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Calcium Intake, Food Sources and Seasonal Variations in Eastern Croatia

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A B S T R A C T

The objective of this study was to examine the quantity of calcium intake among adults, the sources of calcium, differences among seasons, as well as the differences between sexes, correlation with body mass index (BMI), and age. The study included 161 healthy volunteers from the eastern part of Croatia. Each subject completed three food frequency questionnaires (FFQ) with 150 items, at an interval of 3–4 months. The mean calcium intake for whole population for all three FFQs was 965 mg/day. At the same time, the quantity of calcium for all subjects was 14.2 mg/kg, women 14.5 mg/kg, and men 13.6 mg/kg, respectively. There was an inverse relation between calcium intake and age for men (r=–0.32 p=0.028), but not for women. Correlation between calcium intake and BMI was negative, but not significantly. Milk and dairy products were the main source of calcium. Marginally low mean calcium intake goes to show the needful to educate the population.

Key words: *calcium, adults, questionnaire, diet survey, Croatia*

Introduction

A reliable assessment of nutrients intake is a difficult task, and the choice of method depends on the aim of the study, accuracy of the dietary data required, and personnel and economic resources available. Food frequency questionnaire (FFQ)[1–3] is a practical tool for the measurement of a usual food consumption patterns in a large survey, and is widely used for their ease of use, relative low cost, and semi-quantitative data they can collect. Additionally, an FFQ needs to be culturally sensitive, as nutritional habits, food composition, and preparations differ among populations[1].

Optimizing peak bone mass in early life may reduce osteoporosis risk in later life. Such optimization may be partly dependent upon diet[4,5]. Calcium deficiency is considered to be one of the important causative factors of osteoporosis; therefore it is necessary to know the correct requirement and intake of calcium for adults in order to achieve successful prevention of the fraction of this disease due to inadequate calcium intake.

Croatian Food and Nutritional Policy[6] emphasizes that the intake of some nutrients, such as calcium, is lower than the recommended, and the strategy is to permanently monitor the nutritional status and dietary habits of all population groups, taking into consideration regional differences.

The aim of this paper was to establish calcium intake in one part of Croatia, not only for its importance in bone development and maintenance of skeletal mass, and osteoporosis, but also to test the hypothetically inverse association between calcium intake and obesity[7], health problem that is steadily rising.

Subjects and Methods

Subjects

The study was carried out among 161 healthy adults (age 18–55 years), 115 women and 46 men. They were recruited among volunteers, through word-of-mouth and campus advertising.

Questionnaire

Declared calcium intake was assessed by a food frequency questionnaire derived from the questionnaire designed in our laboratory, and on the basis of data in the literature[2,3]. First, an approximate FFQ was created

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and tested on a pilot sample (N=6), but independent of the current study sample, and corrections were done on items as well as of serving size. The questionnaire was adapted to estimate not only the level of calcium intake but also to include an analysis of frequency and of consumed quantities of 150 types of food, separated in 9 groups (fruits; vegetables; meat and products; eggs, milk and dairy products; bread, pasta and cereals; fast food, snack products; fats; drinks; soups). The frequency was estimated by asking the number of intakes per day, week, or month, during last month (such as two or more per day, once per day, 4–6 per week, 2–3 per week, once per week, 2–3 per month, once per month and never). Quantities were described as units of serving (piece, plate, cup, glass, spoon, etc.), and marked as small, medium, or large. The small quantity was defined as half of medium or less, and the large quantity was defined as 1.5 or more than medium. In most cases the trained interviewers filled out questionnaires together with the subjects, especially during the first questionnaire. Each questionnaire required approximately 45 minutes to be filled. The investigation was performed over three different seasons: October/November (FFQ1), April/May (FFQ2), and August/September (FFQ3).

The data were compared with regard to Dietary Reference Intake (DRI)[8].

A computer programme based on national food tables[9] was used to calculate the mean intake of the element, as well as the fraction of intake from different foods. Only a few persons used calcium supplements, but since the aim of the study was to estimate calcium intake through diet, supplementation was not considered.

Statistics

Statistical analysis was performed using Statistica 6.0. (Statsoft Inc.) and Microsoft Excel 2000 (Microsoft Corp., Redmond, USA). Comparison of the calcium intake between men and women, seasons and FFQs was performed using Student's t-test and ANOVA. The normality of data distribution was checked by Kolmogorov-Smirnov test.

