

## Association between Intake during Multiple Eating Occasions and Total Daily Intake among Japanese Young Women

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**Abstract:** Young women in Japan have a poor dietary intake, subjecting them to a risk of inadequate micronutrient intake. This study examined the dietary intake of Japanese young women at multiple eating occasions to identify opportunities for more targeted recommendations and strategies to improve the dietary intake of young women. This study involved 21 female university students. Their dietary intakes were estimated using the 7-day dietary record. Participant-defined eating occasions were classified as breakfast, lunch, dinner, and snack. The mean percent contribution to the total daily intake of shortfall nutrients (calcium, iron, vitamin A, thiamine, riboflavin, and vitamin C) as well as the density, foods consumed, and percentage of days at each occasion were calculated. Daily breakfast consumption had the lowest prevalence (91%), except snack. Breakfast contributed 26% of the total daily energy intake and almost 30% of the daily calcium and riboflavin intake. Milk consumption contributed 16% of the daily calcium intake and 10% of the riboflavin intake. The key opportunities identified for Japanese young women were to increase breakfast consumption, given the high nutrient densities of breakfasts consumed.

**Keywords:** Young Women, Food Intake, Nutrient Intake, Eating Occasion, Diet Quality, Meal Patterns, Japanese

### 1. INTRODUCTION

Adequate nutrition in young women is important for ensuring health. Despite the importance of nutrition in this stage of life, lower intakes of fruits, vegetables, and milks and higher confectionary intake can lead to poor diet quality [1]. Consequently, young Japanese women had lower micronutrient intake and higher percentage of energy from total fat [1]. Moreover, young women (20–29 years) had the highest prevalence of skipping breakfast among women aged  $\geq 20$  years [1]. Examining the dietary intakes at multiple eating occasions, which include the total daily food and nutrient intakes, would identify new opportunities for more targeted recommendations and strategies to improve the diet quality of young women.

Some studies investigated the association between eating occasions and total daily intake. For example, skipping meals are associated with lower micronutrient intake [2]. Moreover, the type of breakfast has been associated with total diet quality in Japanese female college students

[3]. Moreover, intake of nutrients and food groups at each occasion were examined in Japanese female college students. Nutrients and food groups were not equally distributed across all eating occasions [4].

People tend to eat specific combinations of foods at meals [5], and understanding the meal patterns at a certain eating occasion could be useful for the development of public health nutrition policies and recommendations. Inherently, examining individual eating occasions in the context of the total diet does not provide a complete perspective on the impact that each eating occasion has on total daily intake, and, subsequently, the potential opportunities to improve overall diet quality. Examining the multiple components of each eating occasion can further identify more specific areas that need to be targeted to improve dietary intake. Therefore, this study aimed to take a holistic approach to investigate how food and nutrient intakes at multiple eating occasions contributed to the total daily intake of Japanese female college students.

## 2. MATERIALS AND METHODS

We conducted a cross-sectional survey in Japan between February and March 2015. The study involved 21 female students who majored in nutrition and dietetics from a university. The study was reviewed and approved by the Ethics Committee of the Aomori University of Health and Welfare (1711). All participants provided a written informed consent.

Seven-day non-consecutive dietary records were obtained from each participant. The participants recorded all foods consumed by them on the survey day. They weighted the ingredients in dishes whenever possible using the digital scale. If participants ate out and weighing was difficult, they recorded the restaurant's name and name of dishes. Nutrient intake was calculated based on the standard tables of food composition in Japan (2015; seventh revised version) [6].

We considered seven cases as seven dietary records per participant and analyzed 147 cases. Nutrients examined in this study were selected based on the priority of the Dietary Reference Intakes for Japanese (2010) [7], and we selected calcium, iron, vitamin A, thiamine, riboflavin, and vitamin C.

