respectively, of the eligible population. Because only subjects aged <70 y (a total of 24 168 subjects) received the complete diet questionnaire, this study was restricted to those below that age. Because our focus was on calcium intake from dairy sources, subjects who were taking calcium supplements were excluded, as were those taking antihypertensive drugs or drugs for heart disease; those who reported in the health questionnaire that they had had a myocardial infarction, angina, or

TABLE 2
Age, BMI, coffee and alcohol consumption, physical activity, smoking, vitamin D intake, and calcium intake from dairy sources in men and women and Pearson correlation coefficients between these variables and blood pressure (BP)

			Correlation coefficients			
			Systolic BP		Diastolic BP	
	Men	Women	Men	Women	Men	Women
Age (y)	41.9 ± 10.7[1]	41.7 ± 10.8	0.216[2]	0.412[2]	0.412[2]	0.369[2]
BMI (kg/m^2)	25.4 ± 3.2[3]	24.3 ± 4.0	0.236[2]	0.357[2]	0.248[2]	0.288[2]
Coffee (cups/d)	6.0 ± 4.3[3]	4.7 ± 3.4	−0.015	0.038[2]	0.043[2]	0.080[2]
Alcohol (units/14 d)	6.5 ± 7.7[3]	3.1 ± 4.2	0.042[2]	−0.052[2]	0.064[2]	−0.027[4]
Physical acitivity (h/wk)	4.5 ± 2.6[3]	3.9 ± 2.4	−0.014	−0.110[2]	−0.105[2]	−0.092[2]
Smoking (cigarettes/d)	3.0 ± 4.9[3]	2.7 ± 4.1	−0.023[4]	−0.054[2]	−0.009	−0.004
Vitamin D intake (μg/d)[5]	6.8 ± 4.7[3]	5.9 ± 4.6	0.012	0.026[4]	0.023[4]	0.015
Calcium intake (mg/d)	563.8 ± 305.0[3]	444.4 ± 236.0	−0.002	−0.006	−0.061[2]	−0.031[2]
Systolic BP (mm Hg)	130.8 ± 13.9[3]	122.4 ± 15.9	—	—	—	—
Diastolic BP (mm Hg)	75.6 ± 10.8[3]	71.5 ± 10.8	—	—	—	—

[1] $\bar{x}$ ± SD; n = 7543 men, 8053 women.
[2] $P < 0.01$.
[3] Significantly different from women, $P < 0.01$.
[4] $P < 0.05$.
[5] To convert to IU, multiply by 40.

stroke; and pregnant women. Of the remaining 21 388 subjects, 15 596 answered all the questions in the diet questionnaire. Thus, 7543 men and 8053 women were included in the analyses.

Main effects and interactions

The 3-factor ANOVA showed that the subject's sex had a significant effect on systolic and diastolic blood pressure ($P < 0.001$), whereas calcium intake had a significant effect only on diastolic blood pressure ($P < 0.02$). Intake of vitamin D had no significant effects on blood pressure. There were no significant 2- or 3-way interactions on blood pressure between the 3 fixed factors.

Effect of sex and age

Compared with women, men had significantly higher blood pressure; had higher intakes of calcium, vitamin D, coffee, and alcohol; were more physically active; and smoked more cigarettes (Table 1 and **Table 2**). There was a significant linear increase in blood pressure and vitamin D intake with age in both sexes. There was a significant decrease in calcium intake with age in men. This was also seen in the women aged <50 y (**Table 3**).

Effects of calcium intake on blood pressure

Although there was no significant interaction between sex and intake of calcium on blood pressure, the data are presented separately for men and women because of the large differences between the sexes in blood pressure and the other variables. Thus, in both sexes there was a weak negative correlation between calcium intake and blood pressure, but this was significant only for diastolic blood pressure (Table 2). When calcium intake was grouped into increments of 200 mg/d, no significant decrease in unadjusted systolic blood pressure was seen with increasing calcium intake (**Table 4**). However, after systolic blood pressure was adjusted for age and for the other variables, there was a significant linear decrease in both sexes (Table 4). For adjusted and

TABLE 3
Systolic and diastolic blood pressure (BP), calcium intake from dairy products, and vitamin D intake in relation to age and sex in the study population[1]

Sex and age (y)	Systolic BP	Diastolic BP	Calcium intake	Vitamin D intake[2]
	mm Hg	*mm Hg*	*mg/d*	*μg/d*
Men				
25–29 (n = 1016)	129.2 ± 11.6	68.6 ± 9.2	639.9 ± 319.7	6.0 ± 4.5
30–39 (n = 2432)	128.7 ± 11.3	72.5 ± 9.3	585.8 ± 319.5	6.4 ± 4.4
40–49 (n = 2233)	129.6 ± 12.8	77.5 ± 10.1	545.3 ± 289.3	7.0 ± 4.7
50–59 (n = 1306)	133.4 ± 15.7	80.6 ± 10.3	519.6 ± 288.3	7.2 ± 4.9
60–69 (n = 556)	141.7 ± 20.7	83.1 ± 12.0	506.9 ± 275.3	7.8 ± 5.2
P for linear trend	<0.001	<0.001	<0.001	<0.001
Women				
25–29 (n = 1141)	117.2 ± 10.5	66.3 ± 8.5	471.9 ± 265.9	5.0 ± 4.2
30–39 (n = 2660)	117.6 ± 11.1	68.6 ± 9.1	447.2 ± 235.0	5.5 ± 4.3
40–49 (n = 2343)	121.2 ± 14.2	72.3 ± 10.2	432.1 ± 231.7	5.9 ± 4.6
50–59 (n = 1292)	130.4 ± 18.5	76.7 ± 11.5	434.2 ± 226.9	6.7 ± 4.9
60–69 (n = 617)	140.9 ± 20.9	79.1 ± 12.2	449.3 ± 211.3	6.9 ± 5.2
P for linear trend	<0.001	<0.001	NS	<0.001

[1] $\bar{x}$ ± SD.
[2] To convert to IU, multiply by 40.

TABLE 4
Unadjusted and adjusted systolic and diastolic blood pressure (BP) in relation to sex and calcium intake from dairy products

Sex and calcium intake (mg/d)	Systolic BP		Diastolic BP	
	Unadjusted[1]	Adjusted[2]	Unadjusted[1]	Adjusted[2]
	mm Hg			
Men				
0–199 (*n* = 575)	131.0 ± 14.4	132.1 (131.9)	77.0 ± 10.8	76.1 (76.1)
200–399 (*n* = 1982)	130.9 ± 14.3	131.9 (131.7)	76.2 ± 10.9	76.0 (75.9)
400–599 (*n* = 1842)	130.8 ± 14.6	131.9 (131.8)	75.7 ± 11.0	76.0 (75.8)
600–799 (*n* = 1703)	130.5 ± 12.9	131.2 (131.0)	75.4 ± 10.6	75.5 (75.3)
800–999 (*n* = 786)	130.7 ± 14.0	130.5 (130.6)	74.6 ± 11.0	75.0 (75.1)
≥1000 (*n* = 655)	130.8 ± 12.9	130.1 (130.3)	74.1 ± 10.6	74.8 (74.9)
P for linear trend	NS	<0.001 (<0.001)	<0.001	<0.001 (<0.001)
Women				
0–199 (*n* = 918)	122.2 ± 16.0	123.4 (123.3)	72.0 ± 10.7	71.6 (71.6)
200–399 (*n* = 2963)	122.3 ± 15.9	122.8 (122.6)	71.5 ± 10.8	71.3 (71.3)
400–599 (*n* = 2333)	122.9 ± 16.2	123.8 (123.4)	71.6 ± 10.9	71.7 (71.5)
600–799 (*n* = 1261)	122.4 ± 15.2	122.6 (122.4)	71.1 ± 10.6	71.2 (71.1)
800–999 (*n* = 382)	122.2 ± 14.7	122.5 (121.8)	70.7 ± 10.5	71.2 (70.9)
≥1000 (*n* = 196)	121.6 ± 16.7	121.1 (120.6)	70.6 ± 12.2	70.6 (70.5)
P for linear trend	NS	<0.05 (<0.01)	<0.05	<0.01 (<0.05)

[1] $\bar{x}$ ± SD.
[2] $\bar{x}$; adjusted for age; values in parentheses adjusted for age, BMI, alcohol and coffee consumption, physical activity, smoking, and vitamin D intake.

unadjusted diastolic blood pressure, there was a significant linear decrease with increasing calcium intake in both sexes (Table 4).

Calcium intake in relation to blood pressure groups

There was a significant linear decrease in age-adjusted, but not unadjusted, calcium intake with increasing systolic blood pressure in both sexes (**Table 5**). With increasing diastolic blood pressure there was a significant linear decrease in unadjusted calcium intake in men and for age-adjusted calcium intake in both sexes (Table 5). However, when calcium intakes were compared between subjects with and without hypertension and all the other variables were included in the analysis, the hypertensive subjects did not have a significantly lower calcium intake.