Results

We interviewed 164 subjects, but 3 were excluded from further study because they completed FFQs only partially. Table 1 shows results for the total population of 161 subjects, 115 women and 46 men. Subjects' mean age (±SD) was 33.5±10.7 years, 33.5±11.0 years for women, and 34.0±10.2 years for men, respectively. There was no difference between women and men in mean age. Men had significantly higher mean (±SD) BMI (25.2±3.4) compared to women (22.6±3.5) ($p<0.001$).

Mean quantity of calcium consumed per day was 965±433 mg; 909±407 mg for women, and 1105±468 mg for men. The results for FFQ1, FFQ2 and FFQ3, which represented particular periods of the year, were 1049±568 mg, 904±450 mg, and 941±501 mg, respectively. There was a statistically significant difference between daily calcium intake of FFQ1 and FFQ2 ($p<0.001$), and FFQ1 to FFQ3 ($p=0.007$), as well as between genders for FFQ1 ($p=0.007$), and FFQ3 ($p=0.048$), and for the whole population ($p=0.009$) (Table 1). There was significant correlation between daily dietary intake of calcium and

TABLE 1
AGE, BODY MASS INDEX (BMI) AND CALCIUM INTAKE AS IN EASTERN CROATIA (X±SD)

Parameters	Total N=161	Women N=115	Men N=46	p*
Age (years)	33.5±10.7	33.5±11.0	34.0±10.2	ns
Weight (kg)	68.0±14.3	62.7±11.3	81.2±12.3	p<0.001
BMI	23.3±3.7	22.6±3.5	25.2±3.4	p<0.001
Energy, kcal/day				
FFQ1	2786±1146	2538±1026	3405±1205	p<0.001
FFQ2	2502±999	2334±929	2922±1052	p<0.001
FFQ3	2615±1060	2428±896	3083±1282	p<0.001
X	2634±922	2433±822	3137±974	p<0.001
Calcium (mg/day)				
FFQ1	1049±568	974±524	1238±632	0.007
FFQ2	904±450	861±439	1013±465	ns
FFQ3	941±501	892±458	1064±584	0.048
X	965±433	909±407	1105±468	0.009
Calcium (mg/kg)				
FFQ1	15.9±9.0	16.0±9.1	15.6±8.7	ns
FFQ2	13.8±7.4	14.1±7.6	12.9±6.9	ns
FFQ3	14.4±8.0	14.6±7.8	13.7±8.4	ns
X	14.7±7.0	14.9±7.1	14.1±7.0	ns

*p-values differences between men and women obtained by t-test, FFQ – food frequency questionnaire

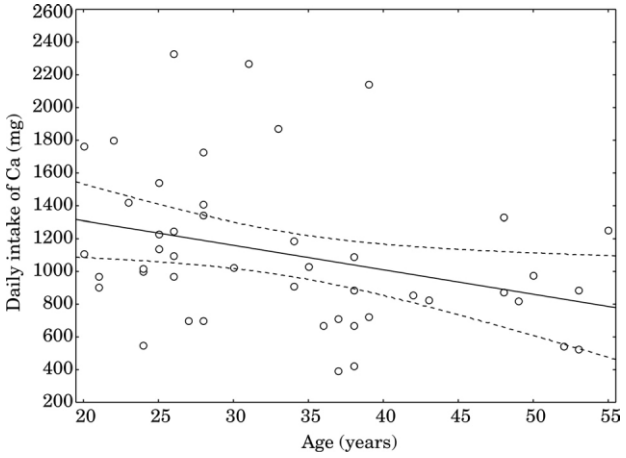

Fig. 1. Relationship between daily intake of calcium (mg) and age for men.

age for men (r=–0.32, p=0.028) (Figure 1), but not for women(r=–0.04, p=0.707). There was no significant correlation between daily dietary intake of calcium and body mass index (BMI) for men (r=–0.21, p=0.163) or for women (r=–0.12, p=0.189).

According to Dietary Reference Intake (DRI) for calcium[8], which is 1000 mg for 19–50 age group, our results show that the subjects intake enough calcium only during the period of FFQ1 (Table 1). The lowest calcium intakes were 261 mg/d in women, and 393 mg/d in men, with a total of 63% of women and 50% of men below respective recommended daily intakes.

Table 2 presents the contribution of particular food sources to calcium intake. For the total population sample, milk and dairy products made greatest contribution to calcium (61.3%) intake, followed by vegetables (14.1%), fruits (7.5%), cereals (5.4%), meat (2.0%), eggs (1.5%), and other. In all FFQs the order of contributing food sources was the same.

