Guardianship dietary and other behavioural factors associated with skipping breakfast in Japanese primary school children: a child-guardian dyad study

Running title: Skipping breakfast in Japanese child-guardian dyad

Juichiro Higashi MA[1], Keiko Asakura PhD[2], Sachie Mori MSc[1], Satoshi Sasaki PhD[3], Yuji Nishiwaki PhD[2]

[1]Department of Environmental and Occupational Health, Toho University Graduate School of Medicine, Tokyo, Japan
[2]Department of Environmental and Occupational Health, School of Medicine, Toho University, Tokyo, Japan
[3]Department of Social and Preventive Epidemiology, School of Public Health, the University of Tokyo, Tokyo, Japan

Authors' email addresses and contributions:
The authors' contributions were as follows: KA (keiko.asakura@med.toho-u.ac.jp) designed the research. SM (ksachie82@gmail.com) and KA performed the survey and collected the data. JH (dr-ju@nctv.co.jp) conceptualized the present study, analyzed the data, and wrote the draft. SS (stssasak@m.u-tokyo.ac.jp) and YN (yuuji.nishiwaki@med.toho-u.ac.jp) supervised all of the procedures and interpreted the results. All authors read and approved the final manuscript.

Corresponding Author: Dr Keiko Asakura, Department of Environmental and Occupational Health, School of Medicine, Toho University, Omori-Nishi 5-21-16, Ota-ku, Tokyo, Japan, #143-8540. Tel: +81-3-3762-4151. Fax: +81-3-5493-5416. Email: JZF01334@nifty.ne.jp, keiko.asakura@med.toho-u.ac.jp

ABSTRACT

Background and Objectives: Regular breakfast consumption is widely considered an important component of healthy dietary habits. In this study, we assessed differences in nutrient/food intake between breakfast consumers and skippers. We also investigated behavioural factors related with breakfast skipping utilizing data collected from both children and their guardians. **Methods and Study Design:** This cross-sectional study was conducted in 14 public primary schools in Japan. Two questionnaires were distributed: a behavioural questionnaire and a brief-type, self-administered diet history questionnaire. In total, 1816 child (10-12 y/o)-guardian dyads were included in the analysis. Intakes of nutrients and foods were compared between breakfast consumers and skippers by the t-test. The relationship between breakfast skipping and behavioural factors was investigated by logistic regression analysis by child sex. **Results:** The proportion of breakfast skippers in the children was 9.8%. Daily intakes of nutrients/foods were better in the breakfast consumers. Later bedtime, lower nutrition knowledge level, and frequent incomplete consumption of home meals was significantly or marginally associated with breakfast skipping. Guardians' breakfast skipping was also associated with children's breakfast skipping. Some relationships between behavioural factors and breakfast skipping differed between boys and girls. **Conclusions:** Breakfast consumers had a more nutritious meal quality. To increase breakfast consumption, morning time schedules may need to be rearranged to avoid time pressure. Nutritional knowledge and dietary behavior appear relevant. Guardians played a major role in coping with breakfast avoidance, in part as role models.

Key Words: skipping breakfast, dietary intake, primary school children, guardian, Japan

INTRODUCTION

Regular breakfast consumption is widely considered an important component of healthy dietary habits, because it can promote adequate nutrient intake and may have several health benefits.[1-3] For example, several large prospective studies showed an association between breakfast consumption and lower risk of obesity and weight gain.[3] Skipping breakfast has been associated with impaired glucose metabolism[4-6] and other cardiometabolic risk factors.[7-9]

Since dietary habits are established in childhood and track into adulthood,[10] it is particularly important for children to develop the habit of regular breakfast consumption. Indeed, the beneficial effect of regular consumption on cardiometabolic risk factors seen in

adults is also reported in children.[2] In a review, a positive association was found between increased frequency of breakfast and academic performance.[11]

In its Third Basic Plan for Promotion of Shokuiku (food and nutrition education), the Japanese government set a target breakfast skipping rate for Japanese children of 0%.[12] However, the percentage of primary school children who consume breakfast every day was 84.8% in 2018,[13] meaning that 15.2% of children sometimes or always skipped breakfast. No decreasing trend in the breakfast skipping rate has been observed among Japanese children over the past 10 years.[13,14]

Risk factors for breakfast skipping have been reported. Skipping is more frequently observed in girls,[2,15,16] older school-age children,[11,15,16] those with a lower family social economic status[3,16] or low family functioning,[16-19] and those in a single-parent families.[2,17] Additional reasons offered included lack of time in the morning,[1] no desire to eat food,[1] and body weight control, especially by girls.[1,2,20]

Although breakfast skipping by children has been closely studied worldwide, few studies of risk factors for skipping have been reported from Japan, or elsewhere in Asia.[21] Further, studies which simultaneously considered the dietary and behavioural factors of children and of their guardians are scarce. Here, we aimed to describe the characteristics of nutrient/food intakes in breakfast skippers and to explore modifiable risk factors of skipping in Japanese primary school children.

MATERIALS AND METHODS

Participants and study outline

The study was implemented in a prefecture in the northern Kanto area, in the central part of the main island of Japan. Seven cities and towns from five administrative districts in the prefecture were selected based on survey feasibility. Two public primary schools with similar characteristics (e.g. number of enrolled children, location (urban/rural)) were then selected from each city/town by the respective municipal board of education. These 14 primary schools enrolled 2650 5th and 6th grade children (10-12 y/o) in April, 2018, all of whom were recruited into the study. At the same time, all of their guardians, most of whom were the main preparers of meals for the children, were also recruited. No exclusion criteria were set for recruitment.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving study participants were approved by the Ethics Committee of the Faculty of Medicine, Toho University (A19003_A17043). Written informed

consent for the children was obtained from their guardians. Regarding the guardians themselves, completion and return of the questionnaires was not mandatory, and those who did so after detailed explanation of the study were deemed to have consented to participation.

