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Consumption of Bone Mineral Density-Associated Nutrients, and Their Food Sources in Pre-school Japanese Children

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Abstract

In order to fortify bone mineral density (BMD), and to prevent osteoporosis in the future, we investigated consumption of BMD-associated nutrients, and their food sources of pre-school Japanese children. Intakes of minerals (calcium, magnesium, and phosphorus) and vitamins (vitamin D, vitamin K, and vitamin C) were studied based on two weekdays dietary record surveys together with photos taken by 84 parents/caregivers of 5-year-old children. Food sources of relevant nutrients were identified according to contribution analyses, and potential associations of consumption of food sources with selected nutrients were investigated. We further conducted a multiple regression analysis to clarify food/food groups providing calcium. Calcium consumption of approximately 40% of the subjects manifested an inadequacy, but intakes of other nutrients met the criteria of Dietary Reference Intakes (DRIs). Major food sources of calcium were milk and dairy products, green and yellow vegetables, soybeans, and other vegetables, and 50% of calcium was supplied by milk and dairy products. Other nutrients were provided by, various food/food items, including milk and dairy products, vegetables, soybeans, fruit, fish and shellfish, meat, eggs, potatoes, and algae. A multiple regression analysis also detected that milk and dairy products were top contributors of calcium intake. Because there was an obvious inadequate intake of calcium in Japanese children, they are advised to enhance consumption of calcium from milk and dairy products and BMD-related minerals and vitamins from green and yellow vegetables, and other vegetables at home. Pertinent nutrition education should be given to parents/caregivers for promotion of bone health.

Keywords: Bone mineral density; Food/food item; Japanese children; Mineral; Vitamin

Abbreviations: AI: Adequate intake; BMD: Bone mineral density; DRIs: Dietary reference intakes; EAR: Estimated average requirement; KNU: Kagawa Nutrition University; QOL: Quality of life; RDA: Recommended dietary allowance; STFC: Standard Tables of Food Composition

Introduction

In Japan, due to the growth of the elderly population, the number of osteoporosis patients has increased annually. Its prevalence was estimated to be 1.28 million (aged 40 years or over) as of 2005 [1]. Osteoporosis brings about health-care problems and social issues because it causes not only bone fracture, bedridden confinement, reduction of activities of daily living, shortening of life/healthy life expectancy, and degrading quality of life (QOL), but also an increase in medical/health-care expenditures.

Since the mid-90s, it has been well established that it is important to achieve as high bone mineral density (BMD) as possible prior to late adolescence when the peak BMD is attained [2-4]. Calcium and other BMD-associated nutrients are critical for fortifying BMD and for bone health [5-7], and it seems prerequisite to increase consumption of calcium-rich and other various food items, and weight-loaded physical exercise from childhood to adolescence [4-8].

Our lifestyle diet, sleep, defecation, tidiness, dressing etc. are developed and stabilized during childhood, and do not change much later in life [9-11]. Pre-school dietary preferences are important, but there are few relevant Japanese studies.

We studied Japanese children's intake of BMD-associated minerals (Ca, Mg and P), vitamins D, K and C and food sources at home attending nurseries to establish a baseline for preventing later osteoporosis development, curricular changes, catering guide-lines and parental advice.

Materials and Methods

Subjects

We invited the Department of Health and Welfare, N City, Aichi Prefecture and guardians of 5-year-olds attending 7 nurseries to study their two weekday dietary surveys, and received data for 84 (34/50 boys/girls) of the 98 participants.

Dietary record surveys

Two weekday dietary records and pre- and post-meal photos were taken during the 1st fortnight in June 2011, including menus and portion sizes for all meals at home. We issued a 3 × 3 cm gridded mat, a 12 cm diameter bowl, and a photo manual, requesting pictures of all food at 45°. Two trained dieticians (SH, RS) estimated the constituents accordingly. School caterers provided menus; it was assumed that everything was consumed.

Classification/categorization of food/food groups

Using the Standard Tables of Food Composition in Japan 2010 (STFC-J 2010) [12], we classified rice, bread, noodles and other cereals, Japanese and Western confectioneries, soy and other beans, green, yellow and other vegetables into 24 groups. Food consumption was assessed using the Kagawa Nutrition University Diet (KNU-Diet) food

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composition [13,14], and wet weights were measured for dried foods.