Effects of vitamin D intake on blood pressure

There was a weak positive correlation between vitamin D intake and blood pressure that was significant for diastolic blood pressure in men and systolic blood pressure in women (Table 2). However, after adjustment for other variables, there were no significant associations between vitamin D intake and blood pressure.

DISCUSSION

In the present study we chose to look at intake of calcium from dairy products only, mainly because the diet questionnaire did not fully cover other calcium sources. Furthermore, from other studies it appears that calcium from dairy sources is the most important in relation to blood pressure, which was our main interest (6–9).

The recommended optimal calcium intake is 1000–1500 mg/d, depending on age and sex (17). We found a mean calcium intake from dairy sources ranging from 640 mg/d in young men to 430 mg/d in middle-aged women. Given that milk and dairy products are responsible for ≈75% of the calcium intake in a Norwegian diet (12), the total calcium intake in our study population was lower than the recommended intake. Calcium intake in our population was also lower than that reported from another Norwegian study, in which the total intake of calcium was 1.1 g in men and 0.9 g in women (18). Furthermore, total calcium intake in our study was slightly lower than that reported from a Belgian study by Kesteloot and Joossens (19) but similar to that found in a US study by McCarron et al (1). On the other hand, total calcium intake in our study was considerably higher than what was reported in Asian studies (9, 20), mainly because of the lower milk intakes in those populations.

As expected, most of the subjects had calcium intakes in the mid-range (200–800 mg/d). However, 1500 subjects had intakes <200 mg/d and 2000 subjects had intakes >800 mg/d, making the distribution of calcium intake fairly wide. Furthermore, groups that could have confounding effects on the results (eg, subjects taking drugs for hypertension or heart disease, subjects reporting cardiovascular disease, and pregnant women) were not included. Finally, because we studied the effect of calcium from dairy sources only, subjects who were taking calcium supplements were excluded. Thus, our data likely show the effect of dairy calcium on blood pressure.

Indeed, we did find a negative association between calcium intake from dairy sources and blood pressure that was significant in the initial 3-factor ANOVA for diastolic blood pressure only. To make sure that the general analysis did not mask effects in subgroups, we also looked separately at blood pressure in relation to various calcium intake groups and calcium intake in relation to blood pressure groups. Using this approach, we found a significant linear decrease in blood pressure with increasing calcium intake. However, the differences in adjusted systolic or diastolic blood pressure between subjects with the highest and subjects with the lowest calcium intake were only 1–3 mm Hg. Furthermore, there was also a significant linear decrease in age-adjusted calcium intake with increasing systolic and diastolic blood pressure, with a difference in calcium intake from 3% to 10% between subjects with the highest and subjects with the lowest blood pressure. On the other hand, when subjects with and subjects without hypertension were compared separately and

TABLE 5
Unadjusted and age-adjusted calcium intake from dairy products in relation to sex and blood pressure (BP)

	Men		Women	
	Unadjusted	Age-adjusted	Unadjusted	Age-adjusted
		mg/d		
Systolic BP (mm Hg)				
< 120 (*n* = 1485 M, 3979 W)	544.4 ± 289.2[1]	567.4[2]	446.7 ± 240.0	446.4
120–139 (*n* = 4397 M, 3061 W)	573.6 ± 312.0	567.7	440.8 ± 230.7	444.1
140–159 (*n* = 1394 M, 745 W)	561.1 ± 300.0	556.3	450.2 ± 238.8	438.5
≥ 160 (*n* = 267 M, 268 W)	524.6 ± 292.9	518.7[3]	434.8 ± 229.5	433.8
P for linear trend	NS	< 0.001	NS	< 0.001
Diastolic BP (mm Hg)				
< 70 (*n* = 2218 M, 3690 W)	586.9 ± 317.8	582.4	456.4 ± 241.0	446.7
70–84 (*n* = 3873 M, 3430 W)	560.6 ± 298.7	561.9	434.2 ± 229.7	443.4
85–99 (*n* = 1268 M, 829 W)	538.6 ± 298.9	543.0	432.3 ± 240.5	439.1
≥ 100 (*n* = 184 M, 104 W)	527.5 ± 302.7	521.3	451.6 ± 203.9	435.7
P for linear trend	< 0.01	< 0.001	NS	< 0.001

[1] $\bar{x}$ ± SD. M, men; W, women.
[2] $\bar{x}$.

all the other variables in the study were controlled for, the lower calcium intake in the hypertensive subjects was not significant, despite a strict definition of systolic and diastolic hypertension that included only 1.8–3.4% of the population and thus those with the lowest calcium intakes.