Questionnaires

The children and their guardians were surveyed using two questionnaires each. The first was a behavioural questionnaire that asked about basic characteristics and nutrition knowledge, as well as attitudes and behaviors toward diet, and the second was a brief-type self-administered diet history questionnaire (BDHQ) that assessed dietary intake.

Intake of nutrients and foods was assessed using the BDHQ for the guardians and the BDHQ15y (BDHQ for Japanese children and adolescents) for the children. The BDHQ is a four-page fixed-portion questionnaire that asks about the consumption frequency of selected foods commonly consumed in Japan, general dietary behavior, and usual cooking methods to estimate the dietary intake of foods and beverage items during the preceding month. Estimates of daily intake for foods, energy, and selected nutrients were calculated using an ad hoc computer algorithm for the BDHQ and BDHQ15y based on the Standard Tables of Food Composition in Japan.[22] Both questionnaires have been appropriately validated[23–25] and used in several epidemiologic studies.[26,27] The children were asked to answer the BDHQ15y with their guardians at home.

The breakfast intake of the children and their guardians was explored in the behavioural questionnaires. Breakfast consumers (consumer) were defined as those who consumed breakfast every day. Otherwise, participants were categorized as breakfast skippers (skipper). Breakfast itself was not specifically defined. Among behavioural factors possibly associated with children's breakfast intake, we selected variables from the children's questionnaire as follows: three time-related variables (bedtime, wake-up time, videogame playing time), nutrition knowledge, attitude toward diet, dietary behavior, and frequency of communication about diet with their guardians. Videogame playing time was categorized with a boundary at 1 hour because past studies have shown that screen media use exceeding 1 hour per day is associated with higher risk for breakfast skipping.[28] In addition to these variables for the children, those selected from the guardian questionnaire were also considered to be factors which possibly affect children's breakfast intake, namely breakfast intake of the guardians, nutrition knowledge of the guardians, attitude of the guardians toward diet, frequency of communication about diet with their child, and subjective socioeconomic status.

The nutrition knowledge questionnaire used to measure the nutritional knowledge of the children and their guardians has been validated.[29] This questionnaire includes the following sections: 1) knowledge about foods as nutrient sources; 2) physiological functions of nutrients in the body; 3) awareness of dietary recommendations (for adults); and 4) relationship between nutrients and health outcomes. The percentage (%) of correct answers was calculated and categorized into tertiles of low, middle, and high knowledge. Attitude toward diet was defined as follows. The children were asked "Do you pay attention to whether your diet is healthy or not?", and given one answer choice (always, often, sometimes, or rarely). Children's intention to lose weight (answer: yes/no) was also used to indicate attitude towards diet. Regarding the guardians' dietary attitude, they read the statement: "I am careful to eat a well-balanced diet for myself", and chose their response to the statement from four answer choices (strongly agree, agree, mostly disagree, disagree). The phrase 'well-balanced diet' is common in Japanese, and it usually means healthy diet including various types of foods such as cereals, vegetables, fruits, pulses, meats, or fish. As to the dietary behavior of the children, two variables were used: the frequency of leaving food in home meals and the frequency of buying and eating snacks by the children themselves (kaigui in Japanese; this word connotes that children characteristically engage in unhealthy snacking when not under adult supervision, and may warrant differentiation from simple snacking in dietary studies in children). Answer choices for these two questions were never, sometimes (<1 day/week), often (1-2 days/week), and very often (≥3 days/week). The children and guardians were both asked about the frequency of communication about diet, as follows: "Do you discuss meals, food, or other nutritional topics with your guardian?" (or 'your child' in the statements for guardians), with responses from the four choices of "often", "sometimes", "not often", or "rarely". The guardians were also asked about their subjective socioeconomic status (SES), with answers selected from the five choices of "very straitened", "straitened", "average", "affluent", or "very affluent". These were then further categorized as "straitened" for those who chose "very straitened" or "straitened"; "average"; and "affluent" for those who chose "affluent" or "very affluent".

Statistical analysis

Among 2650 children in the collaborating schools, 1816 children-guardian pairs who agreed to participate in the study and submitted two questionnaires with sufficient information were included in the analysis. Pairs in which the energy intake of at least one of the pair, estimated using the BDHQ (BDHQ15y for the child), was not between 600 and 4500 kcal were

excluded to avoid the influence of misreporting. Details of this selection process are shown in Figure 1.

Habitual intake of nutrients and foods were compared between breakfast skippers and consumers by the t-test. For protein, fat, and carbohydrate, %energy, i.e. the percentage of energy intake from protein, fat or carbohydrate to total energy intake, was used for comparison. Other nutrients and food intakes in the analysis were energy-adjusted (density method) and are presented as weight (g, mg, µg etc.) per 1000 kcal of energy intake.[30]

The relationship between breakfast skipping and behavioural factors was investigated by multiple logistic regression analysis. Trends of association were also examined for ordinary variables using a logistic regression model which assigned scores to the level of the independent variable. This analysis was performed for boys and girls separately. In the models, breakfast intake (skippers/consumers) of the children was treated as a dependent variable. Behavioural factors of the children and their guardians possibly related to children's breakfast skipping (i.e. independent variables) were listed in the subsection about the questionnaires. We did not use wake-up time in the models but rather bedtime only, because later bedtime was strongly related with later wake-up time, and multicollinearity was highly suspected when they were included in the same model.

In model 1, each of the selected behavioural factors was included as an independent variable in the model, with children's sex, grade, and survey area as covariates. The behavioural factors significantly relating with breakfast skipping in Model 1 were then simultaneously included in Model 2 with the same covariates as Model 1. Regarding boys, two variables for attitude toward diet were not significantly associated with breakfast skipping, and were not included in Model 2. For girls, SES was not included in Model 2.

All analyses were performed using STATA version 15.1 (Texas, USA). Statistical tests were two-sided, and p values <0.05 were considered statistically significant.

