Journal of Women's Health, Issues & Care

Research Article

A SCITECHNOL JOURNAL

Association between Lower Food Consumption and Body Mass Index in Young Japanese Women

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Abstract

Aim: For Japanese women, weight is an important issue since obesity and anorexia are increasing. Therefore, for establishing a dietary education program, we need to grasp the current situation to analyze dietary intake, body mass index, and complaints among young females.

Methods: The survey included 439 female university students in Tokyo, Japan, who provided informed consent. The population included 423 students (mean age: 19.6 ± 1.4); 16 students did not complete a survey. The subjects were asked to complete a dietary intake questionnaire (i.e., food frequency questionnaire with 82-food items) and self-completed lifestyle questionnaires. The Sagami Women's University Ethics Committee approved this study.

Results: A total of 423 women were recruited with an average body mass index ± standard deviation of 20.7 ± 2.4. The distributions of the body mass index <18.5, 18.5 ≤ body mass index ≦ 19.9, and body mass index ≥ 25.0 were 15.6%, 26.6%, and 5.0%, respectively. The average number of complaints was 2.8 per subject. In the mentally alert group, consumption of calcium, potassium, magnesium, and dietary fiber at breakfast ($p<0.01$), energy intake at breakfast, iron intake at dinner, as well as consumption of potassium, calcium, and magnesium during the day ($p<0.05$) were significant.

Conclusion: This cross-sectional study highlighted a population at risk of health impairment due to deficiencies in the body mass index, energy intake, and nutrient intake. The results also indicated the association between breakfast intake and complaints. .

Keywords

Dietary intake; Breakfast; Eating habits; Body mass index; Young Japanese women; Lifestyle situation; Complaints

Introduction

The World Health Organization reported the current critical health issues, such as obesity and malnutrition. Globally, 1.2 billion individuals are obese and 0.8 billion individuals are malnourished. Consequently, health issues associated with these problems have emerged [1]. Approximately 7.2 million individuals have diabetes and one in five females has metabolic syndrome [2], with the incidence of these diseases increasing annually. In addition, the distribution of body type has significantly changed in young females [3]. The percentage of thin females aged 20-29 years (body mass index (BMI)<18.5 kg/m^2) was 24.6% in 2008 and 22.3% in 2014, showing a decreasing trend [2]. In young females, being thin is associated with an increased risk of delivering a low-birth-weight baby or premature baby, while obesity induces pregnancy-related diseases (e.g., diabetes, hypertension) and abnormal delivery. Furthermore, it was reported that fetal malnutrition raises the possibility that children will be subsequently affected by lifestyle-related diseases (Developmental Origins of Health and Disease (DOHaD) theory) [4-8]. Therefore, ensuring optimal nutrition in young Japanese females is a priority for maternal and child health. However, reports suggested that improvements in eating habits after pregnancy are very difficult [9].

Therefore, understanding the regular dietary intake in young females is essential to improve health issues. Recently, evidence-based nutrition has attracted attention; the use of scientifically valid evaluations in dietary education is of great importance. Accordingly, Watanabe et al. developed a simple and highly accurate dietary questionnaire (FFQW65) [10], which they subsequently improved through two iterations (FFQW82) [11]. These investigators reported that vegetarian diets were beneficial for health [12], resulting in significant enhancement of bone density in young females [13], and evaluated the effects of dietary education based on a randomized controlled study [14]. Although there are a number of reports investigating the association between the dietary habits of young women and health, no studies have suggested programs to improve their health. Therefore, in this study, we analyzed current conditions of deficiency and excess in dietary intake, BMI, and complaints in young females to establish a practical dietary education program.

Materials and Methods

Subjects

We conducted a survey of 439 female university students in three universities in Tokyo, Japan, who provided consent to participate in this study. The population included 423 students (mean age: 19.6 ± 1.4); 16 students did not complete a survey form and/or questionnaires for the basic survey. Adequate explanation and information materials were provided prior to conducting the survey. For students aged <20 years, the same information materials were provided to the parent or guardian, prior to obtaining consent. We explained that subjects could withdraw from the study at any point during the survey. This study was approved by the Ethics Committee of Sagami Women's University, and was conducted in strict accordance to the Committee (Approval No. 1234 2012).

