ORIGINAL

Adolescents' Habitual Nutrient Intake Adequacy was Independent of Milk Provision in School Lunch in Japan: A Cross-sectional Study of Japanese Junior High School Female Students

Mai Matsumoto[1, 2], Ayumi Masumoto[3], Azusa Sakamoto[2], Aki Saito[1], Shinji Ikemoto[2] *

[1] *Department of Nutritional Epidemiology and Shokuiku, National Institutes of Bioinnovation, Health and Nutrition., Shinjuku-ku, Tokyo, Japan*
[2] *Department of Human Nutrition, SEITOKU University., Matsudo-shi, Chiba, Japan*
[3] *Saitama city., Saitama-shi, Saitama, Japan*

(Received November 30, 2019)

ABSTRACT *Background and purpose*. Intake of dairy products in adolescence may be of importance in improving nutritional status. Most school lunch programs provide milk in Japan. The aim of this study was to assess the difference in habitual nutrient intake adequacy between Japanese junior high school girls who received milk in their school lunch program and those who did not. *Methods.* Participants were students aged 12-15 years who had school lunch with (n=306) or without milk (n=210). Dietary habits during the preceding month were assessed using a brief self-administered diet history questionnaire for Japanese children and adolescents (BDHQ15y). Inadequacy of each nutrient intake was assessed by the cut-point method, which showed that 14 nutrients were below the estimated average requirement (EAR) and five nutrients were outside the range of the dietary goal (DG). The overall nutritional inadequacy in participants was assessed by the number of nutrients consumed, which did not meet the Dietary Reference Intake for Japanese, 2015 version. *Results.* The intake of niacin, vitamin B_{12}, iron, copper, and salt-equivalent was higher, whereas intake of calcium was lower in students that did not provide milk with their school lunch compared to those that consumed milk ($p<0.05$). Total nutritional inadequacy and nutritional inadequacy for each nutrient separately did not differ significantly between the two groups. *Conclusion.* Our results showed that habitual nutrient intake adequacy for Japanese junior high school female students was independent of milk provision in school lunch programs. Further studies are needed to determine alternative factors that possibly influence dietary intake among Japanese adolescent girls.
Keywords: Milk, School lunch, Adolescent, Nutritional adequacy, Japan.

INTRODUCTION

Adolescence is a critical period during which lifetime habits are established (1). The eating patterns in adolescence also persist into adulthood (2–4). Therefore, nutritional quality during this period is important because it can influence adult morbidity and mortality (5).

Dairy products provide an abundant source of nutrients such as protein, vitamins and minerals and, particularly, calcium (6). Calcium is an essential nutrient for bone mineralisation and rigidity (7, 8). It has been suggested that nutrients from dairy products are essential for building and maintaining strong bones and increasing bone density (9). Especially, the bone mineral accrual rate is the highest during lifetime and approximately 95% of the bone mass peak is acquired in adolescence (10). Thus, adequate dairy intake is necessary for the development and maintenance of the bone mass peak during adolescence and fundamental for bone health later in life (7, 8). Studies have also indicated that intake of milk and other dairy products may improve the overall nutritional quality of adolescents' diets (11, 12). Moreover, the beneficial roles of dairy products have been examined in relation to a variety of chronic diseases including hypertension, metabolic syndrome, type 2 diabetes and cardiovascular disease (6, 13-15). Higher consumption of dairy products and calcium has been associated with a lower prevalence of overweight or obesity (16). Consumption of dairy products in adolescence may be important in a healthy nutritional status.

Currently, 88.1% of junior high schools in Japan provide school lunches based on the School Lunch Act enacted in 1954.17 This school lunch program is based on the combination of main staple food (grains), main dishes (fish, meat, poultry or soy products), side dishes (vegetable and soup, etc.) and milk, therefore most junior high schools provide milk to students every day (full meal which provides main staple food, main dish, side dish and milk: 82.6%, supplementary meal which provides main dish, side dish and milk: 0.4%, milk only: 5.2%) (17). Under this Japanese school lunch program, the same lunch menu is provided to all children in each school. There are no alternative choices except for special cases, such as students with a food allergy. School lunches provide approximately 30% of the daily dietary intake and the school lunch programs in Japan appear to improve total diet quality in Japanese students (18). The nutrient content of school lunches is regulated by the Gakkou-Kyushoku-Jissi-Kijun (Standards for the School Lunch Program). The nutritional standards for most of nutrients are set at 33% of the daily reference values of Dietary Reference Intakes for Japanese, 2015 (DRIs) (19) such as recommended dietary allowance (RDA) or tentative dietary goal to prevent lifestyle-related diseases (DG). However, the nutritional standard for calcium for the school lunches is set at 450 mg per serving, which is 50% of the RDA (900 mg per day), due to the difficulty in obtaining calcium from the habitual Japanese dietary intake. Indeed, milk significantly contributes to the required calcium intake, because 200 ml (1 serving for school lunches) of milk provides approximately 230 mg of calcium (20).