TABLE 2
TOTAL INTAKE OF SOME FOOD GROUPS (g) AND THEIR CONTRIBUTION TO CALCIUM INTAKE (%)

Group		FFQ1 October/ November	FFQ2 April/May	FFQ3 August/ September	X
Milk	g	635.7	545.8	593.0	591.5
	%	60.6	60.4	63.0	61.3
Vegetables	g	134.4	146.5	125.7	135.5
	%	12.8	16.2	13.4	14.1
Meat	g	19.7	19.0	20.2	19.6
	%	1.9	2.1	2.1	2.0
Cereals	g	54.3	49.0	52.1	51.8
	%	5.2	5.4	5.5	5.4
Fruits	g	105.9	51.3	61.8	73.0
	%	10.1	5.7	6.6	7.5
Eggs	g	14.8	13.2	13.7	13.9
	%	1.4	1.5	1.5	1.5
Other (sweets and snacks)	g	84.6	79.5	74.8	79.6
	%	8.1	8.8	7.9	8.3

FFQ – food frequency questionnaire

Discussion

Our results showed mean of 965 mg/day dietary calcium intake (Table 1) for the entire sample of population. Though FFQ method was used, which is known to be severe in under-reporting, the result could be considered as accurate, while the main sources of calcium were milk and diary products and their servings are easy to estimate. The value is higher than the reported 804/day mg of calcium for 31 to 51 years old population in Croatia[10], or 512 mg/day reported in the survey conducted in the DAFNE project in Croatia[11]. The newer results for Croatian adults, 754 mg/day[12] and 518–750 mg/day[13], and for children 570–713 mg/day[14] are also lower. Colić Barić and co-authors[10] investigation was also made by the FFQ method, so the difference in calcium intake between our and their results can be due to the nutritional habits, number of foodstuff included in FFQ or the region the investigation was conducted. The results of DAFNE project[11] and Croatian Health Service[12,13] were obtained by household budget surveys, so the differences to results in this study may be the results of different methodology. The newest results in Croatia obtained by FFQ reported higher calcium intake, where difference between continental (1476 mg/day) and Mediterranean region (1558mg/day) is statistically significant[15].

The recommended dietary allowance of calcium is 800 mg to 1000 mg for adults, depending on the country, increasing to 1200 mg for the elderly[5,8,16]. Since 1994, Croatia has its own recommended values for calcium[17], but researchers often use the recommendation of Food and Nutritional Board, Dietary Reference Intake for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride[8].

There is wide variation in calcium intake not only among our subjects, but also among populations, and nations. There are many countries where daily calcium intake is not sufficient. The data on France[18] reveal that mean calcium consumption is less than two thirds of RDA. Many Americans do not consume sufficiently calcium to meet RDA, either[19,20]. Only Guezennec and co-workers found that the mean of declared calcium intake for young population (mean 19 years) was 1242 mg/day, though 13% of the sample consumed less than 500 mg/day. The lowest intake in our study was 261 mg/day for females and 393 mg/day for males**.** In Japan the RDA is lower than in other countries (600 mg). Even at this low recommended level many Japanese fail to reach the RDA[22].

Although DRIs are higher after the age of 50 (1200 mg/day)[8], previous investigations showed a decrease in calcium intake with age. In our study there were 21 subjects with age 50 and more, and their mean daily intake

was 882 mg, abut 80 mg less than the whole population. Generally, women consume about 200 mg less calcium than men (Table 1) but they consume fewer calories, too. An inverse correlation between age and calcium intake in men was found (Figure 1), but not in women.

Some studies have shown an inverse relation between calcium intake and adiposity[7,23,24], as well as a role of intracellular calcium in the regulation of lipogenesis and lipolysis[25]. The relative risk of adiposity was found to be greatest in those with the lowest calcium intake and was progressively lower as calcium intake increased. In spite of these findings, we found no significant correlation between BMI (body mass index) and calcium intake for men or for women. Anyway, Croatians as well as other nations, should educate people about the benefits of optimal calcium intake, since adiposity has recently become a great problem. Namely, calcium intake could explain as much as 3% of the variability in adult weight[26]. Although the body weight changes little with differences in calcium intake, about 0.35 kg/yr, effects could become substantial over years[26–28]. It is important to say that the dairy vs. non-dairy calcium has markedly greater effects in weight management[25]. But, on the other hand, education should caution at the fact that mega doses of calcium, or any other nutrient, should be avoided.