Survey methods

The survey was conducted between May and October 2013. Body height, weight, waist circumference at the umbilical level, systolic blood pressure, diastolic blood pressure, fasting blood sugar, and bone density were measured. Completion of the survey form for eating and lifestyle habits was explained to the subjects, and they were asked to

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Received: December 16, 2019 **Accepted:** January 24, 2020 **Published:** January 31, 2020

complete the dietary questionnaire (FFQW82) and self-completed lifestyle questionnaire.

The contents of the survey were:

- Self-reported body height data at the time of medical examination in April 2013. The body weight was measured using TANITA (TANITA Co., Tokyo, Japan) weighing scales for physical measurement. Waist circumference at the umbilical level was measured, and subsequently 1.5 cm was subtracted from the measured value. Blood pressure was measured using a digital automated sphygmomanometer (Omron: OMRON Co. Kyoto Japan). A puncture device with disposable needle and surrounding parts was used to measure fasting blood sugar. After measurement, hemostasis was confirmed. Bone density was measured using the ultrasonic bone mass measuring instrument Benus BD-620 (Benus III; TANITA).

- A semi-quantitative food intake frequency questionnaire 82 (FFQW82) was used for the dietary survey. The FFQW82 was a food list comprising 82 items categorized into 16 food groups, and dietary intake was based on the intake frequency (six-point scale) and intake amounts (i.e., small, medium, large) of each food item in the food list. The validity and reproducibility of the questionnaire was confirmed.

- Survey questions using a self-completed lifestyle questionnaire included items relating to eating habits (10 items), lifestyle (8 items), and complaints (8 items). The questionnaire was selected based on previous studies performed by the authors [15].

Analysis methods

Energy intake (EI) for the day and each meal, as well as the intake of each major nutrient was calculated for dietary intake [16]. For the lifestyle questionnaire, answers such as "always", "more than a little" and "sometimes" denoted as "a habit", whereas "on rare occasions" and "hardly" denoted "no habit". For complaints, "I always feel it", "I feel it a lot", "I feel it occasionally", "I don't feel it so much", and "I don't feel it at all" were rated with 5, 4, 3, 2, and 1 point(s), respectively. In addition to the complaints, subjects who chose "I cannot wake up refreshed each morning" were categorized into the mentally tired group, whereas those who chose "I wake up refreshed each morning" were categorized into the mentally alert group. The subjects were stratified into two groups to compare subjects according to risks. The subjects with risks were defined as the groups with BMI <18.5 kg/m^2, 25.0-27.4 kg/m^2, and ≧ 27.5 kg/m^2. Subjects without risks were defined as the groups with BMI 18.5-19.9 kg/m^2, 20.0-22.4 kg/m^2, and 22.5-24.9 kg/m^2. Subjects were stratified into two groups depending on the presence or absence of habit to examine the associations between dietary intake and lifestyle. The SPSS software, version 21.0 (IBM, Armonk, NY, USA) was used for statistical analysis.

Continuous variables were presented as the mean ± standard deviation (SD). The t-test was used for comparisons between two groups, and the two-sided level of significance was set at 5%.

Results

Age and clinical test data

The age and clinical laboratory test data (mean ± SD) for the subjects are shown in Table 1. The BMI was 20.7 ± 2.4 kg/m^2 and was within the range of reference values [16]. The abdominal circumference was 68.4 ± 6.4 cm, and the systolic blood pressure and diastolic blood pressure were 109.1 ± 12.2 mmHg and 66.5 ± 16.7 mm Hg, respectively. These values were also within the range of reference values provided by the Japan Medical Association.

