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Nutritional Intakes of Obese Elementary School Children Residing in the Shimokita Peninsula of Aomori, Japan

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ABSTRACT

This research examined the lifestyles and eating habits of 42 elementary school fifthgraders (20 boys and 22 girls) over a 3-day period;these childrenresided in the Shimokita Peninsula, Aomori prefecture, which has the highest childhood obesity ratein Japan. The children's nutritional intakeswere recordedvia questionnaires and self-documented meal record diaries over a 3-day period (1weekday and the weekend). The meal record diaries recordedwhichmeals the children ate (including snacks) duringthe 3-day period. A regular feature of these children's lifestylewasthe viewing of at least 3 hours of television per day. Compared withthe National Health and Nutrition Survey conducted by the Japanese government,the nutritional and energy intake levels were the same but when we examined food group intakes, the vegetable intake was lower on weekends in comparison to the weekdays when the children were provided school lunches. In addition, salt intake exceeded the recommended standard in more than80% of the study sample. We suggest that the pattern of reduced vegetable intake juxtaposed with high salt intake stems from childhood and is repeated and passed down through generations; therefore,the guardians of these children require nutritional guidance and education.

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1. INTRODUCTION

Childhood obesity is an importantpublic healthissue. One in 10 young school-aged children in Japan is considered obese [1],[2]. A revision of lifestyle habits is needed to prevent infant and child obesity, as these conditