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Calcium Intake, Major Dietary Sources and Bone Health Indicators in Iranian Primary School Children

Nasrin Omidvar [1,*]; Tirang-Reza Neyestani [2]; Majid Hajifaraji [3]; Mohammad-Reza Eshraghian [4]; Arezoo Rezazadeh [1]; Saloumeh Armin [5]; Homa Haidari [5]; Telma Zowghi [5]

[1]Department of Community Nutrition, National Nutrition and Food Technology Research Institute, Faculty of Nutrition and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran
[2]Laboratory of Nutrition Research, National Research Institute, Tehran, IR Iran
[3]Department of Food and Nutrition Policy and Programming Research, Tehran, IR Iran
[4]National Department of Epidemiology and Biostatistics, Faculty of Public Health, Tehran University of Medical Sciences, Tehran, IR Iran
[5]Department of Nutrition Research, National Nutrition and Food Technology Research Institute, Faculty of Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran

Corresponding author: Nasrin Omidvar, Department of Community Nutrition, National Nutrition and Food Technology Research Institute, Faculty of Nutrition and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran. E-mail: omidvar.nasrin@gmail.com

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Background: Adequate calcium intake may have a crucial role with regards to prevention of many chronic diseases, including hypertension, hypercholesterolemia, different types of cancer, obesity and osteoporosis. In children, sufficient calcium intake is especially important to support the accelerated growth spurt during the preteen and teenage years and to increase bone mineral mass to lay the foundation for older age.
Objectives: This study aimed to assess daily calcium intake in school-age children to ensure whether they fulfill the FGP dairy serving recommendations, the recommended levels of daily calcium intake and to assess the relationship between dietary calcium intake and major bone health indicators.
Patients and Methods: A total of 501 Iranian school-age children were randomly selected. Calcium intake was assessed using a semi-quantitative food frequency questionnaire. Bone health indicators were also assessed.
Results: Dairy products contributed to 69.3% of the total calcium intake of the children. Daily adequate intake of calcium was achieved by 17.8% of children. Only 29.8% met the Food guide pyramid recommendations for dairy intake. Dietary calcium intake was not significantly correlated with serum calcium and other selected biochemical indicators of bone health.
Conclusions: The need for planning appropriate nutrition strategies for overcoming inadequate calcium intake in school age children in the city of Tehran is inevitable.

Keywords: Calcium Intake; Food Groups; Children

1. Background

Adequate calcium intake may have a crucial role with regards to prevention of many chronic diseases, including hypertension (1, 2), hypercholesterolemia (3), different types of cancer (4, 5), obesity (6-8) and osteoporosis (9). In children, sufficient calcium intake is especially important to support the accelerated growth spurt during the preteen and teenage years and to increase bone mineral mass to lay the foundation for older age (10-12).

In terms of density and bioavailability, milk and other dairy products are the best dietary sources of calcium (13). Considering the nutritional value of milk and dairy products and the poor food choices in today's daily intake of children and adults, consumption of dairy products is being perceived as an important indicator of adequate calcium intake in one's diet (14). However, the contribution of other sources of calcium to children's diet can vary between different nations due to social, cultural and economic factors that affect dietary pattern (15-18). Recent reports have shown low calcium intake and dairy products consumption globally, especially in children and adolescents (19-22).

In Iran, based on the last national household food consumption survey data, calcium is the most limiting nutrient in the nation's diet (23). On the other hand, previous research done in 23 provinces of Iran reported the prevalence of hypocalcaemia in approximately 60% of eight to ten year old school children (24). In addition, an increase in the prevalence of osteoporosis in the country (2) and recent reports on the high prevalence of vitamin D deficiency in urban children (25), has raised concern about the dietary calcium intake in Iranian children and adolescents. Limited data is available on the dietary intake of Iranian children. From a public health point of view, therefore, determining the extent to which calcium inadequacies may be occurring is of great value.

2. Objectives

We assessed calcium intake in school children to ensure whether they fulfill the Food Guide Pyramid (FGP) dairy serving recommendations, the recommended levels of daily calcium intake and also to evaluate the circulating bone health indicators and their relation to dietary calcium intake.