Intakes of energy and nutrients

Energy and nutrient consumption was calculated using STFC-J 2010 [12] and the Excel Nutrient Calculator, Ver. 6.0 (Kempaku-sha). Nutrient consumption was evaluated with reference to Dietary Reference Intakes for Japanese 2015 (DRIs-J 2015) [15] for Ca, Mg and vitamin C given estimated average requirements (EARs). Deficiencies were judged relative to the EAR using the cut-point method. When intakes of P and vitamins D and K exceeded adequate intake (AI), risks are considered low; comparison was made for weighting EAR and AI values by sex.

Statistical analyses

Statistics were calculated for continuous variables, including mean ± standard deviation (SD). The % contribution of BMD-associated minerals and vitamins and % cumulative contribution by top five foods in food consumed at home was computed as follows.

Percent contribution=(Amount of a nutrient provided by each food/food item/day ÷ total amount of the nutrient provided by all food/food items/day) × 100

We estimated the frequency of daily consumption and median portion sizes of respective foods. To clarify the relationship between foods and nutrients, we obtained Pearson correlation coefficients. The associations between Ca intake and food/food items were assessed using multiple regression analysis with Ca intake as a dependent variable and food consumption as independent parameters. An IBM SPSS Statistics 22 performed the statistical analyses; two-tailed $p<0.05$ was considered statistically significant.

Ethical issue

The Ethics Review Board of Nagoya University of Arts and Sciences (No. 124) approved the research protocol. The pre-school Japanese 5-year-olds' guardians were fully informed, and we obtained written consent.

Results

Study subjects

Anthropometric characteristics: the average height was 110.0 ± 4.6 cm, weight 18.5 ± 3.1 kg (Table 1). Kaup index: (body weight (g) / height (cm)^2) × 10 for 78 subjects was 15.3 ± 1.6, corresponding to the values in the National Survey of School Health Statistics 2011 [16]. The average family had 4.5 members, 2.3 adults and 2.2 children.

Intakes of food/food items and energy and nutrients

Consumption of food/food items: Average intakes of sugar, fish, shellfish and meat exceeded reference values [13,14] i.e., >50% had sufficient (Table 2). Mean intakes of cereals, potatoes, pulses, green, yellow and other vegetables, fruit, eggs, milk and dairy products, fats and oils were < respective standard figures; in particular pulse and fruit consumption was low.

	Mean (SD)[a]	Minimum	Maximum
Height (cm)	110.0 (4.6)	98.9	122.0
Weight (kg)	18.5 (3.1)	14.7	24.8
Kaup index[b]	15.3 (1.6)	13.5	18.9
Number in family (n)	4.5 (1.0)	3	8
Adults (n)	2.3 (0.7)	1	5
Children (n)	2.2 (0.7)	1	4

[a]Mean (standard deviation)
[b](Body weight (g)/body height (cm)^2) × 10 (n=78)

Table 1: Characteristics of study subjects (n=84).

Consumption of energy and nutrients

Average energy consumption: 1,348 ± 151 kcal/day (812 ± 146 kcal/day at home) (Table 3)

Ca intake: 516 ± 118 mg/day (278 ± 120 mg/day)

Mg 182 ± 30 mg/day (110 ± 28 mg/day)

P 757 (670/845, median 25/75th percentile) mg/day (477 [425/562] mg/day)

Vitamin D 2.7 (1.8/4.3) μg/day (1.9 [1.1/3.4] μg/day)

Vitamin K 136 (99/167) μg/day (85 [57/129] μg/day) and

Vitamin C 89 ± 27 mg/day (54 ± 24 mg/day)

42.9% of subjects had inadequate Ca consumption; except for P, other nutrient intakes met DRI criteria. Median P intake was 757 mg/day, AI 800/600 mg for boys/girls; the weighted average for all subjects, 679 mg. The median P consumption exceeded the weighted average. Apart from Ca, all nutrient intakes were satisfactory, home consumption of Ca contributed ~ 54%. Figures for energy and other nutrients ranged from ~ 60% (carbohydrate) to 78% (vitamin D).

Food sources of minerals and vitamins

Contribution analysis: Table 4 shows the % contribution and % cumulative contribution, average frequency of consumption/day and portion size (g) of selected BMD-related nutrients for food/food items consumed at home. The top five food sources contributed proportions ranging from vitamin D (98%) to Mg (50%), varying greatly by nutrient. Milk and dairy products provided 50% of Ca, 24% of P and 12% of Mg. Green and yellow vegetables supplied 41% of vitamin K. Fruit determined vitamin C (34%); green and yellow vegetables (33%). Fish and shellfish provided vitamin D (69%).

Association studies between consumption of food sources and nutrients

Table 5 shows Pearson correlation coefficients between 14 foods and BMD-related nutrients. Strong associations for minerals were observed for milk and dairy products: v Ca (r=0.846) (p<0.01) and v P (r=0.660). Other significant correlation coefficients ranged from ~ 0.2-0.4. Moderate associations for vitamins, were demonstrated for fruit and vitamin C (r=0.480) (p<0.01), fish and and shellfish and vitamin D (r=0.440), and green and yellow vegetables and vitamin K (r=0.403). Other significant correlations ranged from r=0.376 (for both soybeans v vitamin K and meat v vitamin C) to r=0.237 (for seasonings and spices v vitamin K).

Multiple regression analysis

Since Ca intake was deficient, multiple regression analysis was used to investigate the potential of foods for further weighting it, with Ca consumption as a dependent parameter and food intakes (including milk and dairy products, soybeans, green, yellow and other vegetables and Western confectioneries taken from a contribution analysis and algae taken from a correlation study) as independent variables. Table 6 shows significant associations between Ca intake and milk and dairy product consumption, green and yellow vegetables, and soybeans.

Discussion

We analyzed 2 weekday dietary record surveys and photos

Classification in the STFC-J2010[a] (18 groups)	Categorization adopted in the present study (24 groups)	KNU-Diet[b] food consumption	Total intake[c]		Intake at home		Proportion consumed at home (%)[d]
			Mean	SD	Mean	SD	
Cereals	#1 Rice #2 Breads #3 Noodles #4 Other cereals	350	220.3 33.8 18.7 17.1	(60.2) (25.1) (31.6) (8.5)	127.3 27.0 8.3 4.7	(49.4) (22.7) (21.6) (5.9)	57.8 80.1 44.3 27.4
Potatoes and starches	#5 Potatoes and starches	60	41.3	(27.4)	18.6	(17.4)	45.1
Sugars and sweeteners	#6 Sugars and sweeteners	5	5.8	(3.3)	2.6	(2.4)	44.9
Pulses	#7 Soybeans #8 Other beans	60	28.7 7.7	(20.0) (8.1)	16.5 0.4	(16.6) (1.9)	57.6 5.7
Nuts and seeds	#9 Nuts and seeds		0.6	(0.9)	0.4	(0.9)	66.0
Vegetables	#10 Green and yellow vegetables #11 Other vegetables	80 160	76.0 109.9	(31.9) (30.9)	58.0 58.2	(30.8) (28.5)	76.4 53.0
Fruit	#12 Fruit	150	96.7	(49.8)	57.1	(43.6)	59.0
Mushrooms	#13 Mushrooms		5.8	(6.0)	4.1	(5.8)	71.4
Algae	#14 Algae		8.6	(7.5)	4.9	(7.0)	56.6
Fish and shellfish	#15 Fish and shellfish	60	24.9	(17.6)	19.7	(16.9)	79.1
Meat	#16 Meat		55.0	(20.5)	36.2	(19.2)	65.8
Eggs	#17 Eggs	30	27.3	(19.5)	24.4	(19.6)	89.3
Milk and dairy products	#18 Milk and dairy products	250	219.6	(89.6)	116.9	(84.3)	53.2
Fats and oils	#19 Fats and oils	10	6.9	(2.8)	3.6	(2.5)	52.3
Confectioneries	#20 Japanese confectioneries #21 Western confectioneries		4.1 30.9	(7.8) (30.5)	2.7 23.5	(7.2) (28.4)	66.0 76.0
Beverages	#22 Beverages		294.3	(112.8)	114.3	(112.8)	38.8
Seasonings and spices	#23 Seasonings and spices		87.3	(72.3)	78.7	(71.6)	90.2
Prepared foods	#24 Prepared foods		2.3	(4.9)	1.2	(4.6)	50.1

[a]Standard Tables of Food Composition in Japan 2010
[b]Kagawa Nutrition University Diet
[c]Intake at home+intake at nurseries
[d](Intake at home/Total intake) × 100
[e]Weight of dried food/food items eaten after cooking was measured after soaking them in water

Table 2: Daily consumption of food/food items according to the classification adopted in the present study (n=84).

