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Original article

Skipping Breakfast is Correlated with Obesity

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Abstract

Objective: Despite the fact that the total energy intake of Japanese people has decreased, the percentage of obese people has increased. This suggests that the timing of meals is related to obesity. The purpose of the study was to investigate the relationship between the timing of meals and obesity, based on analyses of physical measurements, serum biochemical markers, nutrient intake, and lifestyle factors in the context of Chrononutrition.

Participants and Methods: We analyzed data derived from 766 residents of Toon City (286 males and 480 females) aged 30 to 79 years who underwent detailed medical examinations between 2011 and 2013. These medical examinations included. (1) physical measurements (waist circumference, blood pressure, etc.); (2) serum biochemical markers (total cholesterol, etc.); (3) a detailed questionnaire concerning lifestyle factors such as family structure and daily habits (22 issues), exercise and eating habits (28 issues), alcohol intake and smoking habits; (4) a food frequency questionnaire based on food groups (FFQg); and (5) a questionnaire concerning the times at which meals and snacks are consumed.

Results: The values for body mass index (BMI) and waist circumference were higher for participants who ate dinner less than three hours before bedtime (<3-h group) than those who ate more than three hours before bedtime (>3-h group). The Chi-square test showed that there was a significant difference in eating habits, e.g., eating snacks, eating snacks at night, having dinner after 8 p.m., and having dinner after 9 p.m., between the <3-h group and the >3-h group. Multiple linear regression analysis showed that skipping breakfast significantly influenced both waist circumference ($\beta = 5.271$) and BMI ($\beta = 1.440$) and that eating dinner <3-h before going to bed only influenced BMI ($\beta = 0.581$).

Conclusion: Skipping breakfast had a greater influence on both waist circumference and BMI than eating dinner <3-h before going to bed.

Key words: skipping breakfast, obesity, chrononutrition

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Introduction

The total energy intake of Japanese people has decreased over the last three decades[1]. However, the percentage of obese middle-aged males (including those on the borderline of satisfying the criteria for obesity) has increased, and it is now approximately 50 percent. Chrononutrition is a way of looking at the timing of nutrient intake in relation to body weight. The traditional concept of nutrition emphasizes the amount and types of nutrients in foods consumed, whereas chrononutrition explains nutrition in terms of chronobiology and considers the effects of diurnal rhythms, thereby providing new perspectives in nutrition research[2]. Chrononutrition considers the following three components: (1) timing of meals, (2) speed of eating, and (3) the order of food consumption during a meal.

With respect to the timing of meals, breakfast plays an important role. Recently, the tendency to skip breakfast has become a problem for primary school students, as well as junior and senior high school students. Several epidemiological studies of students have indicated that skipping breakfast leads to a decrease in academic and physical performance[3, 4]. Health research surveys of adults in the United States have

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reported that people skipped breakfast became obese at a rate five times higher than people who ate breakfast[5)].

Although there is already a report about the relationship between skipping a meal at breakfast and obesity in Japanese people, we considered the relationship between mealtimes and obesity from a new viewpoint, one that considers analyses of physical measurements, serum biochemical markers, nutrient intake and lifestyle factors, and METs per day.

Methods

Participants

We analyzed data derived from 766 residents of Toon City (286 males and 480 females) from 30 to 79 years of age who underwent detailed medical examinations performed at Ehime University Graduate School of Medicine between 2011 and 2013.

Physical measurements

We measured body weight and height using a digital scale (Tanita Corporation, Tokyo, Japan) and blood pressure (systolic blood pressure [SBP] and diastolic blood pressure [DBP]) using an automated sphygmomanometer. Body mass index (BMI) was calculated by the following formula: BMI = weight (kg)/height (m^2). We diagnosed whether or not the participants had metabolic syndrome by using the detailed Japanese criteria of metabolic syndrome.

Serum biochemical markers

The serum fasting glucose concentration and 2-h postload glucose concentration following a 75 g oral glucose tolerance test, HbA_{1c}, total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides were measured.

Questionnaire on lifestyle

To detect how lifestyle affects metabolic disorders, a questionnaire was used that included several questions concerning eating, exercise, and sleeping habits.

Questionnaire on food frequency

Daily food intake was recorded using the food frequency questionnaire based on food groups (FFQg, version 3.5), and the nutrient content was analyzed using the Excel Eiyo-kun software (version 6.0; Kenpaku Co., Ltd., Tokyo, Japan).