3. Patients and Methods

3.1. Subjects

The study population was a subsample of a larger study entitled "vitamin D status of 9 - 12-year-old primary-school children in Tehran during autumn and winter 2007 - 2008 (25) who were selected randomly from the main sample. For the main study, a two-stage sampling was performed. In the first stage, sixty primary schools were selected through systematic random sampling from the schools in all nineteen districts of the Ministry of Education in the city of Tehran. In the second phase, sixteen to twenty children from each school from grades 4 and 5 were enrolled in the study. Students provided written consent to enroll in the study. Overall 501 students from grades 4 and 5 from 47 (out of 60 schools in the original study) elementary schools were included in this sub-study. The study protocol was scientifically and ethically approved by the Research Council and the Ethical Committee of the National Nutrition and Food Technology Research Institute, respectively (25).

3.2. Dietary Intake

For this study, calcium intake was assessed using a 60-item quantitative food frequency questionnaire (FFQ), specifically designed for dietary sources of calcium. The steps followed for design and validation of the questionnaire has been reported elsewhere (26). The questionnaire was completed through face-to-face interviews with the children by trained nutritionists at schools. A food photo album and measuring cups were used to ensure accuracy of the reported servings. For each food item in the FFQ, frequency of intake was asked on a "day/week/month/or never" basis. Following this, serving size was assessed as "usual serving size in each time of consumption".

Table 1. Food Groupings in the Study Based on Dietary Guidelines and Calcium Contents

Food Groups	Items
Dairies	
Fluid milk	milk, cocoa milk, coffee milk, chocolate milk, flavoured milk
Yogurt	regular yogurt and drained yogurt
Cheese	all types, mainly feta
Others	kashk/evaporated yogurt, ice cream, dough/yogurt drink
Breads and Cereals	
Breads	different types of Iranian flat breads, white bulky breads, French and other breads
Rice and pasta	all types of rice, pasta, wheat
Cookies, sweet rolls	all kinds of cookies, sweet rolls (biscuits, cookies, cakes, confectionaries, Danish roll)
Fruits	
Citrus	orange, tangerine
Other fruits	apple, dogberry, plums, other
Dried fruits	raisins, dried sloe, dates, tamarind
Fresh fruit juice	natural fruit juice (orange, apple)
Vegetables	
Tomatoes	tomatoes (cooked or raw)
Cucumber	cucumber
Lettuce	lettuce (salad/leaves)
Cabbage	cabbage (white/red/cauliflower/broccoli/ Brussel sprouts as pickled, cooked/raw)
Green leafy vegetables and spinach	green leafy vegetables, spinach (raw, cooked, stewed)
Meats and alternatives	
Meats and eggs	red meat:(stew /broth/muscle/kebab, minced meat, hamburger, chicken, eggs
Fish	any type of fresh or frozen fish, canned tuna fish
Legumes	lentil, beans: red /white/wax bean, peas, split peas, and soy nut
Nuts	walnuts, almonds, peanuts, pistachios, hazelnuts, sunflower seeds, watermelon seeds, pumpkin seeds, hemp, sesame, Halva Shekari/sesame sweets, and chocolate

FFQs were analyzed for the daily amount and food sources of calcium intake. All food items included in the FFQ food list were also grouped according to Iran's Food-Based Dietary Guideline (27). To determine the specific food types, six main groups of the guidelines were then subdivided into 20 groups Table 1.

Number (%) of children meeting the FGP recommendations and Recommended Dietary Allowance (RDA) was identified. FGP recommendation for 9-13 year-old age is three servings/day and RDA recommendation (Adequate Intake: AI) is ≥ 1300 mg/day.

3.3. Socio-Economic Characteristics

Socio-economic factors were evaluated through an interview with a questionnaire. Variables such as: family size, father's and mother's education (illiterate, primary/middle school, high school diploma, university degree), father's and mother's occupation (unemployed, low, middle, high) and Socio Economic Status (SES) by district (low, middle, high) were included.