Several recent reviews addressed the issue of calcium ingestion and blood pressure. In 1990 Cuttler and Brittain (21) found that the evidence for a role of calcium in hypertension was suggestive; Cappuccio et al (22) concluded in 1995 that there was a small, inverse association between dietary calcium intake and blood pressure; whereas Osborne et al (11) in 1996 firmly stated that dietary calcium plays an integral role in the maintenance of normal blood pressure and that an adequate intake may help reduce the risk of hypertension. This may be true, but it is unlikely that the effect of dietary calcium on blood pressure is a major one. If it were, it would have been easily documented for both sexes as well as for systolic and diastolic blood pressure. However, this has not been the case in epidemiologic studies. In a study by Ackley et al (6), the effect was seen in men but not in women. In a study by Ascherio et al (23), the effect in men was seen in lean men only. In women, calcium intake was inversely related to blood pressure but not to the development of hypertension (24). Furthermore, Iso et al (9) found an effect on systolic but not on diastolic blood pressure, whereas Kesteloot and Joossens (19) made the reverse observation. Finally, in all studies in which a negative association between calcium intake and blood pressure was found, the magnitude of the association was moderate.

Similarly, in the metaanalysis by Bucher et al (25), which included 33 studies with a total of 2412 patients, a statistically significant reduction in systolic blood pressure of only 1.27 mm Hg and a nonsignificant reduction in diastolic blood pressure of 0.24 mm Hg were found. However, in some studies, like the one by Buonopane et al (26), the effect was more pronounced. In that study, supplementation with nonfat milk for 8 wk caused a reduction in blood pressure of between 3% and 7%.

Even if the effect of calcium on blood pressure is small, that does not rule out a major effect on cardiovascular disease. Thus, Cook et al (27), in their analysis based on data from the Framingham Study and the National Health and Nutrition Examination Survey, concluded that a 2-mm Hg reduction in diastolic blood pressure could reduce the incidence of coronary heart disease by up to 6% and the incidence of stroke and transient ischemic attack by up to 13%.

Although one cannot rule out the possibility that ingested calcium exerts its effect on blood pressure through release of gastrointestinal hormones or neural reflexes, the absorbed calcium is more likely to be of importance. One would therefore expect that an increased intake of vitamin D, which is the major regulator of calcium absorption (13), would contribute to the effect of calcium on blood pressure. Compared with the literature on calcium, there have been remarkably few studies on vitamin D intake and blood pressure, but the few that are available indicate that vitamin D intake might lower blood pressure. This was shown in an epidemiologic study (3) and when vitamin D was given as a supplement to normocalcemic (28, 29) and hypercalcemic subjects (30).

In Norway, the main sources of vitamin D are cod liver oil and dairy products, which are fortified with vitamin D. In relation to a published recommended intake (31) of 5 μg/d for persons aged < 50 y and of 10 μg/d for those aged 50–70 y, the vitamin D intake in our study was inadequate in the older age groups. Similar to our observations for calcium intake, the major part of the population had an intake in the mid-range (2–10 μg/d), > 2000 subjects had an intake < 2 μg/d, and slightly > 3000 had an intake > 10 μg/d. However, after correcting for the other variables in the study, we did not find any significant relation between vitamin D intake and blood pressure. Furthermore, we did not find any interaction between calcium and vitamin D intakes on blood pressure.

Our study has several shortcomings. First, we looked at calcium intake from dairy products only, and the effect on blood pressure could therefore have come from a number of components found in milk. This concern was emphasized by others (6, 7), and the problem with multicolinearity among dietary factors is well known (8). Second, the circulating amount of vitamin D that would have an effect on blood pressure is not the result of vitamin ingestion only but also of exposure to sunlight (32), which was not evaluated in our study. Finally, we used a self-administered diet questionnaire, which is not as accurate as an interview with a dietitian. However, the reproducibility of dietary data from this self-administered questionnaire was evaluated and a high concordance was found between answers given to the same questions 1 y apart (33).

In conclusion, we found a weak, negative association between calcium intake from dairy sources and blood pressure. This could be important because small reductions in blood pressure might have a significant effect on primary prevention of cardiovascular diseases.

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