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Calcium and Dairy Products Consumption and Association with Total Hip Bone Mineral Density in Women from Kosovo

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ABSTRACT

Background and objective: There is paucity of evidence in southeastern Europe and Kosovo regarding dairy products consumption and association with bone mineral density (BMD). Therefore, the objective of present study was to assess calcium intake and dairy products consumption and to investigate relationship with total hip BMD in a Kosovo women sample. **Methods**: This cross-sectional study included a sample of 185 women divided into respective groups according to total hip BMD. All the study participants completed a food frequency questionnaire and underwent dual-energy X-ray absorptiometry (DEXA) to estimate BMD. Nonparametric tests were performed to compare characteristics of the groups. **Results**: The average dietary calcium intake was 818.41 mg/day. Only 16.75% of the subjects met calcium recommended dietary reference intakes (DRIs). There were no significant differences between low BMD group and normal BMD group regarding average dietary calcium intake, but it was significantly higher in BMDT3 subgroup than in BMDT2 and BMDT1 subgroups. **Conclusions**: The results of this study demonstrate significant relationship of daily dietary calcium intake with upper BMD tertile. Further initiatives are warranted from this study to highlight the importance of nutrition education.

Keywords: Bone mineral density, women, dietary calcium intake, dairy products, risk factors.

1. INTRODUCTION

It is now commonly accepted that osteoporosis is an omnipresent health issue; taking into account only EU and USA, it is estimated that about 70 million patients have osteoporosis with significant economic burden (1-4).

Among many established risk factors of osteoporosis, nutritional factors offer particular opportunity for intervention (5-7). Numerous studies have shown benefits of dairy food consumption on bone health, reporting positive relationship between calcium intake and bone mineral density (BMD) (8-13); however, there are studies who did not find any consistent evidence on bone health (14-16).

At present, there is no information regarding the association between dairy product consumption and dietary calcium (Ca) intake and BMD in Kosovo population. Against this background, the objective of this study was to assess dairy products consumption and dietary calcium intake, as well as to evaluate the association of different types of dairy products with BMD in 185 female subjects.

2. MATERIAL AND METHODS

STUDY POPULATION

A total of 185 female subjects aged 22 to 65 years old residing in Kosovo were included in the study carried out from April through July 2013. Study participants were divided into two groups according to total hip BMD (Total T-score): participants with low BMD (< -1 SD) (n=116) and participants with normal BMD (≥ -1 SD) (n=69). Despite this, three other groups of subjects were created based on total hip BMD (g/cm^2): BMDT1 (<0.813 g/cm^2), BMDT2 (0.813-0.910 g/cm^2) and BMDT3 (>0.910 g/cm^2). Use of calcium and vitamin D supplements during preceding six months and bisphosphonates during preceding 12 months were considered exclusion criteria. Subjects were also not included in the study if they were vegetarians, had metabolic bone diseases, had malabsorptive diseases or were pregnant. All the procedures in this study were according to guidelines in the Declaration of Helsinki, and the study design was approved by Ethics Committee of Faculty of Medicine, under no.1699. All research subjects provided signed informed consent for their participation. Subjects' height (m) and body weight were measured while wearing light clothes and no shoes on. Body mass index (BMI) was expressed in kg/m^2.

BONE MINERAL DENSITY MEASUREMENTS

Dual-energy X-ray absorptiometry (DEXA) with the Hologic equipment (Hologic QDR-4500, USA) was used to measure bone mineral density (BMD) in femoral neck

and total hip. Results were expressed in g/cm2 likewise as T-scores. Based on WHO criteria, T-score ≥ -1 standard deviation (SD) below reference range was considered as normal BMD, while T-scores between -1 SD and -2.5 SD, and ≤2.5 SD were considered as osteopenia and osteoporosis, respectively. Because of convenience, participants in this study with either osteopenia or osteoporosis are considered as with low BMD.

ASSESSMENT OF DAIRY PRODUCTS CONSUMPTION AND CALCIUM INTAKE

Quantification of dairy products consumption and calcium intake was done using the model of semi-quantitative food frequency questionnaire (FFQ) proposed by Wadalowska L *et al*, 2013 (9). The questionnaire was administered through in-person interviews. The following categories of dairy products consumption were used in the food frequency questionnaire: never, less seldom than once a week, once-twice a week, three to four times a week, five to six times a week, once a day, two to three times a day and four or more times a day.

Consumption of dairy products was assessed in portions per week; the quantities considered for calculating calcium intake were obtained from food composition tables (17). Food frequency questionnaire specifies the portion size for each dairy product as follows: milk (250g), cheese (25g), yoghurt (150g), and pudding (125g).

3. STATISTICAL ANALYSIS

All continuous variables are expressed as means and standard deviations and categorical variables as percentages. Characteristics of the groups were compared for significant differences using independent samples t-test and one-way ANOVA, respectively. Comparison of the average dietary calcium intake and the average dairy products intake between respective groups were done using Mann-Whitney U test and Kruskal-Wallis test. Calculations of all statistical analyses were performed using SPSS software version 16.0. Statistical significance was set at $p<0.05$.

4. RESULTS

The overall characteristics of the study population expressed in means±SD and in ranges are presented in Table 1, while baseline characteristics of the participants according to BMD groups are presented in Table 2.

	Mean ± SD	Range (Min-Max)
Age (years)	56.28±8.34	43 (22-65)
Weight (kg)	73.98±12.69	76 (37-113)
Height (m)	1.59±0.06	0.33 (1.41-1.74)
BMI (kg/m^2)	29.25±5.03	29.67 (15.60-45.27)
Total Hip BMD (g/cm^2)	0.87±0.14	1.00 (0.39-1.39)
Total Hip BMD (T-score)	-0.593±1.152	8.20 (-4.50-3.70)
Femur neck BMD (g/cm^2)	0.755±0.125	0.86 (0.35-1.21)
Femur Neck BMD (T-score)	-0.829±1.136	7.80 (-4.50-3.30)
Daily dietary Ca intake (CaDD) (mg/day)	818.41±239.84	1293.20 (338.21-1631.41)
Total Ca intake from dairy products (mg/day)	788.66±390.75	2106.61 (13.39-2120.0)
Milk consumption (portions/week)	10.29±7.7	28 (0.00-28.00)
Cheese consumption (portions/week)	13.53±8.68	28 (0.00-28.00)
Yoghurt consumption (portions/week)	9.31±8.64	28 (0.00-28.00)
Pudding consumption (portions/week)	1.90±2.18	14 (0.00-14.00)
Total dairy products consumption (portions/weeks)	35.04±16.34	84 (3-87).
Women who met calcium DRIs (%)	31 (16.75%)	
Women who reached 3 portions/week (%)	143 (77.30%)	

Table 1. Baseline characteristics of the participants (n=185). DRIs-Dietary Recommended Intakes

There was a certain level of variability in dietary calcium intake and dairy products consumption among study participants. The average dietary calcium intake was 833.29 mg/day and 795.76 mg/day, while the average dairy products intake was 35.89 portions/week and 33.61 portions/week in subjects with low BMD and with normal BMD, respectively. No statistically significant difference between two groups was found using the Mann-Whitney test (Table 3). When subjects were modeled as BMD tertiles (Table 3), by using Kruskal-Wallis test it was shown that, the average dietary calcium intake in BMDT3 subgroup was significantly higher than in BMDT2 and BMDT1 subgroups (887.15 mg/day vs. 785.12 mg/day and 786.75 mg/day, respectively; $p<0.05$), and the average dairy products intake in BMDT3 subgroup was almost significantly higher than in BMDT2 and BMDT1 subgroups (38.85 portions/week vs. 33.02 portions/week and 33.20 portions/week, respectively; $p=0.06$).

5. DISCUSSION

The results of this cross sectional study indicate relatively high average consumption of dairy products (35.04±16.34 portions/week) by study subjects, of whom 143 (77.3%) reached the recommended threshold of 3

Parameters	Bone mineral density						
	BMD < -1 SD	BMD ≥ -1 SD	p-value	BMDT1	BMDT2	BMDT3	p-value
Study population (%)	116 (62.7)	69 (37.3)		61 (33)	62 (33)	62 (33)	
Age (years)#	53.53±7.95	58.84±7.9	p<0.05	53.28±7.98	53.25±8.78	53.29±8.33	p>0.05
BMI (kg/m2)	30.99±4.66	26.33±4.24	p<0.05	26.24±4.25 a	29.65±4.46 a, b	31.80±4.81 b	p<0.05
Total Hip BMD (g/cm2)	0.95±0.10	0.74±0.08	p<0.05	0.72±0.08 c	0.86±0.30 c	1.02±0.89	p<0.05
Met recommended calcium DRIs (%)	24 (20.69%)	7 (11%)	p<0.05*	4d (6.55%)	12 (19.35%)	15d (24.19%)	p<0.05*

Table 2. Baseline characteristics of the participants according to bone mineral density (BMD) groups# # Mean ± SD; * p for chi square test; BMDT1, BMDT2, BMDT3 – terciles of bone mineral density; DRIs-Dietary reference intakes; values with superscripted characters are significantly different

Parameters	Bone mineral density						
	BMD < -1 SD	BMD ≥ -1 SD	p-value for Mann-Whitney U test	BMDT1	BMDT2	BMDT3	p-value for Kruskal-Wallis test
Study population	116	69		61	62	62	
Dairy products consumption (portions/week)							
Milk	10.84±7.83	9.38±7.38	p= 0.223	9.12±7.18	9.59±7.77	12.20±7.82	p = 0.065
Cheese	13.93±8.56	12.87±8.90	p = 0.428	13.02±8.70	13.16±8.73	14.44±8.68	p = 0.616
Yoghurt	9.26±8.96	9.39±8.14	p = 0.647	9.08±7.92	8.55±8.85	10.33±9.14	p = 0.315
Pudding	1.86±1.93	1.97±2.56	p = 0.800	2.17±2.67	1.72±2.16	1.88±1.61	p = 0.563
Total dairy products consumption	35.89±16.51	33.61±16.06	p = 0.306	33.20±15.31	33.02±17.13	38.85±16.03	p = 0.065
Calcium intake from dairy products (mg/day)							
Milk	464.78±335.73	401.86±316.14	p = 0.199	390.71±307.54	411.16±333.08	522.72±335.26	p = 0.065
Cheese	62.19±38.22	57.45±39.74	p = 0.428	58.11±38.85	58.73±38.98	64.48±38.75	p = 0.616
Yoghurt	238.08±230.47	241.49±209.42	p = 0.711	233.57±203.59	219.78±227.51	265.57±235.10	p = 0.315
Pudding	46.57±48.22	49.27±64.16	p = 0.800	52.92±66.72	42.97±54.09	47.13±40.33	p = 0.563
Total Ca intake from dairy products (mg/day)	811.60±406.41	750.08±362.51	p = 0.225	735.31±347.05	732.61±415.67	899.90±386.78	p = 0.016
Daily dietary Ca intake	833.29±247.91	795.76±221.131	p = 0.225	786.75±211.70	785.12±253.56	887.15±235.94	p = 0.016

Table 3. Association between dairy products consumption and calcium intake from dairy products and BMD in study participants#- # Mean ± SD; BMDT1, BMDT2, BMDT3 – tertiles of bone mineral density

portions of dairy products per day (18, 19); no statistically significant differences were noticed between different groups created on the basis of BMD, but a borderline significant difference of BMDT3 compared to lower BMD tertiles (p=0.06) (Table 3).

There are considerable differences from state to state regarding recommended daily dietary calcium intakes (20). Because there is no established national recommendation for daily calcium intake, we adopted recommendations according to Food and Nutrition Board, Institute of Medicine, National Academies (<50 years=1000 mg and > 50 years=1200 mg) (21). Recommended calcium DRIs for their age were met by 31 (16.75%) women; there was a marginally significant difference between women with low BMD and women with normal BMD (20.69% vs. 11%; p=0.06), that can be possibly explained by reverse causality and higher perceived health risk with aging, but significant difference between women in BMDT3 subgroup and women in BMDT1 subgroup (24.19% vs. 6.55%; p<0.05).

Calcium intake from various dairy products as well as daily dietary calcium intake (CaDD), grouped according to total hip T-scores and total hip BMD values, are presented in Table 3. The average calcium intake from total dairy products in analyzed subjects was 788.66mg/day, and dietary calcium intake was 818.41 mg/day; findings from this study are fully consistent with results from Sahni S *et al* (4) and from Gariguet D (22), and partially consistent with results from Fan T *et al* (23) in terms of reporting relatively high average of calcium intakes (829 mg/day and 751mg/day and 1239 mg/day, respectively). However, in contrast to our study, results from two Polish studies conducted by Wadalowska L *et al* (9) and Włodarek D *et al* (12) found relatively low calcium intake from dairy products in women (375 mg/day and 424.7 mg/day, respectively). Similarly, a Korean study conducted by Kim SH *et al* [11] and a Brazilian study conducted by Harter DL *et al* (15) found low average calcium consumption of 547.9mg/day and 418.7 mg/day, respectively.

In current study there were no significant differences in average dairy or dietary calcium intake between two groups created according to total hip BMD T-scores (Table 3). These results fully support the results of Fardellou P *et al* (24) and partially support those of Włodarek D *et al* (12) who reported no significant difference in respect to total hip BMD T-scores, but reported significant association of higher calcium intake with femoral neck BMD T-score that was not included in our analysis. However, upper BMD tertile in our study had significantly higher average dairy and dietary calcium intake than middle or bottom BMD tertiles (p<0.05; Table 3). These results contrast to results reported by Wadalowska L *et al* (9) who observed no significant differences between BMD tertiles in dairy Ca intake.

6. CONCLUSION

Despite limitations with sample size we were able to demonstrate significant relationship between daily calcium intake and BMD in subjects with upper BMD tertile as well as marginally significant relationship with total dairy consumption and daily calcium intake from milk. The fact that adequate daily calcium intake was found in only 16.75% of subjects, warrants further initiatives to highlight the importance of nutrition education.

CONFLICT OF INTEREST: NONE DECLARED

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