Dietary intake

Table 2 shows the EI and the intake of major nutrients (mean ± SD) calculated based on the FFQW82. The subjects were asked to describe mid-morning snacks as breakfast, afternoon snacks as lunch, and late-evening snacks as dinner. The EI of the meals (breakfast, lunch and dinner including in-between snacks) was 1,491 kcal per day. Thus, a deficiency in the EI was observed since the estimated energy requirement for the age group was 1,950 kcal/day [16].

The daily EI for breakfast, lunch, and dinner was 347 kcal (23%), 480 kcal (32%), and 657 kcal (44%), respectively. In addition, the EI ratios of protein (P), fat (F), and carbohydrate (C) (PFC (%EI)) were 16%, 30%, and 54%. Inadequate intake was suggested especially when the values for calcium (Ca), iron (Fe), and dietary fiber were below 344 mg, 6.4 mg, and 10.6 g, respectively.

BMI statistics

The distributions according to the BMI (percentage of subjects) are BMI <18.5, 18.5 ≦ BMI ≧ 19.9, 25.0 ≦ BMI ≦ 27.4 and BMI

Table 1: The age and clinical laboratory test data.

Variables	n	Mean ± SD	Max	Min	Reference value[1]
Age (year)	409	19.6 ± 1.4	29.0	18.0	
BMI (kg/m^2)	420	20.7 ± 2.4	34.4	14.3	18.5-24.9[2]
Abdominal circumference (cm)	421	68.4 ± 6.4	101.0	55.0	< 90 cm
Systolic blood pressure (mmHg)	421	109 ± 12.2	185.0	60.0	130<
Diastolic blood pressure (mmHg)	421	67 ± 10.5	138.0	36.0	85<
FBS (mg/dl)	420	86 ± 16.7	213.0	33.0	80～110
Bone density OSI (×10^6)	222	2.9 ± 0.4	4.4	2.1	2.7 ± 3.2

[1]Japan Medical Association; [2]Japanease Dietary reference intake (2015)

Table 2: Energy intake (EI) and the intake of major nutrients (n=419).

Energy and nutrient	Mean ± SD	Dietary reference intake[1]
		Age (18-29 years)
Breakfast energy intake (kcal)	347 ± 165.3	-
Lunch (kcal)	480 ± 98.6	-
Dinner (kcal)	1491 ± 153.4	-
Daily (kcal)	658 ± 39.0	1,950
Protein (g)	57.8 ± 6.5	50
Fat (g)	49.3 ± 6.4	-
Carbohydrate (g)	196.5 ± 21.3	-
Potassium (mg)	1797.3 ± 336.0	2,600
Calcium (mg)	344.4 ± 97.7	650
Magnesium (mg)	183.3 ± 27.1	270
Fiber (g)	10.6 ± 1.8	18
Iron (mg)	6.4 ± 1.0	10.5[2] 6.0[3]
Salt (g)	7.7 ± 1.1	7.0<
Protein energy ratio (%)	-	<20
Fat energy ratio (%)	-	20-30
Carbohydrate energy ratio (%)	-	50-65

[1]Japanese dietary reference intake (2015); 2Menstruation; 3Non Menstruation; Abbreviations:SD (Standard Deviation)

≧ 27.5 were 15.6%, 26.6%, 3.6%, and 1.4%, respectively. Among the subjects, 15.6% were determined as thin and 5.0% as obese.

Lifestyle, dietary habit, and health awareness

Table 3 shows the lifestyle, food, and health decisions. For body shape, the rates of the subjects who evaluated their own body weight and body shape as obese were 55.4% to the question: "What do you think about your weight?", and 54.8% to the question: "What do you think about your body shape?" Of note, 93.8% of the subjects were not on a diet.

Table 4 shows the relationship between breakfast and daily EI according to lifestyle factors. For daily rhythm, sleep duration was associated with EI at breakfast ($p<0.001$), while eating snacks after 10 p.m. was associated with EI at breakfast ($p<0.05$). For eating habits, the frequency of eating breakfast, a main dish for breakfast, vegetables for breakfast, a main dish for lunch, eating vegetables for lunch, and the frequency of dairy product intake were associated with EI at breakfast ($p<0.001$); the frequency of eating the main dish for breakfast was associated with daily EI ($p<0.01$). Other statistically significant variables are included in Table 5.

Frequency and number of complaints

Here is the occurrence rate of complaints according to items and complaint scores. The occurrence rate of complaints in young females was high in the following order: "I feel tired" (91.2%), "I cannot concentrate" (84.5%), "I have no motivation" (81.1%), "I cannot wake up refreshed every morning" (78.1%), "I have stiff shoulders" (67.6%), and "I feel irritable" (64.3%). The complaint scores were as follows: "I feel tired" (3.3) points, "I cannot wake up refreshed every morning" (3.2), "I get stiff shoulders" (3.1), "I feel irritable" (2.7), "I feel lethargic" (3.0), "I have poor concentration" (3.1), "I suffer headaches" (2.2), and "I have constipation" (2.0). The average number of complaints was 2.8 per subject.

Table 5 shows the relationship between complaints and dietary intake. When a comparison was performed between the high wake-up ability group and low wake-up ability group, consumption of Ca, potassium (K), magnesium (Mg), dietary fiber at breakfast, dietary fiber during a day ($p<0.01$), EI at breakfast, iron intake at dinner, dietary fiber at dinner, and K, Ca, and Mg during a day ($p<0.05$) was significantly higher in the high wake-up ability group compared with that reported in the low wake-up ability group.

Table 3: Lifestyle situation of food and health consciousness.

Variables	n	Not always	Week 1-2	With factors	Week 3-4	Week 5-6	Always	No factor {n (%)}
Life rhythm								
Sleep time takes >21600s	420	51 (12.1)	106 (25.2)	157 (37.3)	134 (31.9)	78 (18.6)	51 (12.1)	263 (62.6)
Sleeping time after Midnight	420	126 (30.0)	146 (34.8)	272 (64.8)	85 (20.2)	41 (9.8)	22 (5.2)	148 (35.2)
		Daily	**Week 5-6**		**Week 3-4**	**Week 1-2**	**Not always**	
Eating dinner after 9 p.m. in the evening	420	12 (2.9)	18 (4.3)	30 (7.2)	93 (22.1)	201 (47.9)	96 (22.9)	390 (92.9)
Snacking after 10 p.m. in the evening	420	6 (1.4)	13 (3.1)	19 (4.5)	45 (10.7)	185 (44.0)	171 (40.7)	401 (95.4)
Eating habits		**Not always eat**	**Week 1-2**		**Week 3-4**	**Week 5-6**	**Eat everyday**	
Frequency of eating breakfast	420	40 (9.5)	21 (5.0)	61 (14.5)	33 (7.9)	66 (15.7)	260 (61.9)	359 (85.5)
Frequency of eating main dishes such as eggs, fish, meat, and tofu for breakfast	420	72 (17.1)	112 (26.7)	184 (43.8)	95 (22.6)	63 (15.0)	78 (18.6)	236 (56.2)
Frequency of eating vegetables for breakfast	420	109 (26.0)	137 (32.6)	246 (58.6)	80 (19.0)	41 (9.8)	53 (12.6)	174 (41.4)
Frequency of eating main dishes such as eggs, fish, meat, and tofu for lunch	420	9 (2.1)	58 (13.8)	67 (15.9)	126 (30.0)	96 (22.9)	131 (31.2)	353 (84.1)
Frequency of eating vegetables for lunch	420	20 (4.8)	84 (20.0)	104 (24.8)	121 (28.8)	100 (23.8)	95 (22.6)	316 (75.2)
Frequency of eating dairy products	419	43 (10.3)	87 (20.8)	130 (31.1)	89 (21.2)	64 (15.3)	136 (32.5)	289 (69.0)
		Eat everyday	**Week 5-6**		**Week 3-4**	**Week 1-2**	**Don't always eat**	
Frequency of eating fast food	420	7 (1.7)	21 (5.0)	28 (6.7)	62 (14.8)	213 (50.7)	117 (27.9)	392 (93.4)
Frequency of taking oily food	420	4 (1.0)	17 (4.0)	21 (5.0)	169 (40.2)	217 (51.7)	13 (3.1)	399 (95.0)
		Not made at all	**Week 1-2**		**Week 3-4**	**Week 5-6**	**Make every day**	
Frequency of making meals	419	26 (6.2)	40 (9.5)	66 (15.7)	63 (15.0)	164 (39.1)	126 (30.1)	353 (84.1)
		Is missing	**Just**		**Overeating**	**Not sure**		
Is the amount of food appropriate?	420	50 (11.9)	109 (26.0)		225 (53.6)	36 (8.6)	0 (0.0)	
Body type		**Too thin**	**Slender**	**Lean self-assessment**	**OK**	**Fat**	**Overweight**	**Obesity self-assessment**
What do you think about your weight?	420	7 (1.7)	24 (5.7)	31 (7.4)	156 (37.1)	195 (46.4)	38 (9.0)	233 (55.4)
What do you think about your body shape?	420	6 (1.4)	24 (5.7)	30 (7.1)	160 (38.1)	196 (46.7)	34 (8.1)	230 (54.8)
		Always	**Week 5-6**		**Week 3-4**	**Week 1-2**	**Sometimes**	**Not always**
I am on a diet	420	13 (3.1)	13 (3.1)	26 (6.2)	34 (8.1)	87 (20.7)	273 (65.0)	394 (93.8)
		Week 5-6	**Week 3-4**		**Week 1-2**	**Three times a month or less**	**Not always**	Not working
Frequency of working part-time	420	12 (2.9)	168 (40.0)	180 (42.9)	135 (32.1)	14 (3.3)	91 (21.7)	240 (57.1)