RESULTS

The characteristics of the children and their guardians are shown in Table 1. The proportion of skippers did not significantly differ between boys (10.1%) and girls (9.5%) (p=0.71). Mean bedtime was significantly later among girls than boys (p=0.02), while videogame playing time was shorter among girls than boys (p<0.001). Regarding the guardians, breakfast skipping was significantly more prevalent in men than women (p=0.01).

Daily nutrient and food intakes among children are shown in Table 2 by breakfast intake status. Intakes of most nutrients, particularly vitamins and minerals, were significantly higher

in the consumers. Consumers also had significantly higher intakes of vegetables and milk/dairy products and lower intakes of confectioneries and soft drinks.

The relationship between children's breakfast skipping and their behavioural factors are shown in Table 3 (for boys) and Table 4 (for girls). This analysis also considered the influence of guardians' behavioural factors on children's breakfast skipping. Later bedtime was significantly associated with higher breakfast skipping risk in boys (p=0.002 by the multivariate-adjusted model (Model 2)) and girls (p=0.003). Higher nutrition knowledge of the children was significantly or marginally related with lower risk of breakfast skipping (p=0.046 in the boys, 0.053 in the girls). A better attitude toward diet of the children, namely frequent attention to the healthfulness of the diet and no intention to lose weight, was associated with breakfast consumption using Model 1 in girls, but these associations became non-significant after adjusting for more covariates in Model 2. Regarding the dietary behavior of the children, frequent incomplete consumption of home meals was significantly or marginally related to higher risk of breakfast skipping (p=0.06 in boys, <0.001 in girls). Frequent kaigui was significantly associated with breakfast skipping in both boys and girls in Model 1, but this relationship became non-significant in Model 2. In girls only, more frequent communication about diet with the guardians was significantly associated with lower risk of breakfast skipping (p=0.006, in Model 2).

The influence of guardian factors on children's breakfast skipping is also shown in Tables 3 and 4. Guardians' breakfast skipping was significantly related with children's breakfast skipping (p<0.001 in boys and girls). Among boys, higher nutrition knowledge of the guardians was marginally associated with lower risk of breakfast skipping of the children (p=0.054, in Model 2). Regarding girls, when the guardians answered that they rarely discuss meals, food, or other nutritional topics with their child, the adjusted odds ratio for children's breakfast skipping was 2.59 (95% confidence interval: 1.00-6.72) compared with those who answered they sometimes or often discuss this subject.

DISCUSSION

In this study, the proportion of breakfast skippers among the analyzed children was 9.8%. Daily intakes of nutrients/foods were more nutritious (e.g. higher intakes of vitamins/minerals as well as vegetables/milk and dairy products) in the breakfast consumers. Later bedtime, lower nutrition knowledge level, and frequent incomplete consumption of home meals was significantly or marginally associated with breakfast skipping. Guardians' breakfast skipping was also associated with children's breakfast skipping. Some relationships between

behavioural factors and breakfast skipping differed between boys and girls: lower nutrition knowledge of the guardians was significantly associated with breakfast skipping in boys only, while rare discussion about diet between children and guardians was marginally associated with breakfast skipping in girls only.

Monzani et al reviewed the prevalence of skipping breakfast among children and adolescents in 33 countries ranged from 10-30%.[2] Although prevalence in that review differed depending on the definition of breakfast skipping, prevalence in our present study appears consistent with those in other countries. Further, a national survey in 2018 reported that the proportion of Japanese school children who had breakfast every day was 84.8%,[13] which is similar to our present rate.

Several studies have reported that intakes of nutrients/foods were less in breakfast skippers than consumers.[1,31,32] In children, Rampersaud et al reported that dietary fiber intake was significantly greater in breakfast eaters than skippers, possibly due to the inclusion of ready-to-eat cereals in breakfast, and that breakfast eaters had higher intakes of micronutrients and were more likely to meet nutrient intake recommendations than skippers.[1] Of course, micronutrient fortification of cereals is an inadequate consideration of the complex nutritional, phytonutrient and physico-chemical contribution that minimally processed grain can make.[33] A recent review also reported higher intake of vitamins and minerals among breakfast consumers.[31] Coulthard et al reported that a lack of breakfast was associated with lower calcium intake, and speculated that this was due to lower intake of calcium-rich foods such as milk.[32] In our study, intake of dietary fiber, calcium, and milk/dairy products was lower in the breakfast skippers than the consumers. Adoption of ready-to-eat cereals and milk into the breakfast menu is convenient, because these foods can be consumed without cooking. They represent one choice in increasing the proportion of breakfast consumers and the quality of daily nutrient/food intakes. The reservation is that they are indicative of and vehicles for simplistic and reductionist approaches to nutritionally related health.[34] Moreover, most studies of breakfast and health outcomes, and of ways to address presumed problems, are Eurocentric, rather than a reflection of food cultures as found more globally, particularly Asia, as in the present study.[21]

In this study, we examined the association between breakfast skipping and three time-related factors: bedtime, wake-up time, and videogame playing time. Later bedtime, later wake-up time, and longer videogame playing time were each significantly associated with breakfast skipping on univariate analysis, but we did not include wake-up time in the multivariate-adjusted model because these time-related factors were significantly and

mutually related. In other words, children who went to bed later woke up later than the others, and had a longer videogame playing time (data not shown). In the multivariate-adjusted model, only later bedtime was significantly associated with higher risk of breakfast skipping, but it may be possible to go to bed earlier by shortening videogame playing time. A similar relationship between longer screen time and breakfast skipping has also been reported previously.[31,35] Given that other studies have also reported that lack of time is a reason for breakfast skipping,[1,36] it appears important to shorten screen time and retain sufficient time for breakfast in the morning.