Questionnaire on meal timing

We interviewed the participants in person about the following issues: (1) whether or not they habitually ate breakfast, lunch, dinner, snacks, and snacks at night, and (2) the times at which they ate breakfast, lunch, dinner, snacks, and night snacks.

Questionnaire on METs

METs are units representing the intensity of physical activity. One MET is defined as the physical activity of a person in a resting state for one hour. When a person performs physical activity, the number of calories consumed by that activity is compared to the caloric consumption in a resting state (one MET). Based on respondents' answers to a questionnaire, we calculated the total number of METs per day for the following activities: sleeping/resting, working, walking, cycling, housework, exercise, and leisure.

Statistical analyses of chrononutritional data

One-way analysis of variance (ANOVA) and Tukey's multiple test were performed to determine the difference in the average values for (1) physical measurements, (2) serum biochemical markers, and (3) nutritional data derived from the FFQg between people who ate dinner less than three hours before bedtime (<3-h group) and people who ate dinner more than three hours before bedtime (>3-h group). A Chi-square test was performed to compare (1) taking medications; (2) eating habits, including eating snacks, eating snacks at night, having dinner after 8 p.m., and having dinner after 9 p.m.; (3) whether or not the participant met the criteria for obesity; and (4) incidence of metabolic syndrome and METs between those who did and did not skip breakfast. Based on the dependent factors, including BMI, waist circumference, obesity (BMI $\geq$ 25.0 kg/m^2), and metabolic syndrome, and the independent factors, including eating dinner less than three hours before bedtime and skipping breakfast, we performed a multiple linear regression analysis to calculate the relationship between each of the four dependent factors and the two independent factors, adjusting for gender, age, energy intake, eating between meals, eating snacks late at night, and having dinner after 9 p.m. Using multiple linear regression analysis, we excluded the following confounding factors: gender, age, energy intake, alcohol consumption, eating between meals, having dinner after 9 p.m., and METs. For these analyses, we used SPSS version 22 (IBM, Tokyo, Japan), and a p-value of <0.05 was considered to be significantly different.

Ethical consideration

The Ethics Committee of the Graduate School of Medicine, Ehime University, approved this study prior to its implementation.

Table 1 Average values of physical measurements and serum biochemical markers for comparison of participants who ate dinner less than or more than three hours before going to bed†

	<3-h group (n = 187)	>3-h group (n = 579)	*p*-value
Male gender, %	56.1	31.3	
Age, year	54	55	
BMI, kg/m^2	23.6	22.5	0.017
Waist circumference, cm	84.9	82.4	0.034
SBP, mmHg	122	121	0.907
DBP, mmHg	75	74	0.959
Fasting glucose, mg/dL	93	92	0.774
2-h post-load glucose, mg/dL	123	124	0.950
HbA_{1c}, %	5.1	5.1	0.750
Total cholesterol, mg/dL	201	204	0.772
HDL cholesterol, mg/dL	59	63	0.388
Triglycerides, mg/dL	108	101	0.977
LDL cholesterol, mg/dL	119	119	0.293

† Results adjusted to account for gender and age. BMI = body mass index; DBP = diastolic blood pressure; HbA_{1c} = glycated hemoglobin; HDL = high-density lipoprotein; LDL = low-density lipoprotein; n = number of participants in group; SBP = systolic blood pressure.

Table 2 A comparison of medications, eating habits, obesity, and metabolic syndrome between participants in the less than three hours group and the more than three hours group†

	<3-h group (n = 187)	>3-h group (n = 579)	*p*-value
Medication for hypertension, %	19.8	16.2	0.298
Medication for lipidemia, %	6.4	13.3	0.089
Medication for diabetes mellitus, %	0.0	0.3	0.418
Eating between meals, %	49.5	63.9	0.101
Eating snacks late at night, %	25.4	9.6	< 0.001
Having dinner after 8 p.m., %	39.0	15.2	< 0.001
Having dinner after 9 p.m., %	29.9	3.1	< 0.001
Skipping breakfast, %	3.7	2.2	0.738
Obesity, %	25.1	21.1	0.871
Metabolic syndrome, %	9.6	9.5	0.247

† Results adjusted to account for gender and age. n = number of participants in group.

Results

Table 1 shows the results of a comparison of the average values of physical measurements (BMI and waist circumference), SBP, DBP, and serum biochemical markers (fasting glucose, 2-h post-load glucose, HbA_{1c}, total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides) for the two groups that included people who ate dinner less than three hours before bedtime (<3-h group) and people who ate dinner more than three hours before bedtime (>3-h group). There was a significant difference in the values for BMI and waist circumference between the <3-h group and the >3-h group as assessed by a one-way ANOVA. The values for BMI and waist circumference were higher in the <3-h group than in the >3-h group.

Table 2 shows a comparison between the <3-h group and >3-h group for the taking of medication, eating habits, obesity, and the incidence of metabolic syndrome. Using the Chi-square test, it was determined that there was a significant difference between the <3-h group and the >3-h group for the factors eating snacks at night, having dinner after 8 p.m., and having dinner after 9 p.m. The percentages of people eating snacks at night, having dinner after 8 p.m., and having dinner after 9 p.m. were higher in the <3-h group

Table 3 A comparison of nutritional intake between participants in the less than three hours group and the more than three hours group†

	<3-h group (n = 187)	>3-h group (n = 579)	*p*-value
Energy, kcal/day	1984	1865	0.008
Protein, g/day	69.4	65.7	0.008
Fats, g/day	65.3	31.7	0.021
Carbohydrates, g/day	257	248	0.148
Cholesterol, mg/day	352	317	0.001
Total volume of food fiber, g/day	12.7	13.1	0.642
Salt, g/day	9.2	9.1	0.381
Protein calories, %	14.0	14.1	0.317
Fat calories, %	29.3	29.5	0.492
Carbohydrates calories, %	56.7	56.4	0.348
Cereal grain calories, %	34.8	35.2	0.210
Animal protein as a % of total protein intake	54.8	53.3	0.039
Green-yellow vegetables as a % of total vegetable intake	35.7	37.7	0.035
Ethanol, g/day	21.0	14.0	0.261
Grain dishes (rice, bread, noodles, and pasta)‡, sv	3.6	3.4	0.122
Vegetable dishes‡, sv	3.7	3.9	0.669
Fish and meat dishes (meat, fish, egg, and soybean)‡, sv	6.5	6.0	0.008
Milk (milk and milk products) ‡, sv	1.6	1.7	0.699
Fruits‡, sv	0.8	0.9	0.668
Snacks and soft drinks‡‡, sv	5.6	4.9	0.092
Metabolic equivalents (METs) per day	35.9	35.1	0.014

† Results adjusted to account for gender and age. ‡ As defined by the Japanese Food Guide Spinning Top (JFGST). n = number of participants per group, sv#(serving scale) = unit for understanding the amount of intake of dishes within the Japanese Food Guide Spinning Top.

than in the >3-h group.

Table 3 shows a comparison of nutritional intakes and METs between the <3-h group and the >3-h group. Using ANOVA, it was determined that there was a significant difference in the consumption of total calories, protein, fat, cholesterol, animal protein, green-yellow vegetables, fish and meat dishes (as defined by the Japanese Food Guide Spinning Top [JFGST], which was developed by the Japanese Ministry of Health, Labour and Welfare and the Ministry of Agriculture, Forestry and Fisheries to promote healthy diets), and METs between the <3-h group and the >3-h group. The <3-h group had a higher intake of energy, protein, fat, cholesterol, animal protein, and fish and meat dishes (based on the JFGST) compared with the >3-h group. As a percentage of total vegetable intake, green-yellow vegetables were lower in the <3-h group compared with the >3-h group. The total number of METs was significantly higher in the <3-h group compared with the >3-h group.

Table 4 shows the physical measurements and serum biochemical markers for people who skipped breakfast. An ANOVA analysis showed that there was a significant difference in SBP, DBP, fasting glucose, 2-h post-load glucose, and triglycerides between participants who skipped breakfast and those who did not. The values for SBP, DBP, fasting glucose, 2-h post-load glucose, and triglycerides in the participants who skipped breakfast were higher than those for participants who did not skip breakfast.

Table 5 shows a comparison of the medication taken, eating habits, obesity rates, and the incidence of metabolic syndrome in participants who skipped breakfast compared with those who did not. The Chi-square test showed that there was a significant difference in responses from participants eating snacks late at night and having dinner after 8 p.m. who skipped breakfast versus those who did not. According to the questionnaire responses, the percentage of people who skipped breakfast was significantly higher in those who were eating snacks late at night and having dinner after 8 p.m.