"Yes" indicates that there is a problem; "None" indicates that there is no problem

Table 4: Relationship between breakfast and daily Energy Intake (EI) according to the presence or absence of lifestyle factors.

Variables	n	Factor*	n (%)	Breakfast EI (M ± SD)	Daily EI (M ± SD)
Life rhythm "Not always" "Week 1–2" "Week 3–4" **Yes** "Week 5–6" "Always" **No**					
Sleep time takes > 21600s	420	Yes	291 (69.2)	327 ± 144.5	1481 ± 146.1
		No	129 (30.7)	398 ± 162.5***	1517 ± 157.2
Sleeping time after Midnight	420	Yes	357 (85.0)	332 ± 143.0	1484 ± 149.4
		No	63 (15.0)	350 ± 161.7	1493 ± 145.4
"Always" "Week 5–6" "Week 3–4" **Yes** "Week 1–2" "Not always" **No**					
Dinner after 9 p.m. in the evening	420	Yes	123 (29.3)	335 ± 151.2	1496 ± 149.5
		No	297 (70.8)	339 ± 148.6	1483 ± 147.5
Snack after 10 p.m. in the evening	420	Yes	64 (4.5)	304 ± 164.9	1495 ± 170.5
		No	356 (84.7)	344 ± 145.6*	1485 ± 142.6
Eating habits "Not always eat" "Week 1–2" "Week 3–4" **Yes** "Week 5–6" "always eat" **No**					
Frequency of eating breakfast	420	Yes	94 (22.4)	253 ± 176.0	1479 ± 175.4
		No	326 (77.6)	363 ± 130.7***	1489 ± 139.3
Frequency of eating main dishes, such as eggs, fish, meat, and tofu for breakfast	420	Yes	279 (66.4)	303 ± 136.9	1473 ± 144.8
		No	141 (33.6)	406 ± 149.3***	1513 ± 151.1**
Frequency of eating vegetables for breakfast	420	Yes	326 (77.6)	317 ± 139.6	1479 ± 148.7
		No	94 (22.4)	411 ± 158.3***	1513 ± 143.5*
Frequency of eating main dishes such as eggs, fish, meat, and tofu for lunch	420	Yes	193 (45.9)	316 ± 151.6	1475 ± 159.5
		No	227 (54.1)	356 ± 144.9***	1497 ± 137.3
Frequency of eating vegetables for lunch	420	Yes	225 (53.6)	324 ± 148.7	1472 ± 150.8
		No	195 (46.4)	354 ± 148.5*	1503 ± 143.5*
Frequency of eating dairy products	419	Yes	219 (52.3)	297 ± 144.4	1465 ± 151.3
		No	200 (47.8)	383 ± 141.3***	1511 ± 140.9*
"Always eat" "Week 5–6" "Week 3–4" **Yes** "Week 1–2" "Not always eat" **No**					
Frequency of eating fast food	420	Yes	90 (21.5)	316 ± 153.8	1486 ± 152.2
		No	330 (78.6)	344 ± 147.6	1487 ± 1147.1
Frequency of taking oily food	420	Yes	190 (45.2)	354 ± 157.3	1519 ± 149.6
		No	230 (54.8)	325 ± 141.7*	1461 ± 141.9***
"I do not cook at all" "Week 1–2" "Week 3–4" **Yes** "Week 5–6" "To cook" **No**					
Frequency of making meals	419	Yes	353 (84.2)	336 ± 147.6	1490 ± 148.5
		No	66 (15.7)	345 ± 157.7	1471 ± 145.9
*Indicates the presence of a factor that is not in good condition					