In addition to the time-related factors, we also investigated the influence of several other factors among children. Higher nutrition knowledge was significantly associated with lower risk of breakfast skipping. This result was also reported by Wadolowska et al,[35] who also found that the predictors of skipping breakfast were similar to those of skipping meals at school.[35] In the present study, children who more frequently left food after a meal at home tended to skip breakfast. Our findings appear to suggest the importance of children acquiring healthy dietary habits such as regular meal consumption and finishing each meal completely. Cheng et al. reported that breakfast skipping among children was associated with a lack of perceived parental emphasis on breakfast.[37] This and our present finding suggest that guardians' attitude toward breakfast is important to establishing good dietary habits in children.

Regarding the guardians, their breakfast skipping was significantly associated with breakfast skipping by their children. This result is plausible, given that children and their guardians usually had breakfast together at home. This finding reinforces the major role played by guardians in children's acquisition of a breakfast consumption habit.

Some relationships between children's breakfast skipping and behavioural factors differed between boys and girls. For example, frequent communication about diet between the children and guardians was negatively associated with breakfast skipping only among girls, whereas higher nutrition knowledge of guardians was significantly associated with lower breakfast skipping risk only among boys. Pedersen et al. reported that low breakfast frequency was associated with low family functioning, and that this association was more pronounced among girls.[18] The reason for these differences is not clear, but it is possible that the provision of appropriate meals based on better nutrition knowledge by guardians is more important for boys, and that an understanding of diet through communication with guardians is more important for girls to have better breakfast habits. Further, several studies reported that skipping breakfast was more prevalent in girls,1 and that this is often ascribable to weight

control. In our univariate analysis, the intention to lose weight was significantly associated with breakfast skipping only among girls. The prevalence of obesity among Japanese school children aged 10-12 years is not particularly high, at approximately 10% in boys and 8% in girls in 2018, and has slightly decreased in recent years.[38] It may be necessary for girls in particular to learn appropriate body weight and the necessity of adequate nutrient intake.

Our study has several strengths. First, the survey participants were recruited from all five administrative districts in the prefecture, which is considered to have ensured high representativeness for the region. The large number of subjects and high response rate (68.5% of child-guardian dyads) supports the high power of the statistical analysis and low selection bias. Also, this condition enabled us to perform analyses stratified by sex and to observe differences between boys and girls. Second, the children and their guardians were surveyed simultaneously, and their data were combined to assess relationships. Third, food intakes were quantitatively assessed using the BDHQ and BDHQ15y, both of which have been validated.[23,24] Fourth, the statistical model made sufficient adjustment for confounding factors such as time-related factors, nutrition knowledge, attitude toward diet, and communication between children and guardians.

Several limitations of this study also warrant mention. First, since all the primary schools were in the same prefecture, the participants may not have represented the general Japanese population. However, the prefecture is located in the central part of the main island of Japan and includes both urban and rural areas, and the survey areas covered all five administrative districts of the prefecture. Second, the intakes of nutrients and foods assessed in this study were daily amounts. In other words, we were not able to evaluate the nutritional quality of breakfast independently. Since the habitual intake of nutrients affects health in the long term, however, comparison of daily intakes between breakfast consumers and skippers should be meaningful, and allows us to provide better suggestions to improve the quality of diets based on the results. Third, since most information was collected by self-administered questionnaire, objectivity could have been impaired for some variables. For example, SES was self-reported and household income was not investigated, due to the difficulty in collecting personal information at public schools. Also, we asked the guardians whether they are careful to eat well-balanced diet or not, but the meaning of 'well-balanced diet' was not specified. The guardians' attitude toward this point was not associated with their children's breakfast skipping in our multivariable analysis. However, if the quality of guardians' diet had been examined more quantitatively and objectively, it might have been related with children's breakfast skipping as suggested in the past study.9 Finally, the variables included in our

statistical models may be associated with each other to some extent, and it was difficult to clarify the direction of these associations. Therefore, it is important to consider the results of both univariate and multivariate analysis when discussing measures to decrease breakfast skipping.

Conclusions

The proportion of breakfast skippers among the children analyzed was 9.8%. Daily nutrient/food intakes were more nutritious in the breakfast consumers. Several factors were associated with breakfast skipping in the children: later bedtime (possibly a marker of time pressure in the morning), lower nutrition knowledge, and inadequate dietary habits such as frequent incomplete consumption of home meals. Their guardians may have played an important role in coping with this issue. Guardians' breakfast consumption, adequate nutrition knowledge, and frequent communication with their children about diet had a positive influence on the children's breakfast consumption

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Table 1. Characteristics of the participants (n=1816)