Previous studies examined school lunches and dietary intake in relation to dairy products or milk. For example, a 3-day dietary record showed that the number of Japanese children aged 10-11 years with insufficient calcium intake, who had a school lunch including milk, was lower compared to children who did not consume milk at lunch (21). Another study reported that Japanese children who were provided with school lunches had greater calcium intake than children who brought their own lunches to school from home (22). A US study showed that the daily calcium intake of female students aged 12 to 18 years who were drinking milk during school lunch was greater than those who did not (23), although the food items in school lunches were consumed by the students ad-lib. Studies have indicated that the intake of milk and other dairy products may improve the overall nutritional quality of adolescents' diets (11, 12). Milk in school lunches may influence the overall dietary intake among adolescents, even though the menus of school lunches in Japan are designed to meet the nutrient standards. However, as milk has been regarded as a necessary item in school lunches in Japan, there has been no study on habitual dietary intake among students in relation to milk supply at school. There is very rare but 0.01% of junior high schools which have not always provided milk on school lunches in Japan because milk does not match with typical Japanese diet with rice as the main staple food. A previous study showed that the higher frequency of meal combining main staple, main dish and side dish led to greater nutrient intake, especially higher calcium intake (24), which might suggest the needlessness for milk on school lunch every day. Here, the aim of this study was to assess the influence of milk in school lunch on habitual nutrient intake adequacy of Japanese junior high school female students.

METHODS

Study population. A set of two self-administered questionnaires (i.e., a diet history questionnaire and lifestyle questionnaire) were distributed by teachers to 742 junior high school female students who attended either a public junior high school that provided school lunch with milk every day (school lunch with milk group) or two private junior high schools that did not always provide school lunch with milk (school lunch without milk group) in Kanto urban region, Japan in June 2016. The content of school lunch in two private junior high schools was the same. Students were asked to answer the questionnaires on their own, or in cooperation with their parents, if necessary. The completed questionnaires were examined by the research staff, and those with missing information were returned to the students for completion. Both questionnaires were completed by 575 female students.

We excluded students with missing data (n=17), with milk allergy (n=8) and with a reported energy intake less than half the energy requirement for the lowest physical activity category, according to the Japanese DRIs or equal to or more than 1.5 times the energy requirement for the highest physical activity category (<1075 kcal/day or ≥4050 kcal/day; n=34) (25). Thus, the final participant list consisted of 516 junior high school female students categorized into the following two groups: school lunch with milk (n=306) and school lunch without milk (n=210). Written informed consent was obtained from all participants and their parents. The present study was granted ethical approval by the Ethics committee of SEITOKU University in accordance to the guidelines of Helsinki Declaration (approval number H27U056).

Dietary assessment. Habitual dietary intake per day during the preceding month were assessed using a brief self-administered diet history questionnaire for Japanese children and adolescents (BDHQ15y) (26). BDHQ15y was developed based on the adult version of the validated a brief self-administered diet history questionnaire (BDHQ) that enquires about the dietary history during the preceding month (27, 28). BDHQ15y is a 4-page structured questionnaire consisting of 67 questions regarding the frequency of intake of food items commonly cooked and consumed in Japan. Daily food, energy and selected nutrient intake were calculated using an ad-hoc computer algorithm for BDHQ15y based on the Standard Tables of Food Composition in Japan (29). The validity of BDHQ15y was verified by a study on the relationship between selected food intake and blood biomarker levels (26). Milk was categorised either as full-fat or low-fat milk. Additionally, food groups were categorized based on the previous study (27). Any self-estimated dietary assessments cannot avoid under- or over-reporting of dietary intake (30, 31). Therefore, in order to render the comparison between the reported nutrient intake and the Japanese DRI values practically possible, we adjusted the reported dietary intake based on the assumption that each participant reported her estimated energy requirement (EER) when her physical activity level was at the second level. The following calculation was used: Dietary intake (unit/day) = reported dietary intake (unit/day)/reported energy intake (kcal/day) × EER (kcal/day). The percentage of daily energy intake was calculated using the crude value for total fat and carbohydrate intake. Additionally, food intake values were energy-adjusted using the density method (i.e. the percentage of energy for energy-providing nutrients and their amounts per 1000 kcal for food groups and other nutrients) to minimise the influence of dietary misreporting.

Information regarding the school lunch menus (number of days that a main staple, main dish, side dish, soup and milk were provided in the school lunch and the mean values of nutrient supply through the school lunch during the survey month) was obtained from each school dietician. The components of each lunch were identified by the dieticians based on the Gakkou-Kyushoku-Jissi-Kijun and its guideline as follows: main staple food (grains: rice, bread, noodles and pasta), main dishes (fish, meat, poultry or soy products), side dishes (vegetable, mushrooms and seaweeds) and soup (miso soup and other soup).

Other variables. Body weight and height were self-reported as part of the BDHQ15y. The body mass index (BMI) was calculated as weight (kilograms) divided by the square of height (meters). In the BDHQ15y, participants also reported the frequency of their exercise such as sports club activities per week for the past month (everyday, 4-6 days/week, 2-3 days/week, a day/week or never). Additionally, participants reported on the following variables by completing a self-administered lifestyle questionnaire: employment status of father (full-time, part-time, housekeeping or other), employment status of mother (full-time, part-time, home manager or other), milk intake frequency at home (everyday, 5-6 days/week, 3-4 days/week, 1-2 days/week or never) and milk intake frequency during school lunch (everyday, 3-4 days/week, 1-2 days/week or never).

Determination of habitual nutrient intake inadequacy. Inadequacy of each nutrient intake was determined by comparing nutrient levels with each dietary reference value according to the Japanese DRIs, using a previously reported method (22, 32, 33). In the Japanese DRIs, different types of reference values are established according to their purpose. The estimated average requirement (EAR) is set to avoid insufficient intake of nutrients and DG is set to prevent lifestyle-related diseases.