Table 5: Relationship between complaints and dietary intake.

Variables	Low wake-up ability group			High wake-up ability group			p-value
	n	Mean ± SD		n	Mean ± SD		
Age	227	20.0	1.4	66	20.1	1.1	0.538
BMI	330	20.6	2.3	94	20.9	2.6	0.594
Breakfast							
Energy (kcal)	329	338.1	171.7	107	374.3	140.2	0.069
Protein (g)	329	12.0	4.7	107	13.1	3.8	0.036*
Fat (g)	329	9.8	4.3	107	10.8	3.7	0.096
Carbohydrate (g)	329	49.9	20.0	107	54.4	15.5	0.046*
Potassium (mg)	329	380.7	250.1	107	451.4	236.9	0.009**
Calcium (mg)	329	108.9	72.6	107	133.2	75.6	0.009**
Magnesium (mg)	329	40.4	19.2	107	46.0	17.5	0.006**
Fiber (g)	329	1.7	0.5	107	1.8	0.4	0.013**
Iron (mg)	329	2.6	0.9	107	2.9	0.8	0.003**
Salt (g)	329	2.1	0.6	107	2.1	0.5	0.323
Lunch							
Energy (kcal)	328	474.8	97.0	108	494.6	101.9	0.551
Protein (g)	328	15.6	4.3	108	16.4	4.5	0.846
Fat (g)	328	14.7	4.7	108	15.6	5.0	0.422

Carbohydrate (g)	328	66.3	11.9	108	68.5	11.8	0.570
Potassium (mg)	328	406.0	151.6	108	425.2	168.0	0.400
Calcium (mg)	328	77.7	27.4	108	82.5	31.0	0.630
Magnesium (mg)	328	45.6	13.9	108	47.6	15.6	0.458
Fiber (g)	328	2.0	0.6	108	2.1	0.6	0.396
Iron (mg)	328	3.3	0.9	108	3.4	0.8	0.123
Salt (g)	328	1.9	0.7	108	2.0	0.7	0.315
Dinner							
Energy (kcal)	328	656.2	38.7	108	661.1	39.7	0.983
Protein (g)	328	29.4	2.3	108	29.5	2.3	0.423
Fat (g)	328	23.5	0.9	108	23.6	1.0	0.799
Carbohydrate (g)	328	78.6	7.6	108	79.4	7.2	0.493
Potassium (mg)	328	909.9	126.1	108	909.8	130.7	0.089
Calcium (mg)	328	134.6	24.2	108	133.9	25.7	0.192
Magnesium (mg)	328	90.1	8.3	108	89.9	8.5	0.058
Fiber (g)	328	3.8	0.2	108	3.8	0.3	0.049*
Iron (mg)	328	5.5	0.7	108	5.5	0.7	0.027*
Salt (g)	328	4.5	0.5	108	4.4	0.5	0.175
Daily							
Energy (kcal)	328	1486.6	144.8	108	1502.6	176.2	0.427
Protein (g)	328	57.7	6.3	108	58.1	7.1	0.123
Fat (g)	328	49.2	6.1	108	49.7	7.3	0.471
Carbohydrate (g)	328	195.9	20.1	108	198.2	24.3	0.635
Potassium (mg)	328	1795.8	324.3	108	1802.3	369.4	0.013*
Calcium (mg)	328	343.6	92.7	108	346.9	111.4	0.023*
Magnesium (mg)	328	183.2	26.1	108	183.6	29.9	0.010*
Fiber (g)	328	6.4	1.0	108	6.5	1.1	0.011*
Iron (mg)	328	10.6	1.8	108	10.6	1.8	0.003**
Salt (g)	328	7.6	1.0	108	7.7	1.1	0.124
*p<0.05; **p<0.01; ***p<0.001							