	DRIs-J 2015[a]	Total intake[b]		Intake at home		Proportion of intake at home (%)	Proportion of inadequacy in reference to DRIs-J 2015 (%)
	(Boys, Girls)	Mean	SD	Mean/Median	SD		
Energy (kcal)	(1,300, 1,250)[c]	1,348	(151)	812	(146)	60.3	
Protein (g)	(20, 20)d	49.8	(6.4)	31.2	(6.3)	62.6	0[e]
Fat (g)	NA[f]	40.5	(7.7)	25.6	(7.1)	63.2	
Carbohydrate (g)	NA	189.9	(24.1)	112.7	(21.4)	59.3	
Calcium (mg)	(500, 450)[d]	516	(118)	278	(120)	53.9	42.9[e]
Magnesium (mg)	(80, 80)[d]	182	(30)	110	(28)	60.5	0[e]
Phosphorus (mg)	(800, 600)[g]	757	[670, 845][h]	477	[425, 562]	65.5	low risk[i]
Vitamin D (μg)	(2.5, 2.0)[g]	2.7	[1.8, 4.3]	1.9	[1.1, 3.4]	78.0	low risk[i]
Vitamin K (μg)	(70, 70)[g]	136	[99,167]	85	[57, 129]	71.8	low risk[i]
Vitamin C (mg)	(35, 35)[d]	89	(27)	54	(24)	60.5	0[e]

[a]Dietary Reference Intakes for Japanese 2015.
[b]Intake at home + intake at nurseries.
[c]Estimated Energy Requirement (EER).
[d]Estimated Average Requirement (EAR).
[e]Proportion of children having nutrient consumption below EAR.
[f]Not available.
[g]Adequate Intake (AI).
[h]Median [25th percentile, 75th percentile].
[i]Because the weighted average intake exceeded AI, the risk was judged as low.

Table 3: Daily consumption of energy, three major nutrients, and BMD-related nutrients (n=84).

Food/food groups	Calcium				
	Ranking	% contribution[a]	% Cumulative contribution[b]	Frequency/day	Portion size (g)
Milk and dairy products	1	50.0	50.0	1.6	78
Green and yellow vegetables	2	7.0	57.0	3.7	11
Soy beans	3	5.7	62.8	0.9	12
Other vegetables	4	5.7	68.5	4.1	10
Western confectioneries	5	5.4	73.9	0.7	30
Food/food groups	**Magnesium**				
	Ranking	**% contribution**	**% Cumulative contribution**	**Frequency /day**	**Portion size (g)**
Milk and dairy products	1	12.3	12.3	1.6	78
Green and yellow vegetables	2	10.0	22.3	3.7	11
Seasonings and spices	3	9.8	32.1	8.4	2
Other vegetables	4	9.1	41.2	4.1	10
Rice	5	8.8	50.1	1.3	99
Food/food groups	**Phosphorus**				
	Ranking	**% contribution**	**% Cumulative contribution**	**Frequency/day**	**Portion size (g)**
Milk and dairy products	1	24.2	24.2	1.6	78
Meat	2	13.5	37.8	1.7	18
Rice	3	9.1	46.9	1.3	99
Fish and shellfish	4	9.1	56.0	1.1	11
Eggs	5	8.4	64.4	1.0	20
Food/food groups	**Vitamin D**				
	Ranking	**% contribution[a]**	**% Cumulative contribution[b]**	**Frequency/day**	**Portion size (g)**
Fish and shellfish	1	69.3	69.3	1.1	11
Eggs	2	14.5	83.8	1.0	20
Milk and dairy products	3	7.4	91.2	1.6	78
Meat	4	3.3	94.5	1.7	18
Mushrooms	5	3.2	97.6	0.6	5
Food/food groups	**Vitamin K**				
	Ranking	**% contribution**	**% cumulative contribution**	**Frequency /day**	**Portion size (g)**
Green and yellow vegetables	1	40.5	40.5	3.7	11
Soy beans	2	23.0	63.5	0.9	12
Other vegetables	3	12.1	75.6	4.1	10
Algae	4	5.7	81.3	0.8	1
Meat	5	5.0	86.3	1.7	18
Food/food groups	**Vitamin C**				
	Ranking	**% contribution**	**% cumulative contribution**	**Frequency /day**	**Portion size (g)**
Fruit	1	34.3	34.3	1.4	31
Green and yellow vegetables	2	33.0	67.3	3.7	11
Other vegetables	3	14.1	81.4	4.1	10
Potatoes	4	9.6	91.0	0.9	16
Meat	5	5.1	96.1	1.7	18

[a](Amount of a nutrient provided by each food/food item/day ÷ total amount of the nutrient provided by all food/food items/day) × 100ss
[b]Sum of % contributions

Table 4: Percent contribution and percent cumulative contribution of food/food groups consumed at home for BMD-related nutrients (n=84).