The intake level below EAR was considered as inadequate using the cut-point method for 14 nutrients with known EARs: protein, vitamin A expressed as retinol activity equivalents, vitamin B_1, vitamin B_2, niacin expressed as niacin equivalent, vitamin B_6, vitamin B_{12}, folate, vitamin C, calcium, magnesium, iron, zinc, and copper. The intake level outside the range of DG values was considered as not meeting the standard for five nutrients with DG: total fat, carbohydrate, total dietary fiber, sodium expressed as salt-equivalent and potassium.

Statistical analysis. All statistical analyses were performed using the IBM SPSS statistics software package (version 22.0, SPSS Inc., Chicago, IL, USA). The differences of characteristics between school lunch with milk and without milk groups were compared using the chi-square test for categorical variables and the independent t-test for continuous variables. The difference of the mean nutrient supply in school lunches per meal between school lunch with milk and without milk was compared using an independent t-test.

Potential confounding factors considered in the first analysis were sex, working status and number of children which were found to be substantially different ($p<0.05$) between groups categorized by nutrition knowledge level. The difference of the habitual nutrients intake of the present study participants was assessed by analysis of co-variance (ANCOVA) adjusted the confounding variables of exercise (everyday, 4-6 days/week, 2-3 days/week, a day/week or never), work status of father (full-time or others) and work status of mother (full-time, part-time or others). The nutritional inadequacy of each nutrient was represented as the percentage of participants whose intake was below the EAR or outside the range of the DG in each group and the logistic regression analysis was used to examine the difference of the prevalence of not-meeting DRIs adjusted the confounding variables of exercise (everyday, 4-6 days/week, 2-3 days/week, a day/week or never), work status of father (full-time or others) and work status of mother (full-time, part-time or others).

The overall nutritional inadequacy of participants was determined based on the number of nutrients that did not meet the DRI values of the 14 nutrients with EAR and 5 nutrients with DG. Differences in the number of nutrients that did not meet DRIs between school lunch with milk and without milk groups were assessed by covariate analysis adjusted the confounding variables of exercise (everyday, 4-6 days/week, 2-3 days/week, a day/week or never), work status of father (full-time or others) and work status of mother (full-time, part-time or others).

Additionally, the difference of the habitual food groups intake between with and without milk groups was assessed by analysis of covariance (ANCOVA) adjusted the confounding variables of exercise (everyday, 4-6 days/week, 2-3 days/week, a day/week or never), work status of father (full-time or others) and work status of mother (full-time, part-time or others).

RESULTS

The characteristics of study participants are shown in Table 1. The mean BMI did not differ significantly between the two groups, while the

Table 1. Characteristics of 516 junior high school female students having school lunch with milk or without milk

	ALL (n=516)		School lunch with milk (n=306)		School lunch without milk (n=210)		p*
Grade							
1	176	(34.1)	105	(34.3)	71	(33.8)	0.857
2	187	(36.2)	113	(36.9)	74	(35.2)	
3	153	(29.7)	88	(28.8)	65	(31.0)	
Body height (cm)	154.5	± 7.8	155.1	± 6.2	153.5	± 9.6	0.016
Body weight (kg)	45.7	± 7.5	45.6	± 7.5	45.9	± 7.5	0.648
Body mass index (kg/m^2)	19.3	± 6.0	18.9	± 2.5	19.9	± 8.8	0.052
Number of days exercising							
Everyday	231	(44.8)	167	(54.6)	64	(30.5)	<0.001
4-6 days/week	78	(15.1)	46	(15.0)	32	(15.2)	
2-3 days/week	61	(11.8)	26	(8.5)	35	(16.7)	
1 day/week	49	(9.5)	19	(6.2)	30	(14.3)	
Never	97	(18.8)	48	(15.7)	49	(23.3)	
Energy intake (kcal/day)	2103	± 547	2158	± 563	2024	± 515	0.006
Milk intake (g/1000kcal)	75	± 80	89	± 82	54	± 72	<0.001
Work status of father							
Full-time	445	(86.2)	279	(91.2)	166	(79.0)	<0.001
Others	71	(13.8)	27	(8.8)	44	(21.0)	
Work status of mother							
Full-time	109	(21.1)	45	(14.7)	64	(30.5)	<0.001
Part-time	204	(39.5)	129	(42.2)	75	(35.7)	
Others	203	(39.3)	132	(43.1)	71	(33.8)	
Number of days drinking milk at home							
Everyday	120	(23.3)	75	(24.5)	45	(21.4)	0.343
5-6 days/week	38	(7.4)	26	(8.5)	12	(5.7)	
3-4 days/week	63	(12.2)	31	(10.1)	32	(15.2)	
1-2 days/week	108	(20.9)	64	(20.9)	44	(21.0)	
Never	187	(36.2)	110	(35.9)	77	(36.7)	
Number of days drinking milk at school lunch							
Everyday	-		265	(86.6)	-		-
3-4 days/week	-		11	(3.6)	-		
1-2 days/week	-		7	(2.3)	-		
Never	-		23	(7.5)	-		

Data are represented as n (%) or mean ± standard deviation.
**The p values are shown for chi-square test for categorical variables and for independent t test for continuous variables between school lunch with milk and without milk.*

mean body height was higher in school lunch with milk group than without milk group(p=0.016). The number of participants who engaged in habitual exercise was greater in the school lunch with milk group than in the school lunch without milk group (p<0.001). The percentage of fathers working full time was greater and mothers working full time was less in the school lunch with milk group than in the school lunch without milk group (p<0.001). Daily milk intake (89±82 g/1000 kcal vs. 54±72 g/1000 kcal, p<0.001) and energy intake (2158±563 kcal/day vs. 2024±515 kcal/day, p=0.006) in the school lunch with milk group were significantly greater than in the school lunch without milk group. There was no difference in the frequency of milk consumption at home between the two groups.

