

Features of Pupils in Each Dinner Habit: Non-late Regular, Regular but Late, and Irregular

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What is already known on this topic?

- Both late and irregular dinner habits have been known to be unhealthy habits. Although increases in both late and irregular dinner habits have been known, few studies have described their rates among children and adolescents. A few studies have investigated the association between dinner habits and lifestyle factors among pupils.

What this study adds on this topic?

- Pupils taking regular but late dinner showed the latest bedtime, the shortest sleep duration, the longest school-day screen time score, and the worst sleepiness and self-reported academic performance scores. More than 30% of pupils took dinner irregularly. Irregular dinner-takers showed the longest after-school activity.

ABSTRACT

Background: Both late and irregular caloric intakes are becoming common, especially among young adults. This study aimed to investigate features of pupils in Japan following different dinner habits.

Methods: Dinner habits were categorized into 3 types: non-late regular, regular but late, and irregular. Questionnaires of 2722 pupils in grades 5 to 12 were included, and a multiple comparison test was conducted to investigate the differences of lifestyle factors among the 3 dinner-pattern categories.

Results: Only half of grade 5 and 6 pupils had non-late regular dinners. The rate of pupils who had regular but late dinners increased from elementary school (11.8%) to senior high school (41.1%) via junior high school (15.1%). More than 30% of pupils took dinner irregularly. The pupils taking non-late regular dinner showed the earliest bedtime and the longest sleep duration among the 3 dinner-time habit categories and also revealed the best academic performance and sleepiness scores. The pupils taking regular but late dinner showed the highest grade, the latest bedtime, the shortest sleep duration, the longest school-day screen time scores, and the worst sleepiness and self-reported academic performance scores. Irregular dinner-takers showed the longest after-school activities.

Conclusions: Further attention should be given to both late and irregular dinner habits of pupils in terms of supporting their health. Further studies are needed to recommend suitable dinner timings for pupils by assessing optimal levels of variable lifestyle factors, including after-school activity.

Keywords: Academic performance, body mass index, skipping breakfast, physical activity, screen time, sleep

INTRODUCTION

The traditional breakfast–lunch–dinner eating pattern has not been observed in a population of healthy, non-shift-working adults.¹ In a study, among 154 recorded days obtained from 8 healthy young non-shift-working adults, only 3 days showed no caloric intake after 8:00 PM (assessed from Figure 4 of the reference).¹ Late dinner is becoming common among young adults, as is irregular eating, especially among young individuals and singles.² Both late and irregular dinner patterns are known to be unhealthy habits.^{2–4}

Dinner time in Japan has also been progressively delayed. It showed a normal distribution with the mean time of 6:15 PM in 1941, started to be delayed between 1965 and 1970, becoming after 7:00 PM since 1985.⁵ According to the National Institute of Health and Nutrition in Japan, the rate of young people (aged between 15 and 19 years) who consumed dinner at 9:00 PM or later increased from 3.9% in 1985 to 17.7% in 2008.⁶ More recently, from 2011⁷ to 2016,⁸ the average dinner times were also delayed during this short period from 7:23 to

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7:30 PM in people aged 15–19 and from 6:58 PM to 7:02 PM in those aged 10–14.

Late dinner is known to be one of the predictors of skipping breakfast in adult populations,⁹ and the combination of late-night eating and skipping breakfast is reported to be associated with a greater risk of metabolic syndrome.¹⁰ Moreover, late dinners are reported to be associated with overweight.^{11–14} However, according to the systematic review investigating the association between night-time eating behavior and adiposity in children and adolescents, Zou et al.¹⁵ concluded that the role of later eating rhythm is still poorly understood. Coulthard and Pot¹⁶ reported no association between late dinners and obesity in both age groups of 4–10 years and 11–18 years. The association between late dinner and obesity among children and adolescents has not been consistent.

In 1997, two-thirds of males in their twenties and the half of those in their thirties in Japan were reported not to take a regular dinner,¹⁷ although no available data on irregular dinner among children and adolescents in Japan were found. Regular dinners are reported to be associated with better academic performance in grade 11 pupils.¹⁸ A recent review reported that irregular eating habits are associated with increased risks of metabolic syndrome and cardiometabolic diseases.¹⁹ Furthermore, Watanabe et al.²⁰ predicted that irregular dinner times may lead to increased screen times and decreased night-time sleep durations. In adolescents, irregular dinner times were found to be significantly associated with sleep loss²¹ and daytime sleepiness.²² A Finnish study on adolescents reported irregular dinner patterns to be inversely associated with underweight compared to regular dinner patterns.²³ Moreover, Chew et al.²⁴ reported a significant association between irregular dinner times and abdominal obesity in pupils aged 15–17 years.

According to a review on factors affecting children's eating habits by Scaglioni et al.,²⁵ in order to establish long-term healthy habits, the importance of promoting physical activity, reducing media usage, and getting adequate sleep have been concluded. These factors might be associated with each other. Therefore, the aim of this study was to assess associations between evening meal habits and variable lifestyle features including body mass index (BMI) of pupils in Japan, hoping to be able to recommend suitable dinner timings for pupils.

METHODS

This study was a part of a survey conducted between October 2016 and November 2018. Details of the survey have been described elsewhere.²⁶

The original questionnaire used (Table 1) was constructed from queries from the Japan Society of School Health.²⁷ The questionnaire was administered to students in grades 5–12 by their school teachers between October 2016 and November 2018. A letter was provided to the students assuring them that their responses would be treated anonymously and confidentially and that participation in the study was voluntary. Written consents on participation in this study (signed by a guardian) and completed questionnaires were collected by school teachers on a different day and subsequently sent to the author.

Of the 4208 students whose questionnaires were distributed to 28 public schools (15 elementary schools (ES), 8 junior high schools (JHS), and 5 senior high schools (SHS)), 2722 agreed to participate in the study and provided complete responses to the required questions. All of the schools included adopted full-time systems, and none were multi-shift, which provided options such as attending school in either the morning or afternoon. Moreover, none of the schools provided a napping period.

The numbers selected in Table 1, corresponding to the questions on sleepiness, skipping breakfast, defecation, school-day screen time, non-school-day screen time, and self-reported academic performance, were termed as the sleepiness, skipping breakfast, defecation, school-day screen time, non-school-day screen time, and self-reported academic performance scores, respectively. Hours of after-school activity per week (obtained from the product of the two numbers of the respective queries, one for frequency and the other for duration) and the number of days engaged in physical activity per week were termed as after-school activity score and physical activity score, respectively.

In regard to dinner timing, choices from 1 to 7 showed actual dinner times, and the 8th choice indicated that dinner times were undetermined. Since the average time at which teenagers in Japan started dinner was 7:30 PM or earlier in 2016,²⁸ the dinner timings were divided into the following 3 categories: "non-late regular," choices 1 (approximately 6:00 PM (earlier than 6:30 PM)) and 2 (approximately 7:00 PM (6:30–7:30 PM)); "regular but late," choices 3 (approximately 8:00 PM (7:30–8:30 PM)) to 7 (later than 11:00 PM); and "irregular," choice 8 (undetermined).

Bedtime before school days, bedtime before non-school days, waking time on school days, and waking time on non-school days were indicated by numbers corresponding to each choice in the questionnaire and were termed as bedtime before school days, bedtime before non-school days, waking time on school days, and waking time on non-school days scores, respectively. To calculate sleep durations, we used a representative time for each category of bedtimes and waking times. The representative times for the bedtime categories (1: before 8:00 PM; 2: 8:00–9:00 PM; 3: 9:00–10:00 PM; 4: 10:00–11:00 PM; 5: 11:00 PM–12:00 AM; 6: 12:00–1:00 AM; 7: 1:00–2:00 AM; 8: 2:00–3:00 AM; and 9: after 3:00 AM) were determined as follows: 7:30 PM, 8:30 PM, 9:30 PM, 10:30 PM, 11:30 PM, 12:30 AM, 1:30 AM, 2:30 AM, and 3:30 AM, respectively. For the waking time categories (1: before 5:00 AM; 2: 5:00–6:00 AM; 3: 6:00–7:00 AM; 4: 7:00–8:00 AM; 5: 8:00–9:00 AM; 6: 9:00–10:00 AM; 7: 10:00–11:00 AM; 8: 11:00 AM–12:00 PM; and 9: after 12:00 PM), the representative times were as follows: 4:30 AM, 5:30 AM, 6:30 AM, 7:30 AM, 8:30 AM, 9:30 AM, 10:30 AM, 11:30 AM, and 12:30 PM, respectively. The night-time sleep duration before the school-day was calculated as the difference between the representative times of the bedtime before school days and waking time on school days. Similarly, the night-time sleep duration before non-school days was calculated as the difference between the representative times of bedtime before non-school days and waking time on non-school days.