As part of the dietary record, participants were asked to classify the eating occasion for each

$$\frac{\text{Calcium}_{\text{breakfast}}/\text{Calcium}_{\text{total}}}{\text{Energy}_{\text{breakfast}}/\text{Energy}_{\text{total}}} = \frac{\% \text{ of daily Calcium}}{\% \text{ of daily Energy}} \quad (1)$$

$$\frac{\text{Calcium}_{\text{breakfast}}/\text{Calcium}_{\text{total}}}{\text{Energy}_{\text{breakfast}}/\text{Energy}_{\text{total}}} = \frac{\text{Calcium}_{\text{breakfast}}/\text{Energy}_{\text{breakfast}}}{\text{Calcium}_{\text{total}}/\text{Energy}_{\text{total}}} \quad (2)$$

The comparison between the nutrient density index of a single eating occasion and the daily intake provides a context beyond the first approach, where nutrient densities are reported as nutrient/energy (kcal). An index of 1 occurs when the nutrient density of a given eating occasion is equal to the nutrient density of the total daily intake among consumers of that eating occasion (Equation 2). It is important to note that given the low quality of the total day, nutrient density indexes above 1 for micronutrients, and nutrient density indexes less than 1 for nutrients to limit, do not necessary indicate a lack of need to make improvements.

Foods were categorized into 17 groups (cereals, potatoes and starches, sugar and sweeteners, pulses, nuts and seeds, vegetables, fruits,

food consumed from four pre-defined options: breakfast, lunch, dinner, and snack. The percentage of days when participants record a food at each eating occasion was reported as the percentage of consumers. Participants were restricted to record one eating occasion at a given time.

The per day percent contribution to total daily energy and nutrient intakes were calculated for each occasion. Two approaches were used to calculate the nutrient density among consumers at the eating occasion. For micronutrients, the nutrient density was calculated per 1000 kcal. For example, the calcium intake (mg) at lunch was divided by the energy intake (kcal) at lunch and then multiplied by 1000. Given the different units for each nutrient, the second approach created a nutrient density index to facilitate the examination of all nutrients simultaneously within each eating occasion [8]. For a given eating occasion, the percentage of total daily nutrient intake was divided by the percentage of the total daily energy intake to give a nutrient density relative to the total daily intake (Equation 1). This nutrient daily energy index is obtained by dividing the nutrient density of eating occasion by the nutrient density of the total daily intake among consumers of a particular eating occasion (Equation 2).

mushrooms, algae, fishes and shellfishes, meats, eggs, milks, fats and oils, confectionaries, beverages, and seasonings and spices) according to the standard tables of food composition in Japan (2015; seventh revised version) [6]. The top five sub-major food groups that largely contributed to the total daily energy, calcium, iron, thiamine, riboflavin, and vitamin C intake were ranked, and the sum of the top five sub-major food groups was calculated for each eating occasion to identify opportunities that can increase the total daily intake.

We considered seven cases as seven dietary records per participant and analyzed 147 cases. The analyses were performed using SPSS ver. 24 (IBM Japan Corporation, Tokyo, Japan). We calculated the mean and 95% confidence

interval for energy and nutrient intake from eating occasions, nutrient densities, and density indexes.

**3. RESULTS AND DISCUSSION**

Except snack, breakfast consumption had the lowest prevalence (90.5%) and slightly contributed to the total daily energy (25.8%) (Table 1). Breakfast contributed a smaller proportion of thiamine (24.4%) and vitamin C (23.5%) than energy, but contributed a higher proportion of calcium (33.1%) and riboflavin (31.9%). Subsequently, the nutrient density indexes were less than 1 for thiamine and vitamin C, while those for calcium and vitamin C were higher than 1.

Almost all participants (96.6%) consumed lunch, and lunch contributed just above a third (35.3%). Relative to its energy contribution, lunch contributed proportional amounts of vitamin A (35.0%) and C (35.1%). The nutrient density indexes for calcium and thiamine at lunch were all below 1.

Dinner contributed 35.8% of the total energy intake. Dinner contributed the highest proportions of daily iron (37.5%), thiamine (40.1%), and vitamin C (37.9%). The nutrient density indexes for these nutrients were nearly 1.

Approximately a quarter of participants (26.5%) consumed snacks. Snacks contributed the least to the total daily energy and nutrient intake. Nutrient density indexes for calcium and iron were above 1.

Examining how eating occasions contributed to the top sources of daily nutrients can identify specific foods to target at each eating occasion, but also the top opportunities across all eating occasions to improve total daily intakes. Examining the percent contribution of foods to total daily intake provides a context for recommendations to change the total daily intakes via a single source of nutrient at a given eating occasion.

Table 1. Energy and nutrient contribution to total daily intake, nutrient density, and nutrient density index by eating occasion

Eating occasion	Energy		Calcium		Iron		Vitamin A		Thiamine		Riboflavin		Vitamin C		
	Contribution to total daily intake (%) †														
Breakfast	25.8	(23.8, 27.8)	33.1	(29.5, 36.7)	26.0	(23.0, 29.1)	26.9	(22.9, 30.9)	24.4	(21.5, 27.3)	31.9	(28.6, 35.2)	23.5	(19.4, 27.6)	
Lunch	35.3	(32.9, 37.8)	29.9	(26.5, 33.3)	33.8	(30.9, 36.6)	35.0	(30.6, 39.4)	33.5	(30.3, 36.7)	31.4	(28.4, 34.5)	35.1	(30.6, 39.7)	
Dinner	35.8	(33.6, 38.0)	33.0	(29.6, 36.4)	37.5	(34.6, 40.5)	36.2	(31.8, 40.5)	40.1	(36.8, 43.3)	33.1	(30.2, 36.0)	37.9	(33.5, 42.4)	
Snack	3.3	(2.1, 4.4)	4.2	(2.6, 5.9)	2.9	(1.8, 4.0)	2.2	(0.9, 3.5)	2.3	(1.3, 3.3)	3.8	(2.4, 5.2)	3.7	(1.5, 5.9)	
Frequent consumer		Nutrient density (/1000 kcal)													
	n	(%)	mg		mg		µg retinol activity equivalent		mg		mg		mg		
Breakfast	133	(90.5)	356	(304, 407)	3.9	(3.5, 4.3)	260	(212, 307)	0.44	(0.39, 0.50)	0.80	(0.71, 0.89)	30	(24, 35)	
Lunch	142	(96.6)	224	(191, 257)	4.3	(3.7, 4.9)	304	(219, 390)	0.47	(0.43, 0.51)	0.55	(0.50, 0.60)	41	(33, 49)	
Dinner	142	(96.6)	260	(209, 311)	4.5	(4.0, 5.0)	415	(221, 608)	0.56	(0.51, 0.62)	0.61	(0.53, 0.69)	43	(35, 50)	
Snack	39	(26.5)	571	(397, 746)	15.4	(4.7, 26.1)	155	(75, 234)	0.29	(0.21, 0.37)	0.38	(0.11, 0.65)	46	(13, 79)	
Total	-	-	268	(240, 296)	4.1	(3.8, 4.3)	308	(245, 372)	0.50	(0.47, 0.53)	0.62	(0.59, 0.66)	39	(35, 43)	
Nutrient density index (% of daily nutrient/% of daily energy)															
Breakfast			1.4	(1.2, 1.5)	1.0	(0.9, 1.0)	1.1	(0.9, 1.2)	0.9	(0.8, 1.0)	1.3	(1.2, 1.4)	0.9	(0.7, 1.0)	
Lunch			0.8	(0.8, 0.9)	1.0	(0.9, 1.1)	1.0	(0.9, 1.2)	1.0	(0.9, 1.0)	0.9	(0.8, 0.9)	1.0	(0.8, 1.2)	
Dinner			1.0	(0.8, 1.1)	1.1	(1.0, 1.1)	1.0	(0.9, 1.2)	1.1	(1.1, 1.2)	1.0	(0.9, 1.0)	1.1	(0.9, 1.2)	
Snack			2.6	(1.5, 3.7)	4.2	(1.1, 7.3)	0.5	(0.3, 0.7)	0.7	(0.5, 1.0)	0.6	(0.2, 1.0)	1.3	(0.3, 2.2)	

Values are shown as mean (95% confidence interval). † Percent contribution represents the mean of the present contribution of each day.

At breakfast, cereals contributed 12.4% of the daily energy intake (Table 2). Milks were among the top five contributors to the daily energy, calcium, vitamin A, thiamine, and riboflavin intake. Milks consumed at breakfast contributed 3.0% of energy, 16.4% of the total calcium, 7.5% of vitamin A, 3.2% of energy, and 9.5% of riboflavin intakes.