Table 2. Number of days in the survey month that each item was provided in school lunch

	School lunch with milk (n=19)	School lunch without milk (n=21)
Main staple	19 (100.0)	21 (100.0)
Main dish	14 (73.7)	16 (76.2)
Side disj	16 (84.2)	20 (95.2)
Soup	10 (52.6)	13 (61.9)
Milk	19 (100.0)	1 (4.8)

Data are represented as n (%).

Table 2 shows the number of days that a main staple, main dish, side dish, soup and milk were provided at school lunches in the two groups. Main staple was provided every day, and main dish and side dish was also provided in most days.

The mean values of nutrient supply through the school lunches with and without milk per meal are shown in Table 3. Supply of energy, protein, carbohydrate, vitamin A, vitamin B_1, vitamin B_2, and calcium was significantly greater in the school lunch with milk than the school lunch without milk.

The daily nutrient intake and each nutrient and overall nutritional inadequacy among 516 junior high school female students eating school lunch are shown in Table 4. Intake of niacin, folate, iron and salt-equivalent was higher in the school lunch without milk group than the school lunch with milk group. The total number of nutrients not meeting EAR and DG did not differ significantly between the two groups. Table 5 shows the habitual foods intake of the present study participants. The daily intake of other vegetables, mushrooms, and fish and shellfish among the students in school lunch without milk group were more than those in with milk group (p=0.028, 0.016 and 0.007, respectively). The only dairy products intake among the students in school lunch without milk groups was more than those in with milk group (p=0.003).

Table 3. Mean values of nutrient supply per meal by the school lunch

	Reference value†	School lunch with milk (total 19 meals)		School lunch without milk (total 21 meals)		p*
		Mean	SD	Mean	SD	
Energy (kcal/meal)	820	778	39	733	66	0.013
Protein (g/meal)	30	29.1	3.6	24.4	3.8	<0.001
Fat (g/meal)	22.8 - 27.3	22.7	4.2	25.0	5.6	0.158
Carbohydrate (g/meal)	―	114.4	12.4	95.5	24.0	0.004
Vitamin A (µgRAE/meal)‡	300	471	155	194	80	<0.001
Vitamin B_1 (mg/meal)	0.5	0.68	0.25	0.41	0.13	<0.001
Vitamin B_2 (mg/meal)	0.6	0.61	0.08	0.36	0.11	<0.001
Vitamin C (mg/meal)	35	40.1	19.4	49.7	38.6	0.336
Calcium (mg/meal)	450	388	63	147	68	<0.001
Iron (mg/meal)	4	3.2	1.2	2.9	0.9	0.329
Total dietary fiber (g/meal)	6.5	6.1	1.5	5.5	1.2	0.182
Sodium (salt equivalent) (g/meal)	< 3	3.3	0.8	3.0	0.5	0.149
Number of meals milk was provided	―	19		1		

SD, standard deviation.

† Nutrient standards for school lunch for 12- to 14-year-old students by the Gakkou-Kyushoku-Jissi-Kijun (Standards for the School Lunch Program).

‡ Sum of retinol, β-carotene/12, α-carotene/24, and cryptoxanthin/24.

** p values are shown for independent t test between school lunch with milk and without milk..*

Table 4. Daily nutrient intakes and prevalence of not meetin g EAR and DG among 516 junior high school female students eating school lunch[a]

	Reference value[b]	School lunch with milk (n=306)	Inadequacy[c] (%)	School lunch without milk (n=210)	Inadequacy[c] (%)	p[†]	OR (95% CI)[‡]
Nutrient with EAR							
Protein (g)	≥45	80 ± 1	0	81 ± 1	0	0.203	-
Vitamin A (μgRAE)[d]	≥500	793 ± 23	17.3	820 ± 28	18.6	0.471	1.121 (0.686 - 1.832)
Vitamin B_1 (mg)	≥1.1	0.95 ± 0.01	80.7	0.95 ± 0.01	81.9	0.821	0.989 (0.606 - 1.614)
Vitamin B_2 (mg)	≥1.2	1.7 ± 0.03	6.5	1.7 ± 0.03	10.5	0.813	1.432 (0.726 - 2.826)
Niacin (mgNE)[e]	≥12	16 ± 0.2	14.1	17 ± 0.3	8.6	0.009	0.592 (0.316 - 1.109)
Vitamin B_6 (mg)	≥1.1	1.3 ± 0.02	20.3	1.4 ± 0.02	20.0	0.050	0.992 (0.617 - 1.594)
Vitamin B_{12} (mg)	≥1.9	8.2 ± 0.2	0.3	8.8 ± 0.3	0	0.083	-
Folate (μg)	≥190	384 ± 8	4.2	411 ± 10	1.9	0.034	0.356 (0.108 - 1.175)
Vitamin C (mg)	≥80	131 ± 3	14.4	141 ± 4	13.8	0.060	0.894 (0.520 - 1.537)
Calcium (mg)	≥700	874 ± 17	29.7	831 ± 20	37.6	0.106	1.300 (0.873 - 1.936)
Magnesium (mg)	≥240	285 ± 3	20.3	289 ± 4	19.5	0.572	0.930 (0.577 - 1.500)
Iron (mg)	≥10.0	8.6 ± 0.1	77.5	9.1 ± 0.1	71.4	0.025	0.773 (0.502 - 1.191)
Zinc (mg)	≥7.0	9.9 ± 0.1	2.0	9.9 ± 0.1	1.0	0.957	0.382 (0.066 - 2.218)
Copper (mg)	≥0.6	1.2 ± 0.01	0	1.3 ± 0.02	0	0.075	-
Total number of nutrients with not-meeting EAR	-	2.9 ± 0.1	-	2.8 ± 0.2	-	0.622	-
Nutrient with DG							
Fat (%energy)	20-30	30 ± 0.3	54.9	30 ± 0.4	57.1	0.515	1.131 (0.773 - 1.655)
Carbohydrate (%energy)	50-65	54 ± 0.4	30.4	54 ± 0.5	35.7	0.930	1.344 (0.897 - 2.014)
Total dietary fiber (g)	≥16	13 ± 0.2	83.0	13 ± 0.3	78.6	0.082	0.729 (0.448 - 1.185)
Sodium (salt-equivalent) (g)	<7.0	12.0 ± 0.1	98.4	12.6 ± 0.2	100	0.022	-
Potassium (mg)	≥2400	2772 ± 41	30.7	2843 ± 50	31.4	0.284	0.910 (0.602 - 1.376)
Total number of nutrients with not-meeting DG	-	3.0 ± 0.1	-	3.0 ± 0.1	-	0.767	-