Queries	Choices for Answer
Please mark your grade	Elementary school (grades 5, 6), junior high school (grades 1, 2, 3), high school (grades 1, 2, 3)
Please mark your gender	Gender (male, female)
Please describe your height and weight	Height (cm), weight (kg)
Please mark your bedtime before school days	1: <8 PM; 2: 8-9 PM; 3: 9-10 PM; 4: 10-11 PM; 5: 11 PM-12 AM; 6: 12-1 AM; 7: 1-2 AM; 8: 2-3 AM; or 9: >3 AM
Please mark your bedtime before non-school days	1: <8 PM; 2: 8-9 PM; 3: 9-10 PM; 4: 10-11 PM; 5: 11 PM-12 AM; 6: 12-1 AM; 7: 1-2 AM; 8: 2-3 AM; or 9: >3 AM
Please mark your wake time on school days	1: <5 AM; 2: 5-6 AM; 3: 6-7 AM; 4: 7-8 AM; 5: 8-9 AM; 6: 9-10 AM; 7: 10-11 AM; 8: 11 AM-12 PM; or 9: >12 PM
Please mark your wake time on non-school days	1: <5 AM; 2: 5-6 AM; 3: 6-7 AM; 4: 7-8 AM; 5: 8-9 AM; 6: 9-10 AM; 7: 10-11 AM; 8: 11 AM-12 PM; or 9: >12 PM
Please mark the frequency you feel sleepy during class	1: never; 2: sometimes; 3: often; or 4: always
Please mark your frequency of eating breakfast	1: always; 2: often; 3: sometimes; or 4: never
Please mark your frequency of defecation	1: every day; 2: every other day; 3: once every 2-3 days; 4: twice a week or less
Please mark the time you usually eat dinner	1: around 6 PM; 2: around 7 PM; 3: around 8 PM; 4: around 9 PM; 5: around 10 PM; 6: around 11 PM; 7: later than 11 PM; or 8: not determined
Do you participate in any kinds of after-school activity?	1: Yes; 2: No
If yes, please mark your frequency of participating in after-school activity	1: once a week; 2: twice a week; 3: 3 times a week; 4: 4 times a week; 5: 5 times a week; 6: 6 times a week; or 7: every day
If yes, please mark the average duration of a single after-school activity	1: 1 hour; 2: 2 hours; 3: 3 hours; 4: 4 hours; or 5: 5 hours or more
How many days a week do you perform habitual exercise except for school lessons?	0: none; 1: 1 day per week; 2: 2 days per week; 3: 3 days per week; 4: 4 days per week; 5: 5 days per week; 6: 6 days per week; or 7: 7 days per week
How long do you use various media devices (television, video, video game, digital versatile disc, computer, tablet, mobile (cell) phone, smart phone) in a day? Please answer separately on school days and non-school days	On a school-day: 1: <2 hours; 2: 2-4 hours; 3: 4-6 hours; 4: 6-8 hours; or 5: 8 hours or more. On a non-school-day: 1: <2 hours; 2: 2-4 hours; 3: 4-6 hours; 4: 6-8 hours; or 5: 8 hours or more.
Please mark the best choice for your overall academic performance	1: very good; 2: good; 3: not good; or 4: poor.

From the figures reported by the subjects themselves (dividing body weight by height squared), BMIs were calculated. Since BMI is reported to vary markedly among school-aged children and adolescents in Japan,²⁷ an analysis of variance was performed to determine the differences among the BMIs of the 16 categories, divided by gender and grade (male and female categories of grades 5-12). The gender- and grade-standardized BMIs were used for the analysis.