Food/food groups	Intake of BMD-related-nutrients					
	Calcium	**Magnesium**	**Phosphorus**	**Vitamin D**	**Vitamin K**	**Vitamin C**
Rice	0.057	0.268*	0.168	-0.096	0.298**	-0.117
Breads	0.051	-0.069	-0.030	-0.050	-0.276*	0.177
Potatoes	0.026	0.067	0.085	-0.084	-0.012	0.263
Soybeans	0.279*	0.397**	0.310**	-0.152	0.376**	-0.050
Nuts and seeds	0.205	0.315**	0.258*	-0.096	-0.015	0.053
Green and yellow vegetables	0.192	0.345**	0.242*	0.028	0.403**	0.318
Other vegetables	-0.023	0.390**	0.168	-0.100	0.092	0.333
Fruit	0.008	0.170	0.045	-0.071	-0.172	0.480
Algae	0.221*	0.247*	0.154	0.091	0.061	0.032

Fish and shellfish	-0.055	0.197	0.125	0.440**	0.158	0.019
Meat	0.042	0.054	0.238*	-0.18	0.134	0.376
Milk and dairy products	0.846**	0.347**	0.660**	-0.100	0.035	-0.053
Japanese confectioneries	0.092	0.142	0.260*	0.194	-0.048	0.141
Seasonings and spices	0.214	0.386**	0.288**	-0.134	0.237*	-0.115

*p<0.05; **p<0.01

Table 5: Pearson correlation coefficients across consumption of 14 food/food groups at home and intake of BMD-related nutrients (n=84).

	Crude coefficient		Standardized coefficient		Significance level
	β	Standard error	β	*t*-value	
Constant	169.753	40.789		4.162	0.000
Milk and dairy products	0.949	0.080	0.765	11.818	0.000
Green and yellow vegetables	0.866	0.234	0.249	3.705	0.000
Soybeans	1.070	0.361	0.192	2.965	0.004
Western confectioneries	0.462	0.245	0.127	1.887	0.063
Algae	1.355	0.955	0.092	1.419	0.160
Other vegetables	0.131	0.230	0.036	0.569	0.571

Table 6: Multiple regression analysis assuming consumption of calcium as a dependent parameter and intakes of food/food groups as independent variables (n=84).

taken by 84 guardians of 5-year-old pre-school Japanese children. >40% manifested inadequate Ca consumption, but intakes of Mg and P, vitamins D, K and C were satisfactory. Contribution analyses demonstrated milk and dairy products, green and yellow vegetables, and soybeans were major sources for Ca. >50% Ca was supplied by milk and dairy products. Various foods, including milk and dairy products, vegetables, soybeans, fruit, and fish and shellfish provided other minerals and vitamins. A multiple regression analysis also detected that milk and dairy products mainly contributed Ca. The present study appears to show inadequate Ca consumption compared with the DRIs-J 2015 values, but not for other BMD-related nutrients.

Strategies and education to increase Ca intake seem essential. Kubota *et al.* reviewing articles of meta-analyses, intervention and cohort studies recruiting children and adolescents [17] suggested dietary Ca of >900 mg/day was required for fortifying BMD and bone health. For American children (both sexes) aged 4-8 years, RDA value was set at 1,000 mg/day [18] and Population Reference Intake (RDA equivalent) at 800 mg for European children aged 4-10 years [19]. These values exceeded Japanese RDA figures (600/550 mg for boys/ girls), indicating greater disparities even when differences in anthropometric sizes are taken into account. These reports suggest it may be necessary to review Japanese Ca DRI values.