Table 6 compares the nutritional intake and METs of participants who skipped breakfast with those of participants who did not skip this meal. ANOVA revealed that there was a significant difference in the intake of energy, protein, fats, carbohydrates, the total volume of food fiber, cereal grains as a percentage of calories, grain dishes, and fish and meat dishes (per the JFGST) between participants who skipped breakfast and those who ate breakfast. The

Table 4 Relationships between physical measurements and serum biochemical markers and whether or not participants skipped breakfast†

	Skipped breakfast (n = 20)	Did not skip breakfast (n = 746)	p-value
Males, %	65	36.6	
Age, year	45	55	
BMI, kg/m^2	23.7	22.7	0.345
Waist circumference, cm	86.1	82.9	0.082
SBP, mmHg	124	122	0.049
DBP, mmHg	79	74	0.030
Fasting glucose, mg/dL	98	92	0.000
2-h post-load glucose, mg/dL	132	123	0.041
HbA_{1c}, %	5.1	5.1	0.079
Total cholesterol, mg/dL	200	204	0.412
HDL cholesterol, mg/dL	55	62	0.115
Triglycerides, mg/dL	129	102	0.042
LDL cholesterol, mg/dL	123	119	0.126

† Results adjusted to account for gender and age. BMI = body mass index; DBP = diastolic blood pressure; HbA_{1c} = glycated hemoglobin; HDL = high-density lipoprotein; LDL = low-density lipoprotein; n = number of participants in group; SBP = systolic blood pressure.

Table 5 Relationships between medication, eating habits, obesity, and metabolic syndrome and whether or not participants skipped breakfast†

	Skipped breakfast (n = 20)	Did not skip breakfast (n = 746)	p-value
Medication for hypertension, %	10.0	17.3	0.991
Medication for lipidemia, %	0.0	11.9	0.562
Medication for diabetes mellitus, %	0.0	0.3	0.947
Eating between meals, %	55.0	60.5	0.888
Eating snacks late at night, %	36.8	12.8	0.014
Having dinner after 8 p.m., %	52.6	20.2	0.021
Having dinner after 9 p.m., %	25.0	9.2	0.218
Obesity, %	30.0	21.8	0.533
Metabolic syndrome, %	15.0	9.4	0.405

† Results adjusted to account for gender and age. n = number of participants in group.

amount of energy, protein, fats, carbohydrates, total volume of food fiber, cereal grains as a percentage of calories, grain dishes, and fish and meat dishes (JFGST) consumed were lower in participants who skipped breakfast than in those who ate breakfast.

There was a relationship between skipping breakfast, obesity, and people who ate dinner less than three hours before going to bed (<3-h group) (Table 7). Using multiple linear regression analysis, the following confounding factors were excluded: gender, age, energy intake, alcohol consumption, eating between meals, having dinner after 9 p.m., and METs. It was revealed that skipping breakfast was significantly correlated with waist circumference and BMI, while eating dinner less than three hours before bedtime was significantly correlated with BMI only. The independent factor of skipping breakfast was more influenced by the dependent factors of waist circumference, BMI, meeting the criteria for obesity, and meeting the Japanese criteria for METs than by eating dinner less than three hours before going to bed.

Discussion

The average daily energy intake for a Japanese person has been decreasing since its peak in the 1970s (2200 kcal), and the average daily energy intake of 1840 kcal in 2011 is even low in comparison with the 1903 kcal average reported in 1946 during a period of food shortages following World War II[1]. Some reports have suggested that factors underlying the increase in the number of obese people, despite a de-

Table 6 Relationships between nutritional intake and whether or not participants skipped breakfast†

	Skipped breakfast (n = 20)	Did not skip breakfast (n = 746)	p-value
Energy, kcal/day	1622	1902	0.001
Protein, g/day	53.5	67.0	0.003
Fats, g/day	55.9	62.7	0.036
Carbohydrates, g/day	208	252	0.001
Cholesterol, mg/day	300	326	0.179
Total volume of food fiber, g/day	9.2	13.1	0.004
Salt, g/day	7.9	9.1	0.364
Protein calories, %	13.3	14.1	0.667
Fat calories, %	30.6	29.4	0.566
Carbohydrates calories, %	56.2	56.5	0.751
Cereal grains calories, %	31.6	35.2	0.034
Animal protein as a % of total protein intake	54.9	53.7	0.586
Green-yellow vegetables as a % of total vegetable intake	36.9	37.2	0.939
Ethanol, g/day	25.4	15.4	0.572
Grain dishes (rice, bread, noodles, and pasta) ‡, sv	2.6	3.4	< 0.001
Vegetable dishes†, sv	2.5	3.9	0.060
Fish and meat dishes (meat, fish, egg, and soybean)‡, sv	4.8	6.1	0.044
Milk (milk and milk products)†, sv	1.1	1.7	0.106
Fruits‡, sv	0.3	0.9	0.055
Snacks and soft drinks‡, sv	6.1	5.0	0.582
Metabolic equivalents (METs) per day	34.8	35.4	0.464

† Results adjusted to account for gender and age. ‡ n = number of participants in group; sv = unit for understanding the amount of intake of dishes within the Japanese Food Guide Spinning Top.

Table 7 Relationships between obesity and skipping breakfast in participants who ate dinner less than three hours before going to bed (<3-h group)†

	Waist circumference		BMI		Obesity		Metabolic syndrome	
	β	p-value	β	p-value	β	p-value	β	p-value
Skipped breakfast	5.271	0.006	1.440	0.044	0.120	0.188	0.114	0.091
Ate dinner <3-h before going to bed	1.303	0.101	0.581	0.049	0.004	0.911	0.017	0.545

creasing average energy intake, include a greater decline in the average calories metabolized through physical activity and an increase in the number of people who skip breakfast and have dinner after 9 p.m. It has been shown that irregular eating patterns, such as skipping breakfast and eating dinner late at night can result in abnormal metabolism[6, 7] and possibly cause obesity. Our results revealed that skipping breakfast was significantly correlated with waist circumference and BMI. Eating dinner less than three hours before bedtime was significantly correlated with BMI only (Table 7).

Esquirol *et al.*[8] reported that people who skip breakfast have a 3.4-fold greater risk of developing metabolic syndrome compared with those who eat dinner less than three hours before bedtime and that people who eat snacks at night have 2.6 times the risk of having metabolic syndrome compared with those who do not eat snacks at night.

It has been reported that in order to reset the body's biological clock, eating breakfast is a more important factor than the time at which dinner is eaten; skipping breakfast causes a shift in the phase of expression of the clock gene, resulting in a nocturnal lifestyle pattern, which may be associated with obesity[9]. Our data suggest that eating breakfast every day is more important for prevention of obesity than having dinner more than three hours before bedtime.

The results of this study showed that although the physical activity level was significantly higher in the <3-h group, their BMI and waist circumference measurements were also significantly higher compared with the >3-h group. This finding was explained by the results showing that there were fewer individuals consuming more energy, protein, fats, cholesterol, animal protein, and grain dishes (as defined by the JFGST) in the <3-h group. This appears to suggest that these eating habits lead to a higher BMI and waist circumference and an increased incidence of obesity. In addition, intake of green-yellow vegetables as a percentage of total vegetable intake tended to be less in the <3-h group than in the >3-h group and was associated with obesity and dietary habits that can be considered less healthy (Tables 1 and 3).

The standard questionnaire about metabolic syndrome compiled by the Japanese Ministry of Health, Labour and Welfare and used in annual medical examinations since April 2008 seeks responses to statements concerning whether or not the respondent eats dinner late at night ("three times a week I eat dinner less than two hours before bedtime") and whether or not the respondent eats snacks late at night ("I eat snacks three times a week after dinner"). In our view, this annual medical examination for preventing metabolic syndrome suggests that the relationship between dinner time and the incidence of obesity can likely be attributed to digestion time. In general, carbohydrates have the shortest digestion time in the stomach, followed by proteins and fats. Most food moves from the stomach to the duodenum in three hours. Given this, when dinner is eaten only a short time before going to bed, the energy consumed is not used by the body and instead accumulates as internal fat[10). Therefore, to reduce the risk of obesity, our results suggest that adequate digestion is necessary, and hence it is preferable to eat dinner at least three hours before going to bed. Shibata's survey[11)] reported that people who got up early and went to bed early (morning lifestyle pattern) and those who stay up late at night and get up late the next morning (night lifestyle pattern) have different favorite foods; people that adopted a morning lifestyle pattern preferred rice, fruit, vegetables, eggs, and dairy products and consumed large quantities of carbohydrates. In contrast, people who adopted a night lifestyle pattern appeared to like noodles and snacks and also consumed large amounts of fat. In the present study, the majority of respondents in the <3-h group ate dinner or snacks after 8 p.m. Further, from a nutritional point of view, there was a large intake of , and a tendency toward a night lifestyle pattern in the <3-h group (Tables 2 and 3).