A multiple comparison test of the Bonferroni post hoc test was used after one-way analysis of variance to determine significant differences in lifestyle habits among the dinner-time categories (non-late regular, regular but late, and irregular). The American Psychological Association recommends describing

size effects in studies.²⁹ Since a Cohen's "small" effect can produce substantial differences, the current discussion was restricted to findings with $P < .05$ with more than a small size effect (Cohen's $d > 0.20$).³⁰ These analyses were conducted using the software program BellCurve for Excel.

This study was approved in 2016 by the Committee for Medical Research Ethics of Tokyo Bay Urayasu Ichikawa Medical Center, with the approval number of 199.

RESULTS

Table 2 shows the distribution of pupils in each dinner timing habit category (non-late regular, regular but late, and

	Non-late Regular	Regular but Late	Irregular	Total Number of Pupils
ES, n (%) (M/F)	482 (50.4%) (216/266)	113 (11.8%) (50/63)	361 (37.8%) (175/186)	956 (441/515)
JHS; n (%) (M/F)	474 (45.2%) (245/229)	158 (15.1%) (68/90)	417 (39.8%) (228/189)	1049 (541/508)
SHS; n (%) (M/F)	195 (27.2%) (91/104)	295 (41.1%) (196/99)	227 (31.7%) (98/129)	717 (385/332)
Total; n (%) (M/F)	1151 (42.3%) (552/599)	566 (20.8%) (314/252)	1005 (36.9%) (501/504)	2722 (1367/1355)

ES, elementary school; JHS, junior high school; SHS, senior high school; M, male; F, female; n, number.

irregular) of each school type for each gender. In ES and JHS, the “non-late regular” category was the one with the highest number of pupils, followed by the “irregular” and “regular but late” categories. In SHS, the category with the highest number of pupils was “regular but late” in males and “irregular” in females.

A multiple comparison test of the Bonferroni method revealed pairs with significant differences among the dinner timing habit categories in the averaged grade values, sleep durations and bedtime, school-day screen time, skipping breakfast, self-reported academic performance, after-school activity, physical activity, and sleepiness scores (Table 3).

The pupils in the “non-late regular” category showed the lowest after-school activity and earliest bedtime scores and the longest sleep duration among the 3 dinner timing habit categories, with significant differences. The pupils in the “regular but late” category showed the highest average grade values, the shortest sleep durations, the latest bedtime scores, the longest school-day screen-time scores, and the worst sleepiness and self-reported academic performance scores, with significant differences among the 3 dinner-time habit categories. Their after-school activity scores were significantly higher than those of the “non-late regular” category. The pupils in the “irregular” category showed the significantly longest after-school activity among the 3 dinner timing categories. They also had significantly later bedtime scores and shorter sleep durations than those in the “non-late regular” category. Skipping breakfast and physical activity scores were significantly higher in the “regular but late” category than those in the “non-late regular” category. Standardized BMI showed no significant differences among the 3 dinner timing habit categories.

DISCUSSION

This study demonstrated 3 issues concerning the distributions of pupils among each dinner category. 1) only half of the ES pupils had non-late regular dinner, 2) the proportion of pupils who had regular but late dinner increased from ES (11.8%) to SHS (41.1%) via JHS (15.1%), and 3) more than 30% of our pupils took dinner irregularly. Both late and irregular dinner habits were found to be dominant, even among ES pupils in Japan. Since both dinner habits were warned as unhealthy habits,²⁻⁴ further attention should be given to the dinner habits of pupils in terms of supporting their health.

Lifestyle features of each dinner category can be summarized as follows: The non-late regular dinner-taking pupils showed the earliest bedtimes and the longest sleep duration among the 3 dinner-time habit categories and also revealed the best academic performance and sleepiness scores. As shown previously, both late¹¹⁻¹⁴ and irregular^{3,23,24} dinner has been known to be associated with overweight. Ministry of Agriculture, Forestry, and Fisheries in Japan³¹ has promoted food education and has worried about the increase of both late and irregular dinner from viewpoints of increasing risks for obesity^{11-14,23,24} and sleep loss.²¹ The present result demonstrated that the non-late regular dinner habit showed the earliest bedtime, the longest sleep duration, the shortest school-day screen time, the least sleepiness, the least breakfast skipping, and the best academic performance. It could be said that the non-late regular dinner habit is the ideal one. However, this non-late regular dinner habit decreased with age progression from ES to SHS via JHS. Why? The progression of 24-hour society³² must be one of backgrounds of this tendency. However, this study added several factors. It should