3.4. Selected Circulating Bone Health Biomarkers

The procedure of blood sampling and handling is fully described elsewhere (25). Briefly, venous blood samples were taken and stored in the dark until serum separation. Sera were transferred to clean micro tubes in aliquots and kept at -80°C until the day of analysis. Serum 25(OH)D3 was determined using a competitive protein-binding assay (Immunodiagnostic, Bensheim, Germany). Concentrations of osteocalcin (OST; Biosource Europe SA, Nivellles, Belgium), intact parathyroid hormone (iPTH; DRG Instruments GmbH, Marburg, Germany) were all determined using enzyme immunoassay by an automatic system (StatFax 3200 micro plate ELISA reader; Awareness Technology, Inc., Palm City, FL, USA). Calcium, magnesium and phosphorous serum levels were measured by commercial kits (Pars Azmoon, Iran) based on colorimetric methods using an automatic device (Selectra E, Vitalab, The Netherlands).

3.5. Estimation of Daily Calcium Intake

Calcium content of food items was determined based on the revised edition of the Iranian food composition table. Estimates of calcium intake per day were obtained using Microsoft Office Excel 2007, by multiplying frequency per day by the calcium content per gram and gram weight of eaten food and adding together total intake.

3.6. Statistical Analysis

Normality of data distribution was evaluated using the Kolmogrov-Smirnov test. Data were expressed as mean and as a standard deviation. Comparison of normally distributed data between the two groups was done by using an independent sample t test. One way-analysis of variance (ANOVA) was used for comparison of more than two groups and post hoc Tukey HSD test was used to compare within-group differences. The Chi square test was used to compare qualitative data between groups. Energy adjusted calcium intake of different food groups was calculated using residual method. Correlations between non-normally distributed variables including dietary calcium intake and serum concentrations of calcium and other bone biomarkers were evaluated using Spearman's equation. $P < 0.05$ was considered statistically significant. All statistical analyses were performed using SPSS version 17 (SPSS Inc., Chicago, IL, USA).

4. Results

Characteristics of the 501 studied school-age children are presented in Table 1. There were no differences in anthropometric profile and the socioeconomic characteristics between girls and boys.

4.1. Total Daily Calcium Intake

Total daily energy and dietary calcium intake of the children and the adequacy of calcium intake compared to RDA is presented in Table 2. The girls in the study consumed less dietary calcium in comparison to the boys but the difference was not statistically significant. However, after adjusting for energy intake, calcium intake of boys from meats and alternatives (specifically meats and eggs subgroups) and, bread and cereals (specifically breads) were significantly higher than for girls. Dairy products were the main food sources of calcium in the studied children; whereas only one third of the children had adequate daily servings of dairy products, based on current recommendations (two to four servings of dairy products daily) (28). Only 17.8% of participants had adequate daily intake of calcium (≥ 1300 mg/day) and 29.8% met the FGP recommendations for dairy intake (≥ 3 serving/day). More than half of the children had calcium intake below 75% of RDA, while inadequate dairy intake (<1 serving/day) was observed in 10.2%. Dairies provided 69.3% of total calcium intake of the studied children.

4.2. Major Sources of Dietary Calcium

As demonstrated in Table 3, major dietary sources of calcium that contributed to total daily calcium intake were dairy products (71.9%) [specifically yogurt and milk], breads and cereals (10.5%) [specially breads], fruits (7.4%) [specially citrus], meats and alternatives (6.6%) [specially nuts], as well as vegetables (4.4%) [specifically green leafy vegetables]. Except for the vegetables, the average calcium intake from the four other groups was higher in boys as compared to girls; the differences were significant just for breads and cereals and fruit groups ($P < 0.05$). After adjusting for energy intake, the differences became significant only in meats and alternatives (specifically in meats and eggs subgroups) and bread and cereals (specifically breads) (data are not shown in Table 3).