Discussion

We aimed to establish a dietary education program for young females by analyzing a range of data. Moreover, we also assessed the association between dietary intake and complaints in 423 female university students across three universities in Tokyo, Japan.

The groups with a BMI<18.5 and BMI ≧ 25 included 15.6% and 5.0% of the subjects, respectively. The results of the dietary survey indicated that the actual average EI of the subjects (1,491 ± 153 kcal/day) was lower than the recommended (1,950 kcal). These results demonstrate that energy and nutrient intake deficiencies are apparent in these young Japanese women. This was also reflected in the relationship between breakfast consumption and the ability to wake-up refreshed and be alert.

Numerous studies have reported that young women have a strong desire to be thin, and the proportion of thin females with low body weight and BMI<18.5 has been increasing [17,18]. According to the National Health and Nutrition Survey Japan, in 2014, the proportions of the female population aged 20-29 years with a BMI<18.5 or BMI 25 were 17.4% and 10.7%, respectively [2]. However, in our study, the proportions of female university students with a BMI<18.5 or BMI 25 were 15.6% and 5.0%, respectively. Therefore, the findings of our study confirmed previous observations regarding this worrying phenomenon. A number of epidemiological studies have demonstrated that children born from malnourished mothers develop lifestyle diseases (e.g., obesity, impaired glucose tolerance, abnormality of lipid metabolism, hypertension, and cardiovascular disease) at high rates in adulthood. This is known as "Barker's hypothesis" [4]. Obesity persists from childhood into adulthood, and it is more likely to progress to metabolic syndrome (e.g., type 2 diabetes, hyperlipidemia, and hypertension) in the future. Simultaneously, being thin in childhood is also associated with various health impairments in the same manner as obesity [19]. Additionally, thinness persists from childhood into childbearing years, and causes low birth-weight infants. This process follows a course consistent with the fetal origins of adult disease hypothesis, Barker's hypothesis, or DOHaD hypothesis [19]. Thus, optimization of the mother's BMI prior to pregnancy is of crucial importance [3]. Furthermore, false recognition of individual body shape has been reported [20,21]. Despite the use of gender-appropriate BMI in this study, 55.4% and 54.8% of subjects responded that their body weight and body shape were trending toward obesity when asked: "What do you think about your weight?" and "What do you think about your body shape?". Therefore, the results of our study confirm the phenomenon of body dysmorphia. One of the most important extrinsic factors associated with eating behavior in young females is information provided by the media that 'thin is healthier and better', which is unhelpful.