~50% of Ca was provided by milk and dairy products, fish and shellfish provided ~ 69% and eggs ~ 15% vitamin D, various vegetables (green and yellow vegetables, and soybeans) ~ 76% vitamin K, and fruit and vegetables ~ 81% vitamin C. A variety of foods including milk and dairy products, green, yellow and other vegetables, rice, seasonings and spices contributed Mg. Food/food items such as milk and dairy products, meat, rice, fish and shellfish and eggs determined P intake. Our observations are compatible with those of Imai *et al.* who recruited elementary 5th and 6th graders, university students, and elderly people [20], noting that milk and dairy products and vegetables provided Ca, and many foods supplied Mg and P for fortifying BMD. It may be recommended that one should consume various foods, primarily milk and dairy products, vegetables, soybeans, fish and shellfish, eggs, and meat.

Keast *et al.* [21], using NHANES 2003-2006 data, reported American children aged 2-18 years consumed on average 1,101 mg/day of Ca from milk and dairy products (61%), yeast breads and rolls (6%), biscuits, corn bread, pancakes and tortillas (3%), fruit juice (3%) and mixtures, mostly grain (3%). Studies conducted in 10 European countries [22] demonstrated mean adult Ca intakes ranged from 620 mg/day (in women, Ragusa in Italy) to 1,190 mg (in men, Greece). Main sources were dairy products (33-62%), cereals and products (5-37%), and beverages, non-alcoholic (2-34%). The European Food Safety Authority recommended consuming milk and milk products, dark green vegetables, small canned fish with bone, and dried pulses as Ca sources [23]. Despite differences in culture and dietary habits across countries, milk and dairy products are major Ca sources, and consumption was greater than in Japan. All these findings seem to support childhood milk and dairy consumption.

Many articles suggested the importance of food/food items other than milk and dairy products for enhancing BMD. Subjects in early puberty demonstrated relations between fruit and vegetable consumption and bone formation [24-26] studies investigating associations between dietary patterns and BMD observed that adult Japanese women eating more fruit and vegetables, mushrooms, fish and shellfish manifested significantly higher BMD values than those consuming meat, fat and oil [27].

For enhancing BMD and bone health, vegetables, milk and dairy products seem of the essence; the % contribution of green, yellow and other vegetables, and soybeans to Ca were unexpectedly less than KNU-Diet values [13,14]. In the present study, frequencies of green and yellow vegetables were low: mini-tomatoes 0.5 times/day, tomatoes 0.4/day, spinach 0.2/day, leek 0.1/day and *komatsuna* (cruciferous vegetable) 0.1/day; median green and yellow vegetable portion size was only 11 g. For soybeans, frequency and portion size were 0.9/day and 12 g, those for other vegetables were 4.1/day and 10 g. Elevated frequency and increased portion size for vegetable intake are recommended to increase Ca and other BDM-related nutrient intake. Introducing ways to serve more palatable vegetable foods seems crucial, children often dislike eating vegetables.

In a meta-analysis of randomized controlled trials of Ca supplementation for children, Winzenberg *et al.* [28] concluded that the effect of Ca supplementation on upper limb BMD was small, it is unlikely to reduce the risk of fracture, either in childhood or later life. It is important to increase Ca intake from food because it may be safe. However, we should not ignore the adverse effects of excessive Ca intake from fortified supplements/medicines. They include such high-Ca intake syndromes as hypercalcaemia, urinary tract stones and vascular calcification.

The limitations of the present study include: first, our surveys were based on dietary records with portion size (albeit confirmed by photos) but no weighing, introducing some uncertainty in estimating intakes of foods and BMD-related nutrients. The two weekday surveys were inadequate to analyze food/food items consumed or enable in-depth discussion. Analyses of variations in weekend diets and seasonal variations could not be made; the number of study subjects may be insufficient and we only obtained data for 5-year-olds attending municipal nurseries. There is nutritional guidance for food services, but no apparent difference in dietary consumption of relevant nutrients across institutions/facilities. The observations could be applied to Japanese children residing elsewhere.

In conclusion, our two weekday dietary record surveys demonstrated that ~ 40% of subjects had inadequate Ca consumption, but intake of other BMD-related minerals and vitamins was satisfactory in 5-year-old pre-school Japanese children. Contribution and multiple regression analyses noted that milk and dairy products were the main food sources for Ca. A variety of food/food items provided other BMD-associated nutrients. We advise increasing consumption of a variety of food/food items, including milk and dairy products at home, for Ca and BMD-related nutrients for fortifying BMD and bone health.

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Conflict of Interest

The authors declare no conflict of interests.

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