Table 2. Total daily Energy, Dietary Calcium Intake and Selected Bone Health Indicators of School age Children in Tehran, 2008 [a, b, c]

Variable	Girls (n = 244)	Boys (n = 257)	Total (n = 501)	P Value
Total energy intake/day	1437.0 (545.0)	1563.2 (597.6)	1501.8 (575.5)	< 0.05
Dietary calcium intake, g/day	901.2 (447.7)	932.8 (434.4)	917.5 (440.8)	0.42
Meeting AI, ≥ 1300 mg/day [d]	46 (18.9)	48 (18.7)	94 (17.8)	0.96
Inadequate calcium intake, Total Ca intake < 75% RDA [d]	151 (30.1)	149 (29.7)	300 (59.9)	0.37
Dairies consumption, serving/day	2.4 (1.3)	2.5 (1.3)	2.3 (1.2)	0.42
Meeting FGP recommendations, ≥ 3 serving/day [d]	74 (30.3)	71 (27.6)	145 (28.9)	0.58
Inadequate dairy intake, < 1 serving/day [d]	27 (11.1)	24 (9.3)	51 (10.2)	0.58
Total calcium intake from dairies [d]	69.8 (13.8)	68.7 (12.0)	69.3 (12.9)	0.10
Serum Ca, mg/dL	9.6 (0.68)	9.7 (0.58)	9.6 (0.03)	0.51
Serum P, mg/dL	4.5 (0.61)	4.5 (0.60)	4.5 (0.03)	0.40
Serum Mg, mg/dL	2.2 (0.17)	2.1 (0.16)	2.1 (0.01)	0.15
iPTH, mg/L	61.4 (41.2)	40.1 (18.6)	43.4 (0.83)	0.53
OST, ng/mL	43.9 (17.4)	42.9 (16.6)	50.7 (1.68)	< 0.001
25(OH)D3, nmol/L	16.9 (14.0)	28.5 (22.2)	22.8 (0.94)	< 0.001

[a] Data are presented as No. (%) or Mean ± SD.
[b] Significance calculated by independent t test or Chi-square test depending on the type of variables.
[c] Food guide pyramid (FGP) recommendations for 9 - 13 year old: three servings/day.
[d] % total calcium intake from dairies: dairy calcium intake, mg/day total calcium intake, mg/day × 100.

Table 3. Contribution of Food Groups (Mean ± SE) to Total Daily Calcium Intake, g/day of School age Children by Gender, Tehran, Autumn and Winter 2007 - 2008 [a]

Food Group	Girls (n = 244)	Boys (n = 257)	Total (n = 501)	From Total Calcium intake, %	P Value
Dairies	653.6 (24.2)	666.2 (22.6)	660.3 (17.7)	71.9	0.91
Fluid milk	272.5 (13.7)	275.3 (11.7)	273.9 (9.0)	29.8	0.49
Yogurt	275.0 (16.1)	277.0 (16. 2)	276.1 (11.4)	30.2	0.93
Cheese	58.7 (3.4)	63.1 (3.3)	60.9 (2.4)	6.6	0.36
Others	47.3 (3.4)	50.7 (3.0)	49.4 (2.0)	5.3	0.43
Breads and Cereals	90.1 (1.3)	100.8 (3.3)	96.7 (2.3)	10.5	< 0.05
Breads	56.9 (3.3)	66.6 (2.4)	62.9 (1.6)	6.8	< 0.01
Rice and pasta	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0	-
Cookies, sweet rolls	33.1 (2.3)	34.1 (1.8)	33.6 (1.4)	3.7	0.73
Fruits	62.5 (2.8)	73.4 (3.3)	68.0 (2.2)	7.4	< 0.05
Citrus fruits	46.6 (2.3)	54.8 (2.6)	50.8 (1.8)	5.5	< 0.05
Other fruits	3.5 (0.2)	4.2 (0.3)	3.8 (0.1)	0.5	0.06
Dried fruits	7.6 (0.8)	10.1 (1.2)	8.9 (0.3)	0.9	0.09
Fresh fruit juice	4.6 (0.4)	4.1 (6.3)	4.3 (0.3)	0.5	0.49
Vegetables	41.6 (2.4)	38.8 (0.3)	40.9 (1.5)	4.4	0.08
Tomatoes	3.8 (0.3)	3.1 (0.2)	3.5 (0.2)	0.3	0.09
Cucumber	9.0 (0.6)	9.5 (0.7)	9.3 (0.4)	1.1	0.57
Lettuce	2.0 (0.1)	2.2 (2.9)	2.1 (0.1)	0.2	0.47
Cabbage	6.0 (0.6)	5.9 (0.1)	6.0 (0.4)	0.6	0.95
Green leafy vegetables and spinach	20.5 (1.7)	17.8 (1.3)	19.1 (1.0)	2.2	0.19
Meats and alternatives	59.8(4.2)	61.5 (3.7)	60.7 (2.8)	6.6	0.36
Meats and eggs	19.2 (0.9)	23.2 (1.0)	21.3 (0.6)	2.2	< 0.01
Fish	1.5 (0.1)	1.8 (0.1)	1.7 (0.1)	0.1	0.12
Legumes	10.9 (1.1)	12.6 (1.3)	11.8 (0.8)	1.2	0.21
Nuts	29.8 (3.5)	26.3 (2.8)	32.1 (2.6)	3.3	0.07

