Dairy consumption and other dietary risk factors for osteoporosis in Croatian young women

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Summary

Among dietary risk factors for developing osteoporosis, calcium intake in the primary prevention of osteoporosis has received much attention. The aim of this study was to determine dietary risk factors for later osteoporosis in Croatian young women (mean age 22 years), especially dairy foods consumption, a food group that is the best calcium source because of its calcium content and bioavailability. Dietary assessment methods used were Food Frequency Questionnaire (FFQ) (n=1372) and Quantified Food Frequency Questionnaire (Q-FFQ) (n=480). Daily consumption of dairy foods reported 76.0 % subjects and 11.6 % subjects consume dairy foods less than once a month. Average daily calcium intake was 1444.4 mg, i.e. 144.4 % Dietary Reference Intake (DRI) and 31.0 % of women had calcium intake less than 100 % DRI. In conclusion, dairy foods were the main source of dietary calcium in a daily diet, what shows significance of this food group in achieving adequate calcium intake in this study.

Key words: diet, dairy foods, dietary calcium, osteoporosis

Introduction

Osteoporosis is a major public health problem that is increasing with growing number of elderly. Osteoporosis decreases the quality of life and creates a burden on health care costs. Taking in consideration that there is currently no cure for the disease, prevention is crucial, and is best accomplished by maximizing peak bone mass during growth (peak bone mass is typically achieved by the age of 30) (The American Dietetic Association, 2004).

Nutrition is an important modifiable factor in bone health. Of all the nutrients or dietary factors that affect bone, calcium and vitamin D are the most important. There is little doubt that bone turnover is responsive to dietary

calcium (Heaney, 2002). Inclusion of low-fat dairy products in the diet is the most desirable way to meet calcium goals (Heaney, 2001).

Risk factors for osteoporosis development include female gender, smoking habit, excessive alcohol consumption, diet, lack of exercise and underweight. Dietary risk factors, besides calcium intake, include soft drinks and caffeinated beverages consumption, phosphorus, magnesium, iron, vitamin D, sodium, and protein intake (Anderson, 2004).

Studies among young women indicated inadequate calcium intake and it was shown that women with low milk intake during childhood and adolescence have less bone mass in adulthood and greater risk of fracture (Susiyanti et al., 1996; Kalkwarf et al., 2003).

The aim of this study was to assess dietary risk factors for later osteoporosis development, especially calcium intake, in Croatian women when peak bone mass is achieved.

Subjects and methods

The subjects were young women, university students from 5 Croatian university centres. Distribution of subjects according to university was in accordance with official data of the Ministry of Science and Technology of Republic of Croatia and Croatian Bureau of Statistics (Croatian Bureau of Statistics, 2001; http://www.mzt.hr/mzt/hrv/djelatnosti/visoko/vucilist/sveucilista.htm).

Dietary assessment methods used were Food Frequency Questionnaire (FFQ) (Group 1; n=1372; 1.2 % of all Croatian university students) and Quantified Food Frequency Questionnaire (Q-FFQ) (Group 2; n=480; 0.4 % of all Croatian university students) (Table 1).

Table 1: Characteristics of the subjects (mean ± SD)

Tablica 1: Karakteristike ispitanica (prosjek ± SD)

Female university students/Studentice	Group 1/Grupa 1	Group 2/Grupa 2
Number of subjects/Broj (n)	1372	480
Age (years)/Dob (godine)	21.5 ± 1.88	21.6 ± 1.79
Body weight/Tjelesna masa (kg)*	58.8 ± 7.07	59.1 ± 6.68
Body height/Tjelesna visina (cm)*	169.2 ± 6.12	169.5 ± 5.64
Body Mass Index/Indeks tjelesne mase (kg/m^2)	20.5 ± 2.01	20.6 ± 2.14

* self-reported values of body weight and height

FFQ was administered to subjects in students' restaurants. Participation was voluntary. The FFQ enabled assessment of consumption frequency of milk and dairy products, alcohol, carbonated soft drinks, smoking habits and data on recreational physical activity. Details on the FFQ and its reproducibility were published elsewhere (Colić Barić et al., 2003).