Table 3. Lifestyle Variables With Pairs Showing Significant Differences

Scores (Except for Sleep Duration and After-School Activity)	Dinner-Time Habit Categories			Pairs Showing Statistical Significance
	Non-late Regular (n = 1151)	Regular but Late (n = 566)	Irregular (n = 1005)	
Grade (range)	7.42 ± 2.00 (5-12)	8.92 ± 2.19 (5-12)	7.75 ± 2.09 (5-12)	Non-late regular/irregular < regular but late
Bedtime before school-day (range)	4.02 ± 1.13 (1-9)	4.78 ± 1.18 (1-9)	4.45 ± 1.28 (1-9)	Non-late regular < irregular < regular but late
Bedtime before non-school-day (range)	4.36 ± 1.22 (1-9)	5.08 ± 1.36 (1-9)	4.74 ± 1.41 (1-9)	Non-late regular < irregular < regular but late
Night-time sleep duration before school-day (range)	7.92 ± 1.13 (3-11)	7.06 ± 1.25 (2-10)	7.52 ± 1.28 (3-11)	Non-late regular > irregular > regular but late
Night-time sleep duration before non-school-day (range)	8.97 ± 1.27 (2-14)	8.31 ± 1.60 (3-14)	8.68 ± 1.39 (4.5-13)	Non-late regular > irregular > regular but late
School-day screen time (range)	1.65 ± 0.81 (1-5)	1.83 ± 0.90 (1-5)	1.64 ± 0.83 (1-5)	Non-late regular/irregular < regular but late
Skipping breakfast (range)	1.16 ± 0.50 (1-4)	1.29 ± 0.67 (1-4)	1.24 ± 0.58 (1-4)	Non-late regular < regular but late
Self-reported academic performance (range)	2.40 ± 0.79 (1-4)	2.60 ± 0.85 (1-4)	2.41 ± 0.81 (1-4)	Non-late regular/irregular < regular but late
After-school activity (range)	2.96 ± 4.74 (0-35)	6.67 ± 8.87 (0-35)	8.91 ± 7.69 (0-35)	Non-late regular < regular but late < irregular
Physical activity (range)	2.86 ± 2.82 (0-7)	3.47 ± 3.05 (0-7)	3.28 ± 2.83 (0-7)	Non-late regular < regular but late
Sleepiness (range)	1.87 ± 0.7 (1-4)	2.23 ± 0.88 (1-4)	1.99 ± 0.83 (1-4)	Non-late regular/irregular < regular but late

Data are presented as n, number, or as mean ± SD.

be noted that after-school activity scores were the lowest in non-late regular dinner-takers. Among the 3 dinner-time habit categories, pupils who spend the longest time on after-school activities were those who took dinner irregularly, and the regular but late dinner-taking pupils showed significantly longer after-school activities than non-late regular dinner-takers. In Japan, 41.3% and 27.2% pupils in JHS and SHS, respectively, were engaged in private cramming schools³³ preparing for entrance examinations or working by themselves. Some pupils also attended piano lessons, swimming clubs, and so on. In addition, 11.3% of the pupils in SHS in Japan were engaged in part-time jobs.³⁴ Indeed, after-school activities such as academic tutoring, sports practice, music classes or part-time jobs have been known to affect lifestyle behaviors, including the eating habits, of adolescents.³⁵ In addition, these activities have been recognized to promote healthy behaviors such as eating and physical habits.³⁶ However, this study raised the possibility that excessive after-school activities may be harmful to adolescents' health through inadequate dinner habits of late or irregular dinner times.