[a] Comparison of calcium intake between two genders was done by t-test. After adjusting for energy intake by residual method, differences between the two genders in calcium intake, mean intake of fruits group, citrus fruits and breads subgroups became insignificant. Instead, the difference of calcium intake of meats and alternatives became significant; breads and cereals group as well as meats and eggs subgroup remained significant (P < 0.05).

4.3. Association Between Dietary Calcium Intake and Socio-Demographic Factors

Comparison of total calcium intake (mg/day) according to the characteristics of socio-economic status (SES) of the school age children by gender is presented in Table 4. Total calcium intake of children was not significantly different between the three socioeconomic districts; however, among girls, mean total daily calcium intake was significantly different between the three SES districts. Comparisons within districts showed that mean total calcium intake of girls in middle SES districts was significantly lower than in boys in both low and high SES districts. Also, significant difference was seen between the two genders' calcium intake in middle SES districts ($P < 0.05$). No significant differences were found between other socioeconomic variables within genders.

Table 4. Comparison of Total Calcium Intake (mg/day) According to Socio-Economic Characteristics of the School age Children by Gender, Tehran [a, b, c, d]

Variables	Girls (n = 244)	Boys (n = 257)	Total (n = 501)	P Value
Family Size				
≤ 3	960.0 (80.2)	879.9 (73.5)	934.5 (55.4)	0.39
> 3	888.0 (30.4)	939.9 (30.1)	917.4 (21.4)	0.22
Father's occupation				
High	836.7 (59.0)	1029.1 (97.6)	920.5 (54.9)	0.09
Middle	944.5 (38.0)	938.7 (33.6)	941.6 (25.3)	0.90
Low	816.4 (69.2)	935.2 (67.6)	878.5 (48.5)	0.22
Unemployed	767.9 (43.2)	795.6 (71.6)	781.6 (70.1)	0.18
P-value	0.30	0.08	0.06	
Father's education				
Illiterate	320.5 (167.2)	1403.2 (290.9)	1186.7 (312.5)	0.19
Primary/middle school	811.9 (47.4)	893.6 (47.6)	857.5 (33.9)	0.23
High school/Diploma	935.3 (50.8)	933.9 (44.1)	934.6 (33.6)	0.98
University degree	955.6 (53.7)	955.7 (54.4)	955.7 (38.1)	0.99
P-value	0.14	0.14	0.13	
Mother's occupation				
High	536.4 (127.8)	-	536.4 (127.8)	-
Middle	1059.5 (73.3)	1036.9 (65.7)	1046.4 (48.6)	0.82
Low	792.3 (273.5)	834.2 (174.8)	822.2 (80.8)	0.83
Unemployed	889.4 (32.4)	918.2 (32.7)	903.3 (23.0)	0.53
P-value	0.16	0.25	0.08	
Mother's education				
Illiterate	808.0 (234.4)	1416.6 (250.4)	1112.7 (256.3)	0.08
Primary/middle school	803.5 (45.0)	925.9 (415.0)	874.2 (32.8)	0.06
High school/ Diploma	949.2 (43.3)	907.4 (42.6)	929.4 (30.4)	0.49
University degree	902.9 (68.0)	1000.3 (58)	952.1 (44.9)	0.28
P-value	0.12	0.08	0.34	
SES by district				
Low	973.0 (57.7)	940.3 (61.3)	958.1 (41.9)	0.41
Middle	780.3 (44.35)	964.5(48.5)	880.3 (33.9)	< 0.05
High	950.2 (46.5)	901.8 (37.6)	925.1 (21.5)	0.10
P-value	< 0.05	0.58	0.31	