Vegetable consumed at lunch contributed 20.2% of the vitamin A and 26.2% of the vitamin C intakes. On the other hand, milks were among

the top five sources of daily calcium and riboflavin; calcium (5.5%) and riboflavin (3.1%) had the lowest prevalence among all eating occasions except snack.

At dinner, cereals contributed 16.1% of the daily energy. Meats were among the top five contributors to daily energy, vitamin A, thiamine, riboflavin, and vitamin C. Meats consumed at dinner contributed 4.8% of energy, 2.6% of vitamin A, 13.1% of thiamine, 7.1% of riboflavin, and 2.1% of vitamin C.

## Association between Intake during Multiple Eating Occasions and Total Daily Intake among Japanese Young Women

Breakfast contributed less to the total daily energy intake than lunch and dinner, partly due to the higher prevalence of skippers. Among meals, breakfast skippers had the highest prevalence. This finding is consistent with the results of the previous studies [1]. Some studies showed that frequency and reasons of breakfast skipping in Japanese college students depend on

the living arrangement [9]. Japanese young women aged 20–29 years had the lowest calcium intake [1]. Peak bone mass reaches the peak level at the age of 20 years [10]. Moreover, calcium intake is associated with bone mineral density in young women [11]. Breakfast with milks promotes calcium intake in young women.

Table 2. Top five sub-major food groups ranked by the contribution of daily energy and nutrient intake