Data are represented as mean ± standard error or %.
CI, confidence interval; DG, tentative dietary goal for preventing life-style related disease; DRI, Dietary Reference Intakes; EA estimated average requirement; OR, odds ratio.
[a] Adjustment of reporting error was performed according to the following: Nutrient intake = reported nutrient intake / report energy intake × estimated energy requirement.
[b] DRIs for 12-14 years old Japanese girl. The estimeated energy requirement of physical activity level Ⅱ is 2400 kcal/day.
[c] Percentage of subjects whose nutrient intake was not-meeting DG or EAR of DRIs. Each nutrient intake was compared with ea DRI value, using the cut-point methods.
[d] Sum of retinol, β-carotene/12, α-carotene/24, and cryptoxanthin/24.
[e] Sum of niacin and protein/6000.
[†] The p values are shown for covariate analysis to analyze difference between school lunch with or without milk groups adjust the confounding variables of exercise(everyday, 4-6 days/week, 2-3 days/week, a day/week or never), work status of fath (full-time or others) and work status of mother (full-time, part-time or others).
[‡] OR (95% CI) are shown for a logistic regression analysis to analyze the presence of nutritional inadequacy school lunch witho milk group compared with milk group adjusted the confounding variables of exercise(everyday, 4-6 days/week, 2-3 days/week day/week or never), work status of father (full-time or others) and work status of mother (full-time, part-time or others).

Table 5. Daily food group intakes among 516 junior high school female students eating school luch with milk or without milk(g/1000kcal)†

	School lunch with milk (n=306)	School lunch without milk (n=210)	p‡
Cereals	208.8 ± 3.7	208.8 ± 4.6	0.996
Rice	160.2 ± 4.0	157.9 ± 4.9	0.726
Bread	21.4 ± 0.8	21.4 ± 1.0	0.977
Noodles	27.2 ± 1.3	29.5 ± 1.5	0.257
Pulses	29.9 ± 1.1	31.5 ± 1.4	0.366
Potatos	15.5 ± 0.6	14.8 ± 0.7	0.486
Sugar	2.5 ± 0.1	2.6 ± 0.2	0.477
Confectioneries	44.2 ± 1.7	43.5 ± 2.0	0.777
Fat and oil	7.7 ± 0.2	7.8 ± 0.2	0.816
Fat	0.6 ± 0.1	0.6 ± 0.1	0.567
Oil	7.2 ± 0.2	7.2 ± 0.2	0.944
Fruits	33.1 ± 1.9	36.2 ± 2.3	0.319
Total vegetables	120.8 ± 4.3	134.0 ± 5.2	0.056
Green and yellow vegetables	45.9 ± 1.8	48.7 ± 2.2	0.346
Other vegetables	60.4 ± 2.3	68.6 ± 2.8	0.028
Pickled vegetables	4.8 ± 0.4	5.4 ± 0.4	0.288
Mushrooms	4.2 ± 0.3	5.3 ± 0.3	0.016
Seaweeds	5.5 ± 0.3	6.0 ± 0.4	0.332
Beverages	310.2 ± 10.4	338.5 ± 12.7	0.094
Fruit and vegetable juice	28.5 ± 2.8	31.9 ± 3.4	0.454
Green tea	195.3 ± 7.5	205.5 ± 9.1	0.400
Black tea	35.4 ± 4.8	46.0 ± 5.9	0.176
Soft drinks	51.0 ± 4.5	55.2 ± 5.5	0.569
Fish and shellfish	29.1 ± 1.0	33.6 ± 1.2	0.007
Meat	37.5 ± 1.0	39.7 ± 1.2	0.188
Eggs	18.1 ± 0.6	18.4 ± 0.7	0.804
Dairy products	137.7 ± 5.6	111.0 ± 6.8	0.003

Data are represented as mean ± standard error.
† Adjustment of reporting error was performed according to the following: Food group intake = reported food group intake / reportedenergy intake × 1000(kcal).
‡ The p values are shown for covariate analysis to analyze difference between school lunch with or without milk groups adjusted the confounding variables of exercise (everyday, 4-6 days/week, 2-3 days/week, a day/week or never), work status of father (full-time or others) and work status of mother (full-time, part-time or others).