[a] Significance of differences between girls and boys calculated by independent t test or one way-ANOVA test depend on the type of variables.
[b] The independent sample t was not computed because High level occupation box in boys group was empty.
[c] One way-ANOVA test was used to compare mean of total calcium intake between groups in each gender and in total participants.
[d] P < 0.05 in comparison with Low and high SES districts. (Tukey HSD test was used in order to comparison within group.

Table 5. Spearman Correlation Between Dietary Calcium Intake and Selected Parameters Affecting Calcium Homeostasis in Iranian School age Children

Coefficient Parameters Total	Dietary Ca, mg/day	Serum Ca, mg/dL	Serum P, mg/dL	Serum Mg, mg/dL	iPTH, mg/L	OST, ng/mL	25(OH)D3, nmol/L
Dietary Ca, mg/day	-	0.09	-0.06	-0.02	-0.08	0.0	
Serum Ca, mg/dL	0.09	-	0.11 [a]	0.05	0.02	-0.18 [b]	0.02
Serum P, mg/dL	-0.06	0.11 [a]	-	0.12 [a]	0.03	-0.12 [a]	0.08
Serum Mg, mg/dL	-0.02	0.05	0.12 [a]	-	0.06	-0.10 [a]	-0.09
Ipth, mg/L	-0.08	-0.22 [b]	0.03	0.06	-	0.11	-0.18 [b]
OST, ng/mL	0.0	-0.18 [b]	-0.12 [a]	-0.10 [a]	0.11	-	0.04
25(OH)D3, nmoL/L	0.08	0.02	0.08	-0.09	-0.18 [b]	0.04	-

[a] $P < 0.05$.
[b] $P < 0.00$.

4.4. Selected Parameters Affecting Calcium Homeostasis

There were no significant differences between boys and girls in serum calcium, phosphorus, magnesium and OST. However, boys had significantly lower serum iPTH but higher 25 (OH) D3 than girls ($P < 0.001$) (Table 2). Dietary calcium intake was not significantly correlated with serum calcium or other biochemical biomarkers of bone health. Serum concentrations of iPTH inversely correlated with those of 25(OH) D3. Table 5 shows the results of Spearman analysis among other variables.

5. Discussion

The findings of this study revealed that the dietary calcium intake of Tehranian 9-12 year-old-children was relatively low, with more than half having inadequate intake. Adequate intake of dairy product is associated with better linear growth and bone development during childhood (29). However, recent reviews of the effect of dairy product and calcium consumption on bone health have presented conflicting conclusions. In the present study, no relationship between dairy product consumption and circulating markers of bone health was observed.

Based on the last report of the American Dietetic Association in 2011, the AI of Ca in 9-13 year old school age children (male and female) is 1300 mg/day (30). In the present study only 17.8% of Tehran school children met the AI. A study by Storey and colleagues on USDA data, on calcium consumption of 9-13 year old girls and boys have shown higher proportion of children with AI: 842 (65% AI) and 1022 (79% AI) mg/day, respectively (18). However, based on CSFII (Continuing Survey of Food Intake by Individuals) and NHANES (National Health and Nutrition Examination Survey) datasets, 18.4% of individuals aged 9-13 years had AI of Ca (13) while in non-Hispanic white girls only 31% of 9 year old and 27% of 11 year old girls met the AI of Ca (31). In a study that was done on 1176 Spanish 5 to 12 years old schoolchildren, calcium intake below 800 mg per day was considered as insufficient intake; and 18% of girls and 13% of boys did not consume these amounts (32). In our study, more than half of children had inadequate calcium intake (< 75% RDA). In comparison with present study, in a representative sample of Spanish children (7 to 11 years) from 10 Spanish provinces, calcium intake was lower than that recommended in 76.7% of the children and 40.1% had insufficient intake (< 67% of recommended intake) (33).