Q-FFQ was conducted with subjects at faculties. Faculties inside universities and classes inside faculties were chosen by random sampling. Participation was voluntary. Q-FFQ enabled evaluation of calcium, phosphorus, protein, iron, magnesium and sodium intake, also coffee, alcohol and carbonated soft drinks consumption. Details on the Q-FFQ and its reproducibility and validity were published elsewhere (Šatalić et al., 2004; Šatalić et al. 2007).

Nutrient intakes were compared with DRI (Dietary Reference Intakes) (Food and Nutrition Board, Institute of Medicine, 1997-2000).

Dietary vitamin D intake was not calculated and instead vitamin D status was evaluated with duration of sunlight exposure. Brief and casual exposure of the face, arms and hands to sunlight is thought to equal about 5 μg of vitamin D (Gallagher, 2004).

In this study methodology of Haines et al. (1999) was used, for translating consumption of beer, wine and strong alcoholic beverages into the number of alcoholic drinks per day, where beer consumption (mL) was divided by 360, wine consumption (mL) by 150 and strong alcoholic beverages (mL) by 45; the sum was the number of alcoholic drinks. Recommendations regarding alcohol consumption for women are not to exceed one drink per day (Di Castelnuovo et al., 2006; O'Keefe et al., 2007).

Self-reported body weight and height were used to calculate body mass index (BMI). Based on other studies, subjects consistently underreport their true weights by approximately 1 kg, however, correlations between reported weights and measured weights are typically quite high, ranging between r=0.96 and r=0.99, therefore adequate for research purposes (Stunkard and Albaum, 1981; Kuczmarski et al., 2001). In subsample of students (women only) (n=100) comparison of reported and measured body weight and body height was made. Correlation coefficient for body weight was r=0.94 and for body height r=0.95.

According to guidelines proposed by the National Institutes of Health, overweight in adults aged 18 years and older is defined as 25.0 kg/m^2 ≤ BMI <

30.0 kg/m^2 and obesity as BMI ≥ 30.0 kg/m^2, and underweight as BMI < 18.5 kg/m^2 (National Institutes of Health, National Heart, Lung, and Blood Institute, 1998). These cut-offs were used to define overweight, obesity and underweight in examined population. Results are presented as mean ± SD and critical correlation coefficients were calculated with STATISTICA 6.

Results and discussion

Among dairy foods, milk is preferred choice in examined population (average consumption frequency is 4.2 times per week) (Table 2). As food choice for snacks, milk and dairy products were option for 38.0 % subjects (higher number (47.2 %) of subjects reported fruit as snack option).

Table 2: Consumption frequency of milk and dairy products determined with Food Frequency Questionnaire (FFQ) (n=1372) (mean ± SD)

Tablica 2: Učestalost konzumiranja mlijeka i mliječnih proizvoda utvrđena upitnikom o učestalosti konzumiranja namirnica (FFQ) (n=1372) (prosjek ± SD)

Food Namirnice	Consumption frequency (n times per week) Učestalost konzumiranja (n puta tjedno)
Milk Mlijeko	4.2 ± 2.81
Fermented dairy drinks Fermentirani mliječni napici	3.4 ± 2.49
Cheeses and cheese spread Sirevi i sirni namaz	2.7 ± 2.31
Low fat dairy products Niskomasni mliječni proizvodi	1.9 ± 2.28

Low fat dairy products are consumed 1.9 times per week and our previous papers showed significantly higher consumption frequency of low fat dairy products among Croatian young females and adolescent girls than among males (Colić Barić et al., 2001; Colić Barić et al., 2003). This can be explained with more pronounced weight concern among females than among males; dairy products are often perceived as high in fat and as a cause of weight gain. Recent studies showed that dairy calcium intake is considered as beneficial in body weight regulation (Baptista Bueno et al., 2008; Barba and Russo, 2006; Astrup, 2008).

Table 3: Osteoporosis risk factors determined with Food Frequency Questionnaire (FFQ) (n=1372) (% subjects)

Tablica 3: Rizični čimbenici za osteoporozu utvrđeni upitnikom o učestalosti konzumiranja namirnica (FFQ) (n=1372) (% ispitanika)

Risk factors / Rizični čimbenici	% subjects / % ispitanika
Consume milk or dairy products less than once a month Konzumiraju mlijeko ili mliječne proizvode manje od jednom mjesečno	11.6
Consumes carbonated soft drinks Konzumiraju gazirana pića	50.1
Consumes carbonated soft drinks daily Konzumiraju gazirana pića dnevno	4.5
Consumes beer or wine Konzumiraju pivo ili vino	39.1
Consumes beer or wine daily Konzumiraju pivo ili vino dnevno	1.3
Consumes strong alcoholic beverages Konzumiraju žestoka alkoholna pića	30.7
Consumes strong alcoholic beverages daily Konzumiraju žestoka alkoholna pića dnevno	0.5
Smokers (at least one cigarette daily) Pušači (barem jedna cigareta dnevno)	33.9
Zero hours of recreational sport per week Nula sati rekreativnog sporta tjedno	64.1
Underweight (Body Mass Index <18.5 kg/m^2) Pothranjeni (Indeks tjelesne mase <18,5 kg/m^2)	13.9
Consume milk or dairy products less than once a month and zero hours of recreational sport per week Konzumiraju mlijeko ili mliječne proizvode manje od jednom mjesečno i nula sati rekreativnog sporta tjedno	7.1
Consume milk or dairy products less than once a month and zero hours of recreational sport per week and underweight (Body Mass Index <18.5 kg/m^2) Konzumiraju mlijeko ili mliječne proizvode manje od jednom mjesečno i nula sati rekreativnog sporta tjedno i pothranjeni (Indeks tjelesne mase <18,5 kg/m^2)	0.7

Study conducted among Spanish university students showed that there is great concern over body weight and in this study 22.4 and 29.6 % males and females respectively considered their own body weight too high (Navia et al., 2003).

Daily consumption of dairy foods reported 76.0 % subjects and 11.6 % subjects consume dairy foods less than once a month (Table 3). Number of subjects that consume milk or dairy products less than once a month and are not engaged in any recreational activities, which are major influences on bone health, was 7.1 %.

Average daily calcium intake was adequate (1444.4 mg, i.e. 144.4 % DRI) but 31.0 % of women had calcium intake less than 100 % DRI (Tables 4 and 5). The recommendation for calcium intake for adults that is valid in Croatia is 800 mg (Ministry of Health and Social Welfare, 2004), and according to that value 18.1 % subjects did not achieve recommended calcium intake. Study with patients with osteoporosis and osteopenia showed that patient's knowledge about osteoporosis is also important in achieving adequate calcium intake, because subjects who knew the recommended calcium intake in average had higher calcium intake than those who did not (Colić Barić et al., 2004). Recommended calcium and phosphorus ratio is 1:1, but this ratio is hard to achieve with modern diets. Dietary phosphorus intakes have risen 10 % to 15 % over the past 20 years because of the increased use of phosphate salts in food additives and carbonated beverages (Food and Nutrition Board, Institute of Medicine, 1997). In this study unfavourable calcium and phosphorus ratio (1:1.4) was observed.

Average phosphorus and magnesium intake were adequate, but iron intake should be increased. Protein intake should be decreased. 61.5 % of subjects had protein intake above 200 % DRI and 5.0 % subjects had inadequate protein intake (<100 % DRI) (Table 5). It appears that both low and high protein diets may be detrimental to bone health. Low protein diets interfere with intestinal calcium absorption and IGF-1 levels, and high protein diets induce excess urine calcium loss (Ilich and Kerstetter, 2000). To offset protein's calciuric effect, greater calcium allowances have been recommended at a calcium-protein ratio (in mg:g) of 20:1 (Massey, 1998; Weaver et al., 1999). In this study the ratio was 12.9 and only 3.8 % subjects had calcium-protein ratio higher than 20:1.

Table 4: Intakes of nutrients important for bone health determined with Quantified Food Frequency Questionnaire (Q-FFQ) (n=480)

Tablica 4: Unos nutrijenata važnih za zdravlje koštanog tkiva utvrđen kvantitativnim upitnikom o učestalosti konzumiranja namirnica (Q-FFQ) (n=480)

Nutrients Nutrijenti	Mean ± SD Prosjek ± SD
Protein Proteini (g)	113.3±49.79
Protein Proteini (% DRI)	246.3±108.24
Calcium Kalcij (mg)	1444.4±739.61
Calcium Kalcij (% DRI)	144.4±73.96
Phosphorus Fosfor (mg)	1899.0±868.47
Phosphorus Fosfor (% DRI)	271.3±124.07
Magnesium Magnezij (mg)	406.0±175.39
Magnesium Magnezij (% DRI)	131.0±56.58
Iron Željezo (mg)	16.1±7.88
Iron Željezo (% DRI)	89.7±43.75
Sodium Natrij (mg)	5283.2±2552.09

Daily sodium should fit into range of 1500-2300 mg (Food and Nutrition Board, Institute of Medicine, 2004). As shown in table 4, average sodium intake was fairly above 2300 mg and 92.7 % subjects had sodium intake above 2300 mg.

Dairy foods in total daily calcium intake contributed with 53.7 % and dairy foods ensured 82.0 % DRI for calcium, which shows significance of this food group in achieving adequate calcium intake in this study. For comparison, in average American diet, milk, cheese, and yogurt reported as a separate survey food items, contributed 42 % of total previous calcium intake. An additional 21 % of dietary calcium came from dairy ingredients in mixed foods (Cook and Friday, 2003). It is advisable that 60 % of the

Recommended Dietary Allowances (RDA) for calcium is dairy calcium (Infante and Tormo, 2000).

Table 5: Intakes of nutrients important for bone health determined with Quantified Food Frequency Questionnaire (Q-FFQ) (n=480) (% subjects)

Tablica 5: Unos nutrijenata važnih za zdravlje koštanog tkiva utvrđen kvantitativnim upitnikom o učestalosti konzumiranja namirnica (Q-FFQ) (n=480) (% ispitanika)

Nutrients Nutrijenti	% subjects % ispitanika
Protein/Proteini (>200 % DRI)	61.5
Protein/Proteini (<100 % DRI)	5.0
Calcium/Kalcij (<100 % DRI)	31.0
Iron/Željezo (<100 % DRI)	67.5
Magnesium/Magnezij (<100 % DRI)	31.5
Phosphorus/Fosfor (<100 % DRI)	3.5
Protein (>200 % DRI) and calcium (<100 % DRI) Proteini (>200 % DRI) i kalcij (<100 % DRI)	5.0
Protein (>200 or <100 % DRI) and calcium, iron, magnesium and phosphorus (<100 % DRI) Proteini (>200 ili <100 % DRI) i kalcij, željezo, magnezij i fosfor (<100 % DRI)	3.3

In several observational studies, intake of carbonated beverages was associated with reduced bone mass or increased fracture risk, both later in life and in children and adolescents, which is explained with calciuric effect of phosphorus, caffeine or fructose from mentioned beverages or simply by displacement of milk (Wyshak et al., 1989; Petridou et al., 1997; Wyshak et al., 1994; Wyshak, 2000).

In this study, no negative correlation for consumption of milk (mL) and carbonated soft drinks (mL) was observed, and also results of FFQ did not show negative correlation for consumption frequencies of milk and carbonated soft drink; also no negative correlation was observed for calcium intake (mg

and % DRI) with carbonated soft drinks consumption (mL), but statistically significant (r=-0.13, p=0.004) correlation was observed for carbonated soft drinks consumption (mL) and calcium intake expressed per units of energy (mg/1000 kcal). Heavy alcohol consumption and excessive caffeine intake may have adverse effects on bone health (Anderson, 2004). As shown in table 6, both alcohol and coffee consumption were moderate.