DISCUSSION

The present study examined the influence of milk in school lunch on the habitual nutrition intake among Japanese junior high school female students. To our knowledge, this is the first study to examine the difference in habitual nutrient intake adequacy between junior high school students who were and were not always provided with milk on their school lunches. Our findings suggested that there might be no difference in habitual nutrient intake adequacy between school lunches with and without milk.

Our study found no difference between groups in nutritional inadequacy for each nutrient and overall nutritional inadequacy in relation to milk supply in school lunches. Although we hypothesised that school lunch with milk would reduce the proportion of inadequacy for calcium intake compared to school lunch without milk, we found no difference in the percentage of students who were below EAR for calcium between school lunch with milk and without milk. A previous study showed that the proportion of elementary school students with a calcium intake below EAR was lower in the school lunch with milk compared to the school lunch without milk (21). In contrast, in our study, the calcium intake and nutritional inadequacy related to calcium did not differ between the two groups. The study design may account for the disparate results. The previous study compared calcium intake from 3 days' dietary records to calcium intake estimated by excluding milk in the school lunches from the records, whereas our study compared the habitual dietary intakes, assessed with a questionnaire, of junior high school female students who had a school lunch with milk every day to those having a school lunch that did not provide milk every day. Therefore, the results may not be comparable, and further study is needed. In the present study, the habitual niacin, folate, iron and sodium intakes were significantly greater in the school lunch without milk group than the school lunch with milk group. It has been reported that the percentages below EAR for iron and out of DG range for fat and dietary fibre were higher, whereas only calcium intake was lower, in elementary school female students eating homemade lunch compared to those eating the school lunch (22). In that previous study, daily salt and iron intakes were greater and only daily calcium was lower in the homemade lunch box group compared to the school lunch program group. Additionally, in homemade lunch boxes , staple foods, such as rice, were the main item followed by some main dish items, such as meat and fish and side dish items, such as vegetables, but hardly any dairy products were included (34). These studies can partly explain the current results regarding the higher iron intake and lower calcium intake among our participants in the school lunch without milk group. However, the results on nutritional inadequacy in the present study were different from the previous study comparing homemade boxed lunch with school lunch. The reason for this difference may be explained by the fact that school lunches were made according to certain nutrient standards regardless of milk supply. Indeed, in the present study, more side dishes and soup were provided in the school lunches without milk group. This may be because school lunches without milk were required to meet the nutrient standards for each nutrient, especially regarding vitamins and minerals, using side dishes and soup, which mainly consisted of vegetables, pulse, and seaweeds, instead of milk. Additionally, there were differences in the supply per meal of energy, protein, carbohydrate, vitamin A, vitamin B_1, vitamin B_2, and calcium by the school lunch between the two study groups. In detail, the supply of nutrients such as energy, protein, carbohydrate, vitamin A, vitamin B_1, vitamin B_2 and calcium was higher in school lunch with milk than school lunch without milk. Moreover, the number of the nutrients which met the standard value by Gakkou-Kyushoku-Jissi-Kijun of school lunch with milk was more than those of school lunch without milk. Thus, milk may play an important role in meeting the nutrient requirements in school lunches. However, no difference was observed in the habitual intake of these nutrients between two groups among students who participated in the present study. Especially, the calcium supply in the school lunch with milk and without milk groups was 388 mg/day and 147 mg/day, respectively, which showed that the difference of the calcium supply between two groups was just the amount of milk supply per day. One possible reason of this could be that the source of calcium intake by Japanese is not only from dairy products but also from soybeans, fish, seaweed or vegetables, which are rich in calcium, protein, vitamin group and iron (29). A Japanese study reported that young adults who had more frequency of meal combining main staple, main dish and side dish were greater consumption of calcium (24). Indeed, the habitual intake of dairy products including milk among participants in school lunch with milk was more than those in without milk, while the habitual other vegetables, mushrooms and fish intakes by participants in the school lunch without milk group were higher than those in the school lunch with milk group. In other words, when the intake of calcium-rich food is sufficient, milk in school lunch may be dispensable for the calcium intake adequacy in adolescents. In addition, these foods are cooked with salt seasoning, which was reported as the main source of sodium in the Japanese diet (35). This may partly explain the current result that daily intakes of niacin, folate and sodium may be higher among participants in the school lunch without milk group.

The percentage of individuals not drinking milk at home (35%) in this study was similar to that in a Japanese previous study (36), and the difference in daily milk intake between the two groups of this study (about 84 ml/EER) was less than 50% of the amount of milk (200 ml) provided in the school lunch. Milk was consumed by 65% of the present study participants at home. Therefore, the amount of daily milk intake was mainly influenced by the amount of milk consumed at home. Similar results have been observed in a British study that compared dietary intake according to lunch type (school meal vs. packed meal). In that previous study, students that ate the school meal consumed more milk than those eating packed lunch during school lunchtime, although this difference was not observed in overall nutrient intake (37). These results suggest that the influence of the home/family environment is stronger than that of the school environment on milk consumption. Additionally, previous studies reported that the diet of adolescents was influenced by their parents, including the home environment (38, 39). These may partly explain the current result that the nutrition adequacy among female junior high school students was not likely to be affected by the school lunch with or without milk. In other words, nutritional adequacy among adolescents might be influenced by the home environment including household income, parent's nutrition knowledge, employment, and dietary intake. Another study has shown that the prevalence of inadequate nutrient intake was clearly higher on a non-school day than a school day for almost all nutrients among Japanese elementary school and junior high school students (18). These results, consistent with our findings, demonstrate that school lunches may have contributed to the dietary intake quality during adolescence and dietary intake may have been influenced by the dietary habits at home rather than school.