Variable	Number (%) or mean, SD		*p* value
Children	Boys (n=884)	Girls (n=932)	
Grade			
5th	433 (49.0)	458 (49.1)	0.95
6th	451 (51.0)	474 (50.9)	
Height (cm)	142.3, 7.4	143.5,7.5	<0.01
Weight (kg)	36.7, 8.7	36.7, 8.2	0.99
BMI	18.0, 3.1	17.7, 2.7	0.03
Energy intake (kcal/day)	2164, 672	1945, 632	<0.01
Breakfast intake			
Consumer	795 (89.9)	843 (90.5)	0.71
Skipper	89 (10.1)	89 (9.5)	
Sleeping time (hr, min)	8 hr, 34 min, 50 min	8 hr, 30 min, 45 min	0.10
Bedtime	9:35 PM, 44 min	9:40 PM, 43 min	0.02
Wake-up time	6:10 AM, 33 min	6:11 AM, 28 min	0.35
Videogame playing time			
<1 hour	351 (39.7)	446 (47.8)	
≥1 hours	395 (44.7)	160 (17.2)	
Nutrition knowledge [correct answer (%)]	69.7, 13.5	70.4, 12.0	0.22
Do you pay attention to whether your diet is healthy or not?			
Always	162 (18.3)	168 (18.0)	<010.
Often	323 (36.5)	381 (40.9)	
Sometimes	273 (30.9)	302 (32.4)	
Rarely	126 (14.3)	81 (8.7)	
Intention to lose weight			
No	653 (73.9)	652 (70.0)	0.06
Yes	231 (26.1)	280 (30.0)	
Incomplete consumption of home meals			
Very often (≥3 d/w)	51 (5.8)	66 (7.1)	0.01
Often (1-2 d/w)	140 (15.8)	176 (18.9)	
Sometimes (<1 d/w)	285 (32.2)	330 (35.4)	
Never	408 (46.2)	360 (38.6)	
Buying and eating snacks by children themselves *(kaigui)*			
Very often (≥3 d/w)	61 (6.9)	48 (5.2)	0.34
Often (1-2 d/w)	131 (14.8)	135 (14.5)	
Sometimes (<1 d/w)	317 (35.9)	360 (38.6)	
Never	375 (42.4)	389 (41.7)	
Do you discuss meals, food, or other nutritional topics with your guardian?			
Often/sometimes	342 (38.7)	387 (41.5)	0.23
Not often	303 (34.3)	324 (34.8)	
Rarely	239 (27.0)	221 (23.7)	
Guardians	Men (n=104)	Women (n=1712)	
Children's grade			
5th	64 (61.5)	827 (48.3)	0.01
6th	40 (38.5)	885 (51.7)	
Height (cm)	171.0, 6.5	158.4, 5.3	<0.01
Weight (kg)	69.3, 9.2	54.3, 8.6	<0.01
BMI	23.7, 2.9	21.6, 3.2	<0.01
Energy intake (kcal/day)	1929, 599	1564, 454	<0.01
Breakfast intake			
Consumer	74 (71.2)	1402 (81.9)	0.01
Skipper	30 (28.8)	310 (18.1)	
Nutrition knowledge [correct answer (%)]	68.5, 14.2	69.0, 14.3	0.72
I am careful to eat a well-balanced diet for myself			
Strongly agree	8 (7.7)	278 (16.2)	<0.01
Agree	56 (53.8)	1072 (62.6)	
Mostly disagree/disagree	40 (38.5)	362 (21.1)	

BMI: body mass index; d/w: days/week; SD: standard deviation.

Table 1. Characteristics of the participants (n=1816) (cont.)

Variable	Number (%) or mean, SD		*p* value
Guardians	Men (n=104)	Women (n=1712)	
Do you discuss meals, food, or other nutritional topics with your child?			
Often/sometimes	52 (50.0)	1194 (69.7)	<0.01
Not often	45 (43.3)	441 (25.8)	
Rarely	7 (6.7)	77 (4.5)	
Socioeconomic status			
Affluent	16 (15.4)	216 (12.6)	0.71
Ordinary	56 (53.8)	962 (56.2)	
Poor	32 (30.8)	534 (31.2)	

BMI: body mass index; d/w: days/week; SD: standard deviation.

Table 2. Intake of selected nutrients/foods by breakfast intake status in Japanese children (n=1816)

Variable	Breakfast consumer (n=1638) mean, SD	Breakfast skipper (n=178) mean, SD	*p* value
BMI (kg/m^2)	17.8, 2.93	18.2, 3.07	0.07
Nutrient			
Protein (%energy)	13.7, 2.34	13.0, 2.27	<0.01
Fat (%energy)	29.1, 5.77	29.3, 6.62	0.69
Carbohydrate (%energy)	55.7, 6.92	56.1, 7.78	0.42
Total dietary fiber (g/1000kcal)	5.44, 1.50	5.11, 1.45	<0.01
Vitamin A (µgRAE/1000kcal)	310, 173	268, 161	<0.01
Vitamin B-1 (mg/1000kcal)	0.40, 0.07	0.38, 0.07	<0.01
Vitamin B-2 (mg/1000kcal)	0.70, 0.18	0.64, 0.18	<0.01
Vitamin B-6 (mg/1000kcal)	0.55, 0.13	0.52, 0.11	<0.01
Vitamin B-12 (µg/1000kcal)	3.53, 1.83	3.25, 1.74	0.06
Folate (µg/1000kcal)	146, 53.0	129, 47.5	<0.01
Vitamin C (mg/1000kcal)	48.3, 22.3	43.5, 21.1	0.01
Salt equivalent (g/1000kcal)	4.52, 1.06	4.41, 1.12	0.20
Potassium (mg/1000kcal)	1141, 275	1069, 259	<0.01
Calcium (mg/1000kcal)	333, 112	302, 116	<0.01
Iron (mg/1000kcal)	3.60, 0.84	3.39, 0.78	<0.01
Food group			
Well-milled rice (g/1000kcal)	178, 75.9	172, 84.0	0.31
Bread (g/1000kcal)	17.3, 14.0	16.6, 12.3	0.51
Staple foods† (g/1000kcal)	225, 69.9	220, 76.9	0.36
Potatoes (g/1000kcal)	15.0, 10.3	15.7, 11.1	0.44
Soy products‡ (g/1000kcal)	22.1, 17.0	19.9, 16.2	0.09
Vegetables (g/1000kcal)	94.8, 57.8	80.2, 59.7	<0.01
Fruits (g/1000kcal)	46.2, 45.3	45.2, 49.9	0.76
Fish and shellfish (g/1000kcal)	28.5, 17.7	25,.9, 16.9	0.06
Meat (g/1000kcal)	36.2, 18.2	36.5, 18.6	0.81
Eggs (g/1000kcal)	16.1, 10.9	14.8, 12.8	0.16
Milk and dairy products (g/1000kcal)	113, 85.3	94.1, 86.8	<0.01
Confectioneries (g/1000kcal)	47.5, 26.7	52.5, 28.5	0.02
Soft drinks (g/1000kcal)	64.2, 71.4	97.3, 97.7	<0.01

BMI: body mass index; RAE: retinol activity equivalents.
†Intake of staple foods was the sum of rice, bread, and noodles.
‡Soybeans and soy products.

Table 3. Relationship between breakfast intake and behavioural factors among boys (n=884)

	Consumer (n=795)	Skipper (n=89)	Adjusted OR (Model 1[†])	95% CI	p for trend	Adjusted OR (Model 2 [‡])	95% CI	p for trend
Behavioural factor								
Bedtime								
before 9 pm	381 (93.8)	25 (6.2)	0.50	(0.30, 0.84)*	<0.001	0.54	(0.30, 0.96)*	0.002
9-10 pm	355 (88.8)	45 (11.2)	ref			ref		
later than 10 pm	59 (75.6)	19 (24.4)	2.51	(1.36, 4.62)*		1.88	(0.92, 3.85)	
Videogame playing time								
Never	126 (91.3)	12 (8.7)	ref		0.003	ref		0.10
<1 hour	333 (94.9)	18(5.1)	0.52	(0.24, 1.13)		0.57	(0.25, 1.32)	
≥1 hour	336 (85.1)	59 (14.9)	1.68	(0.86, 3.30)		1.33	(0.62, 2.83)	
Nutrition knowledge								
Low (0~64.7%)	277 (85.8)	46 (14.2)	ref		0.001	ref		0.046
Middle (66.7~76.5%)	256 (90.8)	26(9.2)	0.61	(0.36, 1.02)		0.67	(0.37, 1.20)	
High (78.4~100%)	262 (93.9)	17 (6.1)	0.39	(0.21, 0.70)*		0.52	(0.27, 1.03)	
Do you pay attention to whether your diet is healthy or not?								
Always	148 (91.4)	14(8.6)	ref		0.23			
Often	295 (91.3)	28 (8.7)	0.98	(0.50, 1.92)				
Sometimes	240 (87.9)	33 (12.1)	1.40	(0.72, 2.71)				
Rarely	112 (88.9)	14 (11.1)	1.33	(0.60, 2.93)				
Intention to lose weight								
No	593 (90.8)	60 (9.2)	ref		0.19			
Yes	202 (87.5)	29 (12.5)	1.38	(0.86, 2.22)				
Incomplete consumption of home meals								
Never	378 (92.7)	30(7.3)	ref		0.009	ref		0.06
Sometimes (<1 d/w)	255 (89.5)	30 (10.5)	1.45	(0.85, 2.48)		1.19	(0.65, 2.17)	
Often (1-2 d/w)	118 (84.3)	22 (15.7)	2.26	(1.25, 4.08)*		2.43	(1.23, 4.81)*	
Very often (≥3 d/w)	44 (86.3)	7 (13.7)	1.90	(0.78, 4.64)		1.31	(0.48, 3.63)	
Buying and eating snacks by children themselves (*kaigui*)								
Never	346 (92.3)	29 (7.7)	ref		0.001	ref		0.20
Sometimes (<1 d/w)	290 (91.5)	27 (8.5)	1.07	(0.62, 1.86)		0.97	(0.53, 1.78)	
Often (1-2 d/w)	111 (84.7)	20 (15.3)	2.03	(1.09, 3.77)*		1.37	(0.68, 2.80)	
Very often (≥3 d/w)	48 (78.7)	13 (21.3)	3.09	(1.48, 6.46)*		1.69	(0.71, 4.05)	

CI: confidence interval; d/w: days/week; OR: odds ratio; ref: reference.

[†]The relationship between breakfast intake and behavioural factors was investigated by multiple logistic regression analysis.

Model 1 included breakfast intake as a dependent variable, and each of the behavioural variables in the table as an independent variable with children's sex, grade, and survey areas as covariates. ORs higher than one indicate higher risk of breakfast skipping.

[‡]Model 2 included breakfast intake as a dependent variable and all behavioural variables in the table as independent variables simultaneously. Children's sex, grade, and survey area were also included as covariates. Two variables about attitude toward diet were not included in Model 2 due to a non-significant relationship in Model 1.

Table 3. Relationship between breakfast intake and behavioural factors among boys (n=884) (cont.)

	Consumer (n=795)	Skipper (n=89)	Adjusted OR (Model 1[†])	95% CI	*p* for trend	Adjusted OR (Model 2 [‡])	95% CI	*p* for trend
Behavioural factor								
Do you discuss meals, food, or other nutritional topics with your guardian?								
Often/sometimes	313 (91.5)	29 (8.5)	ref		0.03	ref		0.44
Not often	277 (91.4)	26 (8.6)	1.02	(0.59, 1.78)		0.84	(0.45, 1.57)	
Rarely	205 (85.8)	34 (14.2)	1.81	(1.06, 3.07)*		1.28	(0.69, 2.36)	
Guardian factor								
Breakfast intake								
Consumer	666 (94.1)	42 (5.9)	ref			ref		
Skipper	129 (73.3)	47 (26.7)	5.68	(3.57, 9.04)*	<0.001	4.81	(2.88, 8.04)*	<0.001
Nutrition knowledge								
Low (0~65.9%)	267 (85.9)	44 (14.1)	ref		0.005	ref		0.054
Middle (67.1~75.6%)	280 (91.5)	26 (8.5)	0.55	(0.33, 0.93)*		0.57	(0.31, 1.03)	
High (76.8~100%)	248 (92.9)	19 (7.1)	0.46	(0.26, 0.82)*		0.55	(0.28, 1.06)	
I am careful to eat well-balanced diet for myself.								
Strongly agree	127 (94.8)	7 (5.2)	ref		0.002	ref		0.17
Agree	507 (90.9)	51 (9.1)	1.74	(0.77, 3.94)		2.12	(0.82, 5.49)	
Mostly disagree/disagree	161 (83.9)	31 (16.1)	3.28	(1.38, 7.77)*		2.34	(0.84, 6.54)	
Do you discuss meals, food, or other nutritional topics with your child?								
Often/sometimes	561 (92.1)	48 (7.9)	ref		0.001	ref		0.55
Not often	199 (86.2)	32 (13.8)	1.85	(1.14, 2.98)*		1.16	(0.67, 2.00)	
Rarely	35 (79.6)	9 (20.4)	2.90	(1.30, 6.45)*		1.24	(0.48, 3.24)	
Socioeconomic status								
Affluent	104 (92.9)	8 (7.1)	ref		0.02	ref		0.32
Average	447 (91,4)	42 (8.6)	1.19	(0.54, 2.62)		0.87	(0.37, 2.08)	
Poor	244 (86.2)	39 (13.8)	1.96	(0.88, 4.39)		1.17	(0.47, 2.86)	

CI: confidence interval; d/w: days/week; OR: odds ratio; ref: reference.