In this study, mean total calcium intake of girls and boys was not significantly different however, girls in middle socioeconomic districts had a significant lower intake than in high and low SES districts. It has been shown that good calcium intake during adolescence may improve peak bone mass (34). This effect may be due to the linkage of calcium intake with androgens, as low calcium intake may be associated with decreased serum androgens in pre-pubertal girls which may lead to delayed skeletal maturity (35). No difference was observed in calcium intake of boys based on SES.

In the USDA report, there was a small difference in calcium intake between American boys and girls after controlling of confounders (age, race/ethnicity, diet, and beverages); however, being female was significantly associated with 26 mg less calcium consumption in 9–18 year old children (18). Also, an analysis on NHANES II data has shown higher intake of calcium in 3-18 year old boys compared to girls (36). Fiorito and colleagues in a survey on 151 girls from middle-class, non- Hispanic white families living in central Pennsylvania, showed that girls at age 9 and 11 years did not meet calcium and phosphorus recommendations (31).

Dairy products are the best sources of calcium because of their high calcium content and bioavailability, high amounts of other essential nutrients for bone health with relative low cost (13). USDA's Food Guide Pyramid (FGP) recommends that individuals 2 years and over consume 2-3 servings of dairy per day depending on age (37). In our study, almost two thirds of participants (69.7% of girls and 72.4% of boys) did not meet the Food Guide Pyramid (FGP) recommendations for dairy intake. However, in datasets of the CSFII and NHANES, 44.5% of American children in 2-8 years of age and 19.2% of them in 9-18 years of age met the FGP (13). Furthermore, Fiorito and colleagues found that girls at age 7, 9, and 11 years did not meet the recommended dairy level for their age (three servings per day) and only 39% of 11 year old girls met dairy recommendations (31). In the USDA survey, servings of milk products had the strongest relationship with calcium consumption and each additional gram of milk product was associated with a 1.2 mg increase in calcium consumption for ages 9-18 (18). Storey and colleagues showed that consumption of milk and milk products has the strongest association with calcium consumption (18). Also, Gao and colleagues have reported that in American 9 to 18 year old participants of NHANES from 2001-2002, average calcium intakes in both females and males were lower in those who did not consume dairy products in comparison with those who consumed these products (38).

In the present study, some differences in food sources of calcium were observed between the two genders. After adjusting for energy intake, the calcium intake of boys from meats and alternatives (specifically in meats and eggs subgroups) and, bread and cereals (specifically in breads) groups were significantly higher in the boys compared to the girls. In total sample, calcium was mainly provided by dairy products (especially yogurt and milk). Other sources of calcium, in order of the amount of consumption, were bread and cereals, meat and alternatives, fruits and vegetables. In the current study, findings are relatively comparable with results of the study in Spanish schoolchildren in whom food dietary calcium came from dairy products, dietetic products and infant formulae, cereals, vegetables, fruits, pre-cooked meals, meats, fish and pulses, respectively and there was no difference between genders (33). Furthermore, in 696 of 2.5-6.5 year-old Flemish preschoolers, in 58 food groups, calcium and vitamin D intake was computed and milk, sweetened milk drinks and cheese were the main sources of calcium intake (16).

Few studies have described socio-demographic factors associated with low calcium intake (17, 39-41). In the present study, socioeconomic factors were not related with mean calcium intake. However, calcium intake of middle classes districts was lower than that of both wealthy and deprived group and a significant result was seen only in girls. In the current study, results are in line with those of Eck and Hackett-Renner (36) on NHANES II data in 3-18 year old boys and girls indicating that socioeconomic status was not a significant predictor of Ca intake. In contrast, Sanwalka and colleagues (17) in a study on calcium intake and its sources in 400 adolescent boys and girls from two lower and upper socioeconomic strata, in Pune, India, showed significant difference between districts and genders. The highest median of calcium intake was in the upper economic strata boys (893 mg, 689-1295) and the lowest intake was in lower economic strata girls (506 mg, 380-674). The median calcium intake was much lower in lower economic strata than in the upper economic strata both in boys and girls; and, girls from both groups had less access to dairy products as compared to boys. Also, the results of current study is consistent with findings of the study performed by the Mexican National Health and Nutrition Survey in 2006 that school-age children at the lowest SES, showed the highest inadequacy for calcium intake (42). In 5-11 year old participants of NHANES III , 44.0% of Low SES girls and 37.3% of Low SES boys had enough dairies consumption (adequate dairy recommendation in this study was defined as ≥ 3 servings/day in girls and ≥ 4 servings/day in boys) (43). However, in the present study, only in the middle district mean intake of boys was significantly higher than that of girls. This does not appear to be due to less access to dairy products or other calcium rich foods in girls, since dairy intake and total calcium intake was not significantly different between the two genders. There is no logic explanation for the lower calcium intake observed in children from middle districts; it may be attributed to low accuracy in data collection or other factors that cannot be clarified by the present data.

In the present study, dietary calcium intake was not correlated with serum calcium and other studied indicators of bone health. Similar to our study, in white adolescent girls at 11 to 16.9 years of age serum calcium and phosphate levels were not associated with calcium intake; while 25 (OH) D levels was associated with calcium and phosphate levels (44). In contrast, Bueno and colleagues (45) assessed calcium and vitamin D intake and biochemical tests in 58 short-stature Brazilian children and adolescents and showed that there is a negative correlation between calcium intake and PTH and a positive relationship between dietary calcium and serum 25(OH)D and 25(OH)D and serum calcium. Rajah and colleagues (46) found same results and reported that 25(OH)D concentrations were directly correlated with calcium, phosphorous and PTH. However in our study, serum levels of calcium and 25(OH) D were not correlated. In another study done on young Japanese women (aged 18-22) dietary intake and serum phosphorus and calcium were positively correlated (47).

There were not any significant differences between boys and girls in serum calcium, phosphorus, magnesium and OST; but serum iPTH and 25(OH) D3 were significantly higher in boys. Based on our previous report (25), 86% of the children had vitamin D deficiency, with 38.3% being severely deficient (25(OH) D $<$ 12.5 nmol/L) and 10.4% of them being hypocalcemic (serum Ca $<$ 9 mg/dL). In a study conducted on 183 urban boys and girls (≤ 12 years old living in Abu Dhabi, in 8-12 years old group, 31.2% had vitamin D deficiency, and 14.5% were hypokalemic (46).

Serum iPTH was inversely correlated with serum 25-OH D3 that is in accordance with other similar studies (44, 46, 48, 49) however, this result was not observed in a study performed on short stature children in Brazil (45). Scant evidence supports nutrition guidelines focused specifically on increasing milk or other dairy product intake for promoting child and adolescent bone mineralization (50).

In our study, serum calcium was directly correlated with serum phosphorus and inversely correlated with serum iPTH and osteocalcin, and serum calcium, phosphorus and magnesium were inversely associated with serum osteocalcin. Similar findings are reported by other studies (51, 52). In contrast to our findings, in a study done on black children of South Africa, there was no correlation between serum Ca and P concentrations (53).

To our knowledge, this is the first report on calcium intake of Iranian primary school children. The strength of this study was the high response rate in all schools. The study has some limitations attributed to all cross-sectional studies. The observational design of this study does not allow one to conclude cause-effect relations.

The findings suggest inadequate calcium consumption among both genders of Tehran's school age children. Dietary calcium was not related to any of the bone health indicators. Considering the fact that dairy products were the main dietary source of calcium in the studied children, the best way to increase calcium consumption in studied samples is implementation of strategies and nutritional educational programs that increase the consumption of dairy products in this vulnerable group. Also based on Dietary Guidelines (13), other nondairy sources of calcium (e.g. canned fish with bones, fortified orange juice, fortified soy beverage, and some dark green leafy vegetables) should be promoted in food baskets of Iranians in order to secure the amount of recommended calcium in the diet. Physical activity appears to be one of the primary modifiable stimuli for increased bone growth and development. Future studies should include modifying factors affecting on bone health and growth such as physical activity in their design and analysis.

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