Nutrient	Top five sub-major food groups	Contribution to total daily		Contribution to total daily nutrient intake by eating occasion (% †)							
		nutrient intake (% †)		Breakfast	Lunch	Dinner	Snack				
Energy	Cereals	46.9	(44.8 , 49.1)	12.4	(11.2 , 13.6)	18.1	(16.3 , 19.9)	16.1	(14.7 , 17.5)	0.3	(0.0 , 0.6)
	Meats	10.2	(8.8 , 11.5)	1.1	(0.7 , 1.5)	4.3	(3.4 , 5.2)	4.8	(3.9 , 5.7)	0.0	(0.0 , 0.0)
	Milks	6.0	(4.9 , 7.1)	3.0	(2.4 , 3.6)	1.2	(0.5 , 1.9)	1.3	(0.8 , 1.9)	0.4	(0.1 , 0.8)
	Fishes and shellfishes	5.1	(3.9 , 6.3)	1.0	(0.6 , 1.4)	1.1	(0.6 , 1.6)	3.0	(1.9 , 4.1)	0.0	(0.0 , 0.0)
	Seasonings and spices	4.7	(4.0 , 5.3)	1.1	(0.8 , 1.4)	1.7	(1.4 , 2.1)	1.9	(1.4 , 2.4)	0.0	(0.0 , 0.0)
	Sum of top sources		72.8		18.5		26.4		27.1		0.8
Calcium	Milks	29.6	(25.4 , 33.7)	16.4	(13.0 , 19.8)	5.5	(3.2 , 7.8)	6.0	(3.7 , 8.2)	1.7	(0.5 , 2.9)
	Vegetables	22.1	(19.3 , 24.9)	0.8	(0.3 , 1.3)	9.1	(7.0 , 11.2)	8.9	(7.3 , 10.5)	0.1	(0.0 , 0.1)
	Pulses	9.2	(7.3 , 11.2)	3.3	(2.2 , 4.3)	1.6	(0.8 , 2.5)	4.3	(2.8 , 5.8)	0.0	(0.0 , 0.0)
	Cereals	8.9	(7.7 , 10.2)	2.4	(1.9 , 3.0)	4.0	(3.1 , 4.9)	2.3	(1.8 , 2.7)	0.2	(0.0 , 0.4)
	Seasonings and spices	6.6	(5.1 , 8.0)	1.3	(0.9 , 1.7)	2.0	(1.5 , 2.5)	3.2	(1.9 , 4.6)	0.0	(0.0 , 0.0)
	Sum of top sources		76.4		24.2		22.3		24.7		1.9
Iron	Cereals	17.1	(14.9 , 19.2)	4.6	(3.6 , 5.7)	7.3	(5.6 , 9.0)	4.8	(3.9 , 5.7)	0.3	(0.0 , 0.7)
	Vegetables	15.0	(13.5 , 16.6)	2.8	(2.1 , 3.5)	6.4	(5.1 , 7.6)	5.8	(4.9 , 6.7)	0.1	(0.0 , 0.2)
	Pulses	13.1	(10.5 , 15.8)	6.1	(4.2 , 7.9)	2.3	(1.1 , 3.5)	4.7	(3.1 , 6.3)	0.0	(0.0 , 0.0)
	Eggs	11.9	(9.9 , 13.9)	4.3	(3.1 , 5.6)	5.0	(3.7 , 6.3)	2.5	(1.5 , 3.5)	0.0	(0.0 , 0.1)
	Seasonings and spices	11.5	(9.8 , 13.3)	2.4	(1.8 , 3.1)	3.7	(3.0 , 4.5)	5.4	(3.8 , 6.9)	0.0	(0.0 , 0.0)
	Sum of top sources		68.7		20.3		24.8		23.2		0.4
Vitamin A	Vegetables	51.3	(46.4 , 56.3)	8.9	(6.1 , 11.6)	20.2	(16.1 , 24.3)	21.8	(18.1 , 25.5)	0.5	(-0.5 , 1.5)
	Eggs	17.1	(13.8 , 20.4)	6.6	(4.4 , 8.8)	6.9	(4.8 , 8.9)	3.6	(2.0 , 5.3)	0.0	(0.0 , 0.1)
	Milks	13.2	(10.4 , 15.9)	7.5	(5.4 , 9.6)	2.7	(1.0 , 4.4)	2.4	(1.3 , 3.5)	0.6	(0.1 , 1.0)
	Fishes and shellfishes	4.5	(2.5 , 6.5)	0.7	(0.2 , 1.3)	0.9	(0.1 , 1.7)	2.9	(1.2 , 4.6)	0.0	(0.0 , 0.0)
	Meats	3.9	(2.1 , 5.7)	0.1	(0.0 , 0.1)	1.3	(0.6 , 1.9)	2.6	(0.9 , 4.3)	0.0	(0.0 , 0.0)
	Sum of top sources		90.0		23.8		31.9		33.2		1.1
Thiamine	Meats	27.7	(24.0 , 31.4)	3.5	(1.7 , 5.2)	11.1	(8.5 , 13.7)	13.1	(10.4 , 15.9)	0.0	(0.0 , 0.0)
	Cereals	19.3	(17.0 , 21.5)	5.3	(4.3 , 6.2)	7.4	(6.0 , 8.9)	6.3	(5.0 , 7.5)	0.3	(0.0 , 0.7)
	Vegetables	12.9	(11.6 , 14.2)	2.6	(2.0 , 3.2)	5.2	(4.2 , 6.1)	5.0	(4.3 , 5.7)	0.2	(0.0 , 0.3)
	Fishes and shellfishes	8.9	(6.7 , 11.1)	1.8	(1.1 , 2.6)	1.4	(0.7 , 2.1)	5.7	(3.6 , 7.7)	0.0	(0.0 , 0.0)
	Milks	6.0	(4.7 , 7.3)	3.2	(2.5 , 4.0)	1.3	(0.3 , 2.4)	1.1	(0.6 , 1.7)	0.3	(0.1 , 0.6)
	Sum of top sources		74.8		16.4		26.4		31.2		0.8
Riboflavin	Eggs	17.7	(14.8 , 20.5)	6.2	(4.3 , 8.1)	7.9	(5.7 , 10.0)	3.6	(2.2 , 5.0)	0.0	(0.0 , 0.1)
	Milks	16.9	(14.1 , 19.7)	9.5	(7.4 , 11.5)	3.1	(1.4 , 4.8)	3.5	(2.1 , 4.9)	0.8	(0.2 , 1.4)
	Meats	13.8	(11.8 , 15.8)	1.4	(0.7 , 2.1)	5.3	(4.0 , 6.6)	7.1	(5.6 , 8.6)	0.0	(0.0 , 0.0)
	Vegetables	10.5	(9.2 , 11.8)	1.9	(1.3 , 2.5)	4.5	(3.5 , 5.5)	3.9	(3.3 , 4.6)	0.1	(0.0 , 0.3)
	Fishes and shellfishes	9.0	(7.0 , 11.1)	2.1	(1.3 , 2.9)	1.7	(0.7 , 2.6)	5.3	(3.4 , 7.2)	0.0	(0.0 , 0.0)
	Sum of top sources		67.9		21.0		22.5		23.5		0.9
Vitamin C	Vegetables	66.5	(62.4 , 70.6)	13.4	(10.0 , 16.9)	26.2	(21.8 , 30.7)	26.7	(22.8 , 30.6)	0.2	(-0.1 , 0.4)
	Fruits	11.9	(8.6 , 15.2)	5.4	(3.2 , 7.5)	2.5	(1.2 , 3.8)	2.7	(0.9 , 4.6)	1.3	(-0.1 , 2.7)
	Meats	5.7	(4.1 , 7.3)	0.9	(0.4 , 1.5)	2.7	(1.7 , 3.7)	2.1	(1.2 , 3.0)	0.0	(0.0 , 0.0)
	Potatoes and starches	5.1	(3.1 , 7.1)	1.4	(0.3 , 2.5)	0.9	(0.3 , 1.6)	2.4	(1.2 , 3.7)	0.4	(-0.4 , 1.2)
	Beverages	4.1	(2.1 , 6.0)	0.4	(-0.1 , 0.8)	0.6	(0.3 , 1.0)	0.7	(0.2 , 1.2)	1.8	(0.3 , 3.4)
	Sum of top sources		93.3		21.5		33.0		34.6		3.7