[†]The relationship between breakfast intake and behavioural factors was investigated by multiple logistic regression analysis.

Model 1 included breakfast intake as a dependent variable, and each of the behavioural variables in the table as an independent variable with children's sex, grade, and survey areas as covariates. ORs higher than one indicate higher risk of breakfast skipping.

[‡]Model 2 included breakfast intake as a dependent variable and all behavioural variables in the table as independent variables simultaneously. Children's sex, grade, and survey area were also included as covariates. Two variables about attitude toward diet were not included in Model 2 due to a non-significant relationship in Model 1.

Table 4. Relationship between breakfast intake and behavioural factors among girls (n=932)

	Consumer (n=795)	Skipper (n=89)	Adjusted OR (Model 1[†])	95% CI	*p* for trend	Adjusted OR (Model 2 [‡])	95% CI	*p* for trend
Behavioural factor								
Bedtime								
before 9 pm	348 (93.8)	23 (6.2)	0.60	(0.35, 1.03)	<0.001	0.80	(0.45, 1.44)	0.003
9-10 pm	425 (90.6)	44 (9.4)	ref			ref		
later than 10 pm	70 (76.1)	22 (23.9)	3.34	(1.86, 5.99)*		2.75	(1.42, 5.32)*	
Videogame playing time								
Never	300 (92.0)	26 (8.0)	ref		0.005	ref		0.41
< 1 hour	410 (91.9)	36 (8.1)	1.01	(0.59,1.72)		0.95	(0.53, 1.71)	
≥1 hour	133 (83.1)	27 (16.9)	2.19	(1.22, 3.95)*		1.30	(0.66, 2.56)	
Nutrition knowledge								
Low (0~64.7%)	270 (86.3)	43 (13.7)	ref		0.007	ref		0.053
Middle (66.7~76.5%)	323 (91.8)	29 (8.2)	0.58	(0.35, 0.96)*		0.61	(0.35, 1.09)	
High (78.4~100%)	250 (93.6)	17 (6.4)	0.46	(0.25, 0.84)*		0.52	(0.26, 1.06)	
Do you pay attention to whether your diet is healthy or not?								
Always	160 (95.2)	8 (4.8)	ref		0.002	ref		0.10
Often	348 (91.3)	33 (8.7)	1.91	(0.86, 4.24)		1.64	(0.69, 3.92)	
Sometimes	265 (87.8)	37 (12.2)	2.98	(1.35, 6.60)*		2.21	(0.92, 5.32)	
Rarely	70 (86.4)	11 (13.6)	3.37	(1.29, 8.81)*		2.03	(0.68, 6.07)	
Intention to lose weight								
No	599 (91.9)	53 (8.1)	ref		0.046	ref		0.14
Yes	244 (87.1)	36 (12.9)	1.59	(1.01, 2.50)*		1.47	(0.88, 2.45)	
Incomplete consumption of home meals								
Never	339 (94.2)	21 (5.8)	ref		<0.001	ref		<0.001
Sometimes (< 1 d/w)	300 (90.9)	30 (9.1)	1.57	(0.87, 2.81)		1.65	(0.88, 3.10)	
Often (1-2 d/w)	154 (87.5)	22 (12.5)	2.20	(1.17, 4.16)*		2.19	(1.08, 4.44)*	
Very often (≥ 3d/w)	50 (75.8)	16 (24.2)	5.11	(2.46, 10.6)		4.94	(2.17, 11.2)*	
Buying and eating snacks by children themselves (*kaigui*)								
Never	358 (92.0)	31 (8.0)	ref		0.03	ref		0.91
Sometimes (< 1 d/w)	328 (91.1)	32 (8.9)	1.08	(0.64, 1.82)		0.87	(0.49, 1.56)	
Often (1-2 d/w)	119 (88.2)	16 (11.8)	1.45	(0.75, 2.79)		0.89	(0.42, 1.88)	
Very often (≥ 3d/w)	38 (79.2)	10 (20.8)	2.77	(1.24, 6.18)*		1.22	(0.47, 3.12)	

CI: confidence interval; d/w: days/week; OR: odds ratio; ref: reference.

[†]The relationship between breakfast intake and behavioural factors was investigated by multiple logistic regression analysis.

Model 1 included breakfast intake as a dependent variable, and each of the behavioural variables in the table as an independent variable with children's sex, grade, and survey areas as covariates. ORs higher than one indicate higher risk of breakfast skipping.

[‡]Model 2 included breakfast intake as a dependent variable and all behavioural variables in the table as independent variables simultaneously. Children's sex, grade, and survey area were also included as covariates. Two variables about attitude toward diet were not included in Model 2 due to a non-significant relationship in Model 1.

Table 4. Relationship between breakfast intake and behavioural factors among girls (n=932) (cont.)