The differences in calcium intake between sexes are partly the consequences of the body size[22], so body weight should be considered when comparing the RDAs among different populations, or sexes. There is a hypothesis of a body-weight-dependency of the RDA for calcium, which may be confirmed, so when values for calcium intake are normalized by body weight, the mean recommended values for calcium are 18.1 to 18.5 mg/kg body weight per day[22]. We found an intake of 13.6 mg/kg for men and 14.5 mg/kg for women, which is 75–80% of recommended level of 18.1 mg/kg. If we take into consideration both mean weight for men and women and the recommended intake of 18.1 mg/kg, in our sample men and women should take 1470 mg and 1135 mg calcium per day, respectively. From this point of view, calcium intake within our group is even less.

The intake of calcium in FFQ1 was higher than in FFQ2 and FFQ3 (Table 1), which obviously reflects the difference in the energy intake. Namely, the intake of energy and calcium are the largest in FFQ1, followed by FFQ3 and FFQ2. FFQ1 is performed during October/November, so the highest intake of energy is consistent with cold temperature.

Milk and dairy products represent the main source of calcium, contributing 70–75% in France[18,29] and 70% in US[19] of daily calcium intake. That is very important because the organic or mineral calcium bound to casein in milk is readily released during digestion, and there is a general agreement that its potential bioavailability is high. So, the coefficient of absorption is about 30% to 40%[29]. In our study only 61.3% of total calcium came from milk and milk product (Table 2). The situation is problematic because, at the same time, milk and milk products are excellent sources of phosphorus (P), which is essential for bone deposition, as well. It should be remembered that milk and dairy product are not only excellent sources of calcium and P, but also represent an almost complete diet whose consumption makes provisions for »meal effect«[29]. There is a caution that individuals who consume less milk also have lower intakes of fat soluble vitamins, some vitamins of B complex and magnesium[20].

In Croatia, data on milk consumption in the adult population show that only about 45% of adults consume milk every day[14]. According to data obtained by household budget surveys in Croatia, milk and dairy products contribute less than 10% of total daily energy intake[30] (half of the desirable 20%). We found that 10.8% of energy came from milk and dairy products. Because of low calcium intake and milk consumption estimated in Croatia[6,31], one of the objectives of Croatian food and nutrition policy until 2005 is to achieve increase of milk and milk products consumption by 25%[6].

Vegetables, fruits, and cereals contributed to 14.1%, 7.5%, and 5.4% of total calcium intake, respectively, far less than milk and dairy products (Table 2). In addition, calcium in vegetables, fruits, and cereals is present as an insoluble form, like oxalate or phytate, so it is the extreme example of poor bioavailability. Also, the ratio of Ca:P in vegetables and cereals is unfavorable (1:5 for potato and 1:7 for flour), additionally engendering poor bioavailability. The intake of fruits obtained by FFQ1 was higher in comparison with FFQ2 and FFQ3 (Table 2), which could be result of seasonal availability of fruits at the market.

Conclusion

In conclusion, the marginally low mean calcium intake in women determined in this work, demonstrate necessity of comprehensive measures to educate the population on the importance of adequate calcium intake, and ways to achieve an optimal provision with this element. This study also supports the Croatian food and nutritional policy until 2005 in efforts to increase consumption of milk and dairy products in the general population for 25%.

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UNOS, IZVORI I SEZONSKE VARIJACIJE KALCIJA U ISTOČNOJ HRVATSKOJ

SAŽETAK

Cilj je rada bio odrediti količinu hranom unesenoga kalcija u odraslih osoba, utvrditi koje su namirnice njegov izvor i ovisi li unos o godišnjem dobu. Također, ispitivano je postoje li razlike u unosu kalcija među spolovima, kao i povezanost sa stanjem uhranjenosti (BMI) i dobi osoba. Ispitivanjem je bio obuhvaćen 161 dobrovoljac iz istočnog dijela Hrvatske. Svaki je ispitanik popunio tri upitnika o učestalosti potrošnje namirnica (FFQ). Upitnik je sadržavao pitanja o unosu 150 namirnica, a popunjavan je u razmacima od 3 od 4 mjeseca. Srednji je unos kalcija za ispitivano razdoblje za sve osobe bio je 965 mg/dan, ili 14.2 mg/kg. Za žene je bio 14.5 mg/kg, a muškarce 13.6 mg/kg. U žene nije dokazana statistički bitna povezanost između unosa kalcija i dobi, a za muškarce je dokazana obrnuta povezanost ($r=-0.32$ $p=0.028$). Korelacija je između indeksa mase tijela (BMI) i unosa kalcija bila negativna, ali ne bitna. Mlijeko i mliječni proizvodi glavni su izvori kalcija. Suboptimalani unos kalcija pokazuje kako je prijeko potrebna edukacija populacije.