Several limitations of this study need to be mentioned. First, the participants were selected from three schools in Kanto urban region in Japan, not a random selection. Also, there were several demographic difference between the two groups, which indicates the probability of that our results might be influenced by the difference in those characteristics. However, the participants in the school lunch without milk group were of particular value, because they were enrolled among 0.1% of schools in Japan that do not always provide milk everyday on school lunch. Our selection of the subjects was the only way to fulfil the purpose of this study. Further studies are needed to validate our findings regarding the total Japanese adolescent population. Second, we used BDHQ15y to assess dietary intake although its ability to estimate dietary intakes has been validated on limited foods and nutrients. Third, we could not include intake from dietary supplements in the analysis because reliable composition tables of dietary supplements were lacking in Japan. Fourth, household income, education and nutritional habits of participants' parents were not investigated. Those factors were reported to influence children's diets (38-40). Although the employment status of participant's parents was examined in this study, this information is not necessarily equivalent to household income. Finally, we did not examine whether the participants had their first menstruation, although the EAR for iron changes depending on menstruation. It was reported that 585 out of 4769 female students (12.3%) aged 12-15 years did not have their first menstruation and most of them were 12 years old (36). Because junior high school female students were considered to have their first menstruation shortly, they would need higher iron intake that takes menstruation into consideration. Thus, we considered that the EAR for iron of female individuals with menstruation were more appropriate to assess nutritional adequacy in this study.

CONCLUSION The results of this study showed that habitual nutrient intake adequacy of Japanese junior high school female students was independent of milk provision in school lunch, although milk may help meet the standard requirements of school lunch programs. Therefore, other factors such as the home/family environment may affect the nutritional adequacy among adolescent girls. Further studies are needed to determine alternative factors that possibly influence dietary intake among Japanese adolescent girls.

Acknowledgement

The authors would like to express their thanks to N Hiroki and A Noguchi who provided the school lunch menu and their nutrients information and each school teachers who distributed the questionnaires.

Conflict of interest and funding disclosure

The authors declare that they have no conflict of interests. This study was supported by Milk Education Research Council and Japan Daily Association.

REFERENCES

1) Cavadini C, Siega-Riz AM, Popkin BM. US adolescent food intake trends from 1965 to 1996. West J Med. 173(6):378-383. 2000.
2) Kelder SH, Perry CL, Klepp KI, Lytle LL. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. Am J Public Health. 84(7):1121-1126. 1994.
3) Lien N, Lytle LA, Klepp KI. Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21. Prev Med (Baltim). 33(3):217-226. 2001.
4) Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. Am J Health Promot. 14(4):222-228. 2000.
5) Grosso G, Mistretta A, Turconi G, Cena H, Roggi C, Galvano F. Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. Public Health Nutr. 16(10):1827-1836. 2013.
6) Lamarche B. Review of the Effect of Dairy Products on Non-Lipid Risk Factors for Cardiovascular Disease. J Am Coll Nutr. 27(6):741S-746S. 2008.
7) Golden NH, Abrams SA. Optimizing Bone Health in Children and Adolescents. Pediatrics. 134(4):e1229-e1243. 2014.
8) Bueno AL, Czepielewski MA. The importance for growth of dietary intake of calcium and vitamin D. J Pediatr (Rio J). 84(5):386-394. 2008.
9) Heaney RP. Dairy and bone health. J Am Coll Nutr. 28 Suppl 1:82S-90S. 2009.
10) Teegarden D, Proulx WR, Martin BR, et al. Peak bone mass in young women. J Bone Miner Res. 10(5):711-715. 1995.
11) Agostoni C, Rottoli A, Trojan S, Riva E. Dairy products and adolescent nutrition. J Int Med Res. 22(2):67-76. 1994.
12) Parker CE, Vivian WJ, Oddy WH, Beilin LJ, Mori TA, O'Sullivan TA. Changes in dairy food and nutrient intakes in Australian adolescents. Nutrients. 4(12):1794-1811. 2012.
13) Malik VS, Sun Q, Van Dam RM, et al. Adolescent dairy product consumption and risk of type 2 diabetes in middle-aged women. Am J Clin Nutr. 94(3):854-861. 2011.
14) Elwood PC, Pickering JE, Givens DI, Gallacher JE. The Consumption of Milk and Dairy Foods and the Incidence of Vascular Disease and Diabetes: An Overview of the Evidence. Lipids. 45(10):925-939. 2010.
15) Tremblay A, Gilbert J-A. Milk products, insulin resistance syndrome and type 2 diabetes. J Am Coll Nutr. 28 Suppl 1:91S-102S. 2009.
16) Keast DR, Hill Gallant KM, Albertson AM, Gugger CK, Holschuh NM. Associations between yogurt, dairy, calcium, and vitamin D Intake and Obesity among U.S. children aged 8-18 years: NHANES, 2005-2008. Nutrients. 7(3):1577-1593. 2015.
17) Ministry of Education Science Sports and Culture. Survey for the School Lunch Program (in Japanese). http://www.mext.go.jp/b_menu/toukei/chousa05/kyuushoku/kekka/k_detail/icsFiles/afieldfile/2017/01/18/1381230_1_2_1.pdf. Published 2017. Accessed November 28, 2018.
18) Asakura K, Sasaki S. School lunches in Japan: their contribution to healthier nutrient intake among elementary-school and junior high-school children. Public Health Nutr. 20(9):1523-1533. 2017.
19) Ministy of Health Labour and Welfare. Dietary Reference Intakes for Japanese, 2015. Toyko: Daiichi Shuppan Publishing Co., Ltd.; 2014.
20) The Counsil for Science and Technology Ministry of Education Science Sports and Culture. Standard Tables of Food Composition in Japan, 2015 (Seventh Edition). Tokyo: Official Gazette Co-operation.; 2015.
21) Nozue M, Jun K, Ishihara Y, et al. How does fortification affect the distribution of calcium and vitamin B-1 intake at the school lunch for fifth-grade children? J Nutr Sci Vitaminol (Tokyo). 59(1):22-28. 2013.
22) Kohri T, Kaba N, Itoh T, Sasaki S. Effects of the National School Lunch Program on Bone Growth in Japanese Elementary School Children. J Nutr Sci Vitaminol (Tokyo). 62(5):303-309.