	Consumer (n=795)	Skipper (n=89)	Adjusted OR (Model 1[†])	95% CI	*p* for trend	Adjusted OR (Model 2 [‡])	95% CI	*p* for trend
Behavioural factor								
Do you discuss meals, food, or other nutritional topics with your guardian?								
Often/sometimes	363 (93.8)	24 (6.2)	ref		<0.001	ref		0.006
Not often	297 (91.7)	27 (8.3)	1.40	(0.78, 2.49)		1.06	(0.56, 2.00)	
Rarely	183 (82.8)	38 (17.2)	3.40	(1.96, 5.89)*		2.42	(1.29, 4.54)*	
Guardian factor								
Breakfast intake								
Consumer	715 (93.1)	53 (6.9)	ref			ref		
Skipper	128 (78.1)	36 (21.9)	3.72	(2.33, 5.93)*	<0.001	3.10	(1.82, 5.26)*	<0.001
Nutrition knowledge								
Low (0~65.9%)	295 (89.9)	33 (10.1)	ref		0.35	ref		0.63
Middle (67.1~75.6%)	261 (88.5)	34 (11.5)	1.18	(0.71, 1.95)		1.37	(0.77, 2.44)	
High (76.8~100%)	287 (92.9)	22 (7.1)	0.72	(0.40, 1.31)		1.12	(0.56, 2.24)	
I am careful to eat well-balanced diet for myself.								
Strongly agree	146 (96.1)	6 (3.9)	ref		0.01	ref		0.52
Agree	514 (90.2)	56 (9.8)	2.55	(1.07, 6.05)*		1.80	(0.72, 4.49)	
Mostly disagree/disagree	183 (87.1)	27 (12.9)	3.35	(1.34, 8.37)*		1.65	(0.61, 4.43)	
Do you discuss meals, food, or other nutritional topics with your child?								
Often/sometimes	587 (92.2)	50 (7.8)	ref		0.002	ref		0.11
Not often	225 (88.2)	30 (11.8)	1.53	(0.95, 2.48)		1.16	(0.67, 2.01)	
Rarely	31 (77.5)	9 (22.5)	3.51	(1.56, 7.87)*		2.59	(1.00, 6.72)*	
Socioeconomic status								
Affluent	110 (91.7)	10 (8.3)	ref		0.55			
Average	481 (90.9)	48 (9.1)	0.96	(0.47, 1.99)				
Poor	252 (89.1)	31 (10.9)	1.12	(0.52, 2,41)				

CI: confidence interval; d/w: days/week; OR: odds ratio; ref: reference.

[†]The relationship between breakfast intake and behavioural factors was investigated by multiple logistic regression analysis.

Model 1 included breakfast intake as a dependent variable, and each of the behavioural variables in the table as an independent variable with children's sex, grade, and survey areas as covariates. ORs higher than one indicate higher risk of breakfast skipping.

[‡]Model 2 included breakfast intake as a dependent variable and all behavioural variables in the table as independent variables simultaneously. Children's sex, grade, and survey area were also included as covariates. Two variables about attitude toward diet were not included in Model 2 due to a non-significant relationship in Model 1.
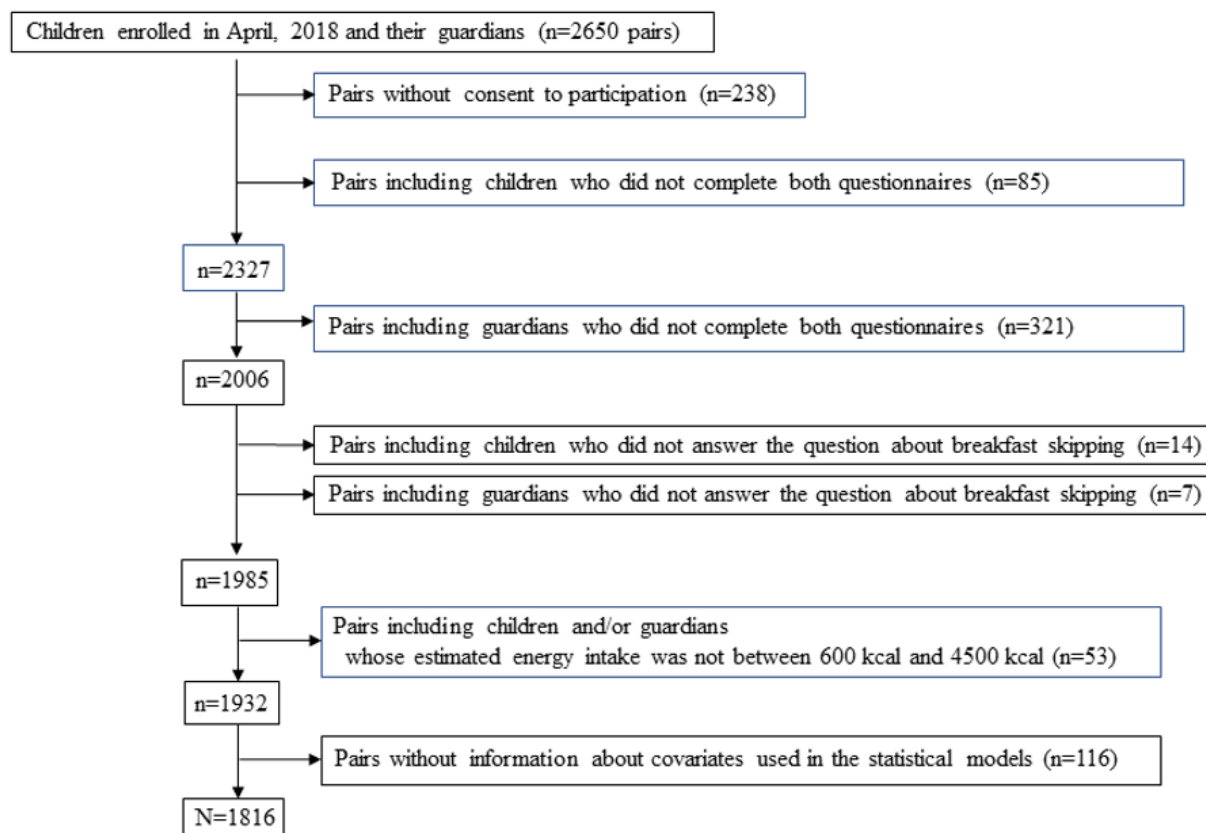
Figure 1. Flow diagram of participant selection for analysis.