We noted a relationship between the ability to wake-up refreshed each morning and breakfast. It has been reported that breakfast adjusts the circadian rhythm of peripheral clock genes [22] and enhances intellectual activities. In contrast, irregular dietary intake causes disturbance in corticosteroid secretion, and may induce deterioration of mental and physical conditions [23]. The results of this study also supported findings obtained from previous studies that individuals

who sleep less do not wake up refreshed and often skip breakfast because of this delay. Even if good habits are acquired in childhood, disturbance of the life rhythm occurs due to university student life associated with late-night part-time jobs, which can also result in skipping breakfast [24]. Consequently, these individuals develop a habit of breakfast skipping due to the reduction in sleeping time, resulting in a decrease in BMI and additional complaints. Azadbakht et al. investigated breakfast skipping and reported that subjects eating breakfast had an appropriate BMI [25]. In addition, breakfast skipping is associated with daily EI and activity in the morning [26]. Therefore, our study supports these previous studies demonstrating that consumption of breakfast is important for improving the BMI in young females.

Female university students may be especially susceptible to changes in the environment, including effort spent on academic work, establishment of human relationships in their part-time job, and living on their own, which may lead to disproportionate self-occupation. Given such conditions, depression has been reported to occur more often in female university students [27]. These conditions can result in irregular rhythm of life, sleep deprivation, breakfast skipping, and alcohol consumption. The occurrence of complaints among female university students increases when the mind and body are unstable or when there is functional disturbance without organic disease, which can occur due to modulation of the autonomic nerve system [27,28]. The average score of complaints was 2.8 per subject. Our study clarified the relationship between lifestyle, dietary intake, and complaints: the mentally alert group had significantly higher breakfast intake of energy, sugar, K, Ca, Mg, protein, fat, and Fe, and higher dinner intake of K, Ca, Mg, fiber, salt, and Fe compared with the mentally tired group. Ikeda et al. hypothesized that proper eating habits were related to the rate of fatigue, and our results were consistent with those reported in previous studies [29].

Acquiring proper eating behaviors in humans is regarded as a stepwise process since early adolescence. It ranges from food preparation to consideration of food and its relationship with health. This includes the rhythm of dietary life during the lactation and weaning periods, development of the sense of taste, and enjoyable family gatherings around the table [30]. Hayashi et al. pointed out that disordered eating behaviors were attributed to the impaired process of learning. Furthermore, the background of altered eating behaviors was induced by subsequent various experiences and environmental changes even if an appropriate eating behavior was adopted [31]. In recent years, lifestyle habits including the popularization of convenience stores where foods are always available, use of electronic devices resulting in late nights, and playing computer games have emerged as social issues. These issues may be associated with an increased propensity for thinness among young females. We expect that provision of an effective dietary education program targeted toward young females will contribute to improving weight patterns in young females in Japan by increasing the dietary intake of nutrients.

According to recent Japanese dietary intake standards [16], energy balance can significantly influence the body weight or BMI. Therefore, if the change in weight and BMI can be perceived by the individuals, it may be possible to understand the essence of energy balance [16].

The limitation of this study is its cross-sectional design. Thus, it was not possible to identify the causal relationships between the dietary intake of nutrients, BMI, and complaints amongst subjects. In addition, we should be cautious in generalizing these results despite the high consent rate. Furthermore, approximately 15% of females found under-reported in their EI [16]. There is an inverse relationship between the BMI and the rate of under-reporting and under-reporting occurs in non-obese as well as thin subjects [32].

The objectives of this study were achieved. We provided an approach for educational intervention through understanding of the current conditions, and established a study program to improve dietary intake in young females.

Conclusion

The present cross-sectional study highlighted a population at risk of health impairment due to deficiencies in the BMI, EI, and nutrient intake. The results also indicated the association between breakfast intake and complaints. These findings contributed to the formulation of an educational program with practical interventions for young females in the future.

Acknowledgements

We wish to thank the students of the universities in the Tokyo metropolitan area who participated in this study.

Conflict of Interest

There is no conflict of interests in this study.

Data Funding

This study was supported by Grants-in-Aid for Scientific Research: a scientific research grant program, (Basic Research Program [C]), Grant No. 25350147 on “Modeling of practical dietary education to avoid health risks caused by deficiency and excess in dietary intake” (FY2013 to FY2015).

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