2016.

23) Murphy MM, Douglass JS, Johnson RK, Spence LA. Drinking Flavored or Plain Milk Is Positively Associated with Nutrient Intake and Is Not Associated with Adverse Effects on Weight Status in US Children and Adolescents. J Am Diet Assoc. 108(4):631-639. 2008.
24) Kakutani Y, Kamiya S, Omi N. Association between the Frequency of Meals Combining “Shushoku, Shusai, and Hukusai” (Staple Food, Main Dish, and Side Dish) and Intake of Nutrients and Food Groups among Japanese Young Adults Aged 18-24 Years: a Cross-Sectional Study. J Nutr Sci Vitaminol (Tokyo). 61(1):55-63. 2015.
25) Murakami K, Miyake Y, Sasaki S, Tanaka K, Arakawa M. Dietary glycemic index and glycemic load in relation to risk of overweight in Japanese children and adolescents: the Ryukyus Child Health Study. Int J Obes. 35(7):925-936. 2011.
26) Okuda M, Sasaki S, Bando N, et al. Carotenoid, Tocopherol, and Fatty Acid Biomarkers and Dietary Intake Estimated by Using a Brief Self-Administered Diet History Questionnaire for Older Japanese Children and Adolescents. J Nutr Sci Vitaminol (Tokyo). 55(3):231-241. 2009.
27) Kobayashi S, Murakami K, Sasaki S, et al. Comparison of relative validity of food group intakes estimated by comprehensive and brief-type self-administered diet history questionnaires against 16 d dietary records in Japanese adults. Public Health Nutr. 14(7):1200-1211. 2011.
28) Kobayashi S, Honda S, Murakami K, et al. Both comprehensive and brief self-administered diet history questionnaires satisfactorily rank nutrient intakes in Japanese adults. J Epidemiol. 22(2):151-159. 2012.
29) The Council for Science and Technology Ministry of Education Culture Sports and Technology. Standard Tables of Food Composition in Japan - 2010. Tokyo: Official Gazette Co-operation.; 2010.
30) Murakami K, Miyake Y, Sasaki S, Tanaka K, Arakawa M. Characteristics of under- and over-reporters of energy intake among Japanese children and adolescents: The Ryukyus Child Health Study. Nutrition. 28(5):532-538. 2012.
31) Murakami K, Sasaki S, Takahashi Y, et al. Misreporting of dietary energy, protein, potassium and sodium in relation to body mass index in young Japanese women. Eur J Clin Nutr. 62(1):111-118. 2008.
32) Okubo H, Sasaki S, Murakami K, Takahashi Y. Nutritional adequacy of four dietary patterns defined by cluster analysis in Japanese women aged 18-20 years. Asia Pac J Clin Nutr. 19(4):555-563. 2010.
33) Kobayashi S, Asakura K, Suga H, Sasaki S. Living status and frequency of eating out-of-home foods in relation to nutritional adequacy in 4,017 Japanese female dietetic students aged 18–20 years: A multicenter cross-sectional study. J Epidemiol. 27(6):287-293. 2017.
34) Kohri T. Usefulness of a Handmade Box Lunch as a Common Dietary Education Tool to School Children and Parents. J Child Heal. 73(5):663-671. 2014. (in Japanese).
35) Asakura K, Uechi K, Masayasu S, Sasaki S. Sodium sources in the Japanese diet: difference between generations and sexes. Public Health Nutr. 19(11):2011-2023. 2016.
36) Tamura Y, Saito I, Asada Y, Kishida T, Yamaizumi M, Kato T. A cross-sectional survey of factors influencing bone mass in junior high school students. Environ Health Prev Med. 18(4):313-322. 2013.
37) Harrison F, Jennings A, Jones A, et al. Food and drink consumption at school lunchtime: the impact of lunch type and contribution to overall intake in British 9–10-year-old children. Public Health Nutr. 16(6):1132-1139. 2013.
38) Serra-Majem L, Ribas L, Ngo J, et al. Food, youth and the Mediterranean diet in Spain. Development of KIDMED, Mediterranean Diet Quality Index in children and adolescents. Public Health Nutr. 7(7):931-935. 2004.
39) Sweeting H, West P. Dietary habits and children’s family lives. J Hum Nutr Diet. 18(2):93-97. 2005.
40) Al-shukaily L. Effect of Mothers Nutritional Knowledge and Attitudes on Omani Children’s Dietary Intake. Oman Med J. 26(4):253-257. 2011.