The regular but late dinner-taking pupils showed the highest grades, the latest bedtimes, the shortest sleep durations, the longest school-day screen time score, and the worst sleepiness and self-reported academic performance scores. Older adolescents may increase their screen time and delay their bedtime at the expense of sleep duration, resulting in increased sleepiness and poor academic performance. These associations may suggest that an increase in nocturnal or night-oriented lifestyles^{27,32} might be one of possible background factors for late dinner-takers. Regular but late dinner-taking pupils showed the highest skipping-breakfast score, as previously reported⁹ and the highest physical activity score. On the latter finding, as opposed to the prediction made by Scaglioni et al.,²⁵ excessive physical activity may result in late dinners, which is known to be an unhealthy habit.¹¹⁻¹⁴ It should also be noted that not only low but also high levels of physical activity induce sleepiness,³⁷ which is known to show unfavorable effects on the executive functioning³⁸ and self-regulation³⁹ of pupils.

Current studies have failed to show a significant association between dinner habits and BMI, although Wilkie et al.⁴⁰ identified the *four* key modifiable lifestyle factors influencing the body weight of children: physical activity, sleep, screen time, and eating habits. The present results on the association between late dinner and overweight or obesity were consistent with the report by Coulthard et al.,¹⁶ whereas the result on the association between irregular dinner times and body weight was inconsistent with previous reports.^{23,24} It should be noted that the prevalence of childhood overweight and obesity in Japan has been low compared to other countries.⁴¹ The *fifth* unknown key factor protecting pupils in Japan from overweight, such as the school lunch program⁴² or genetic background⁴³ may affect the present result. The association between eating habits and body weight remains to be investigated.

There were some limitations to this study. First, it used a cross-sectional design and was unable to identify causal relationships. Secondly, the questionnaire was not validated; however, it was constructed with reference to a questionnaire used in a

national survey, the results of which have been used as fundamental data for policymaking and manuals on the proper lifestyles of children in Japan.²⁷ Thirdly, the responses to the questionnaire depended on self-reports with no objective measurements. In addition, queries were intended to be answered by students, but it was not confirmed. It should be noted, however, that the mean BMI values obtained were similar to those reported for Japanese schoolchildren.²⁷ A fourth limitation was the lack of queries on important factors such as demographic factors (family composition, socioeconomic status, and parents' educational backgrounds), underlying diseases, the content or the form (junk food, home cooking, etc.) of dinner, and age-related information, as the queries we referred to lacked questions on these issues.²⁷ It should not be forgotten, however, that age is an important biological factor. A fifth limitation was that each query was too simple to obtain answer for certain, although details on academic performance⁴⁴ or physical activity⁴⁵ have been studied elsewhere. This concept of questionnaire seemed to be succeeded, resulting in obtaining 2722 complete answer sheets. Finally, the timing of food intake relative to melatonin onset⁴⁶ was not analyzed. Adequate dinner timing should be further investigated by considering personal circadian rhythms.

Despite the above limitations, this study demonstrated specific features of pupils in each of 3 dinner-time habit categories. To support the health of pupils, further studies are needed to recommend suitable dinner timings for pupils by assessing optimal levels of variable lifestyle factors, including after-school activity. In order to improve dinner-time habits, education on the importance of circadian biology⁴⁴ from early stage of life and the use of self-monitoring tool² should be encouraged.

Ethical Committee Approval: Ethics committee approval was received from the Committee for Medical Research Ethics of Tokyo Bay Urayasu Ichikawa Medical Center (date: 2016, no: 199).

Informed Consent: Written informed consent was obtained from the guardian of pupils.

Peer Review: Externally peer-reviewed.

Author Contributions: Concept, Design, Supervision, Resource, Materials, Data Collection and/or Processing, Analysis and/or Interpretation, Literature Search, Writing – J.K.

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Conflict of Interest: I have got consulting fee from ARETECO HOLDINGS Co. Ltd. for their homepage related to sleep issues 200 000 yen per month since January 2021, from Limne Co. Ltd. for their homepage related to sleep issues 200 000 yen per year since January 2021. I have asked to make educational speaks from Nobelpharma Co. Ltd. for 5 times during these 12 months with the total fee of 450 000 yen, from Eisai Co. Ltd. for 1 time during these 12 months with the fee of 50 000 yen. I have asked to support edit of Japanese version of a journal named *Epilepsia* from Eisai Co. Ltd. during these 36 months with the annual fee of 300 000 Yen.

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