From the viewpoint of chrononutrition, the evening is considered to be the period in which one can easily gain weight. Gaining weight at night is thought to be related to the BMAL1 gene (one of the clock genes), which has also been linked to hypertension and diabetes[12)]. BMAL1 is considered to be most active in the period from 10 p.m. to 2 a.m., so the later dinner is eaten, the more strongly BMAL1 is activated and the more likely it is to cause an accumulation of internal fat[12)]. These results indicate that two key dietary behaviors for reducing the risk for obesity may be (1) avoiding the consumption of fatty foods at night, and (2) eating dinner at least three hours before going to bed.

The percentage of people who ate snacks late at night and had dinner after 8 p.m. was significantly higher for the group that skipped breakfast compared with the group that did not skip breakfast. The intake of energy and protein, fats, carbohydrates, and fiber for participants in the group that did not skip breakfast was significantly higher than for those in the group that did skip breakfast. Consumption of grain dishes and fish and meat dishes (as defined by the JFGST) for the group that did not skip breakfast was significantly higher than for the group that skipped breakfast. The intake of snacks and soft drinks (as defined by the JFGST) was numerically, but not significantly, higher for the group that skipped breakfast compared with the group that did not skip breakfast. Although the group that skipped breakfast consumed fewer calories, our results suggest that this group had an increased tendency for the following dietary habits: (1) eating snacks late at night, (2) having dinner after 8 p.m., and (3) increased intake of snacks and soft drinks. These ill-advised dietary habits can lead to obesity (Tables 5 and 6).

Earlier studies have provided three lines of evidence for why skipping breakfast can cause obesity, despite a decreased energy intake. First, skipping breakfast can cause not only a decrease in physical activities in the morning but also a decrease in total energy expenditure which can result in the development of obesity. Second, a far-infrared radiation thermograph test that measures thermal release from the body showed that participants who skip breakfast have a low body temperature and decreased energy metabolism. Third, while skipping meals reduces overall calorie consumption, it results in blood sugar level spikes[13–15)]. Forgoing breakfast can cause a decrease in serum blood sugar concentrations, resulting in the breakdown of muscle tissue via the gluconeogenic pathway as a means to provide glucose for the brain; the decrease in muscle volume leads to a subsequent decrease in physical strength[16, 17)]. Our results suggested that a decrease in muscle volume causes a decrease in basic metabolism. Furthermore, when individuals are hungry, they can conserve energy by limiting physical activities, which can result in a condition whereby the body does not lose weight but instead gains weight easily.

Study Limitation

Our study showed the relationship among the timing of meals and BMI, waist circumference, obesity, and incidence of metabolic syndrome. However, we did not survey participants to determine what types of foods were consumed during each time period. Further studies should be planned in this area.

On review of the original data, it was noted that all twenty respondents in this study belonging to the skipped breakfast group also ate dinner more than three hours before going to bed.

In a future study, we will perform a multiple linear regression analysis to calculate the relationship between the three independent factors (skipping breakfast, eating dinner less than three hours before bedtime, and their combination) and each of the four dependent factors (waist circumference, BMI, obesity, and metabolic syndrome).

In this study, we did not measure the percentage of body fat or body water percentage, but we will add these two elements in future studies.

The FFQg method was used in this study because we had also used it in our studies in other areas of Ehime Prefecture since 2009. In future studies, we will make use of another evaluation method, the brief-type self-administered diet history questionnaire (BDHQ).

Conclusion

In both Japanese males and females, dietary habits such as eating dinner less than three hours before bedtime and skipping breakfast were significantly related to obesity. Skipping breakfast was more strongly correlated with obesity than eating dinner less than three hours before bedtime.

Conflict of interest: The authors declare that there are no conflicts of interest.

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