Table 6: Consumption of milk, carbonated soft drinks, coffee and alcohol determined with Quantified Food Frequency Questionnaire (Q-FFQ) (n=480)

Tablica 6: Konzumiranje mlijeka, gaziranih pića, kave i alkoholnih pića utvrđeno kvantitativnim upitnikom o učestalosti konzumiranja namirnica (Q-FFQ) (n=480)

Food Namirnica	Mean ± SD Prosjek ± SD
Milk (plain or chocolate, as beverage, over breakfast cereal, with coffee) (mL/day) Mlijeko (obično ili čokoladno, kao napitak, s žitaricama za zajutrak, s kavom) (mL/dan)	329.1±281.60
Carbonated soft drinks (mL/day) Gazirana pića (mL/dan)	41.8±70.60
Coffee (with or without milk) (mL/day) Kava (s ili bez mlijeka) (mL/ dan)	136.6±149.24
Alcohol (number of drinks per week) Alkoholna pića (broj pića tjedno)	1.5±2.16

Vitamin D status primarily depends on sunlight exposure since there are just a few foods that are naturally rich in vitamin D, like butter, margarine, liver and eggs. Practice of enriching, especially dairy food, with vitamin D is uncommon in Croatia, so vitamin D status was estimated through time spend on exposing at least skin of face and hands to sunlight: 3.6 hours per day during summer and 1.6 hours per week during winter. 9.4% of subjects reported to have avoided sun because of health problems, dislike or lack of time. On average, these subjects had calcium intake of 141.9 % DRI and 40 % of them had calcium intake under 100 % DRI. Many epidemiologic studies have identified strong inverse correlations between adiposity and calcium intake (Parikh and Yanovski, 2003). In this study negative correlation for calcium intake (mg) and Body Mass Index (kg/m^2) (r=-0.13, p=0.006) was also observed.

Conclusion

The results indicated that high number of young women consumed milk and dairy products on a daily basis. The average daily calcium intake was adequate in studied population. Dairy foods were the main source of dietary calcium in a daily diet, which shows significance of this food group in achieving adequate calcium intake in this study.

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KONZUMIRANJE MLIJEKA I MLIJEČNIH PROIZVODA I DRUGI PREHRAMBENI RIZICI ZA OSTEOPOROZU U MLADIH ŽENA U HRVATSKOJ

Sažetak

Među prehrambenim rizičnim čimbenicima za razvoj osteoporoze značajnu ulogu u primarnoj prevenciji osteoporoze ima unos kalcija. Cilj ovog istraživanja je bio utvrditi prehrambene rizike za kasniji razvoj osteoporoze u mladih žena u Hrvatskoj (prosječne dobi 22 godine), posebno konzumiranje mlijeka i mliječnih proizvoda, skupine namirnica koja je najbolji izvor kalcija zbog sadržaja kalcija i njegove bioiskoristivosti. Za procjenu kakvoće prehrane korišten je upitnik o učestalosti konzumiranja namirnica (FFQ) (n=1372) i kvantitativni upitnik o učestalosti konzumiranja namirnica (Q-FFQ) (n=480). Dnevno konzumiranje mlijeka i mliječnih proizvoda je utvrđeno u 76,0 % ispitanica, a 11,6 % ispitanica konzumira mliječne proizvode manje od jednom mjesečno. Prosječni dnevni unos kalcija je bio 1444,4 mg, tj. 144,4 % DRI, a 31,0 % žena je imalo unos kalcija manji od 100 % DRI. U zaključku, mlijeko i mliječni proizvodi su bili glavni izvor kalcija u dnevnoj prehrani, što pokazuje značaj ove skupine namirnica u postizanju adekvatnog unosa kalcija u ovom istraživanju.

Ključne riječi: prehrana, mlijeko i mliječni proizvodi, kalcij, osteoporoza

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