Values are shown as mean (95% confidence interval). † Represents the the proportion of total nutrient intake from all days that came from each food group.

Vegetables contributed a large proportion of vitamin A and C. Most participants consumed vegetables at lunch and dinner. Japanese people, particularly young adults, consume vegetable much less than the amount recommended by the Health Japan (the second term) [12], which is the national health promotion movement in Japan. Although Health Japan (the second term) had tackled the increasing vegetable consumption in Japan, changes or decline in vegetable consumption have not been reported in the last decade [1]. Japanese people are encouraged to consume more vegetables at breakfast as well as lunch and dinner.

With respect to the daily intakes of specific micronutrients, 15.4% of women aged 20–29 years were reported to have anemia [13]. The top three sources of iron are plant based. As regards higher iron bioavailability and density, consumption of animal-based protein sources may be an effective means to increase the intake of iron. Moreover, research showed that Japanese young women are more likely to consume meats at lunch or dinner than breakfast [4]. Therefore, promoting the consumption of animal-based sources high in iron at lunch or dinner, with greater vegetable variety, including vegetables that are also high in iron, may help address low iron intakes and improve diet quality.

Cereals include rice, bread, and noodles and were consumed as staple foods by Japanese people. The amount of food consumed from this group was higher than that of other food groups. Accordingly, this food group was among the top five contributors to the daily calcium, iron, and thiamine requirement as well as energy requirement.

#### 4. CONCLUSION

In conclusion, these identified eating occasion-specific opportunities can potentially improve diet quality by increasing intakes of shortfall nutrients among Japanese young women. Increasing the number of young women consuming breakfast with milk and increasing vegetable consumption at breakfast as well as lunch or dinner were the key opportunities identified. Moreover, promoting the consumption of animal-based sources high in iron at lunch or dinner, with greater vegetable variety, including vegetables that are also high in iron, may help address low iron intakes and improve diet quality.

#### ACKNOWLEDGMENTS

We express our deepest appreciation to the participants for their cooperation throughout the study. We have no potential conflicts of interest to declare.

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**Citation:** *Tatsuya Koyama. Association between Intake during Multiple Eating Occasions and Total Daily Intake among Japanese Young Women. ARC Journal of Nutrition and Growth.2018; 4(1): 4-9. DOI: dx.doi.org/ 10.20431/ 2455-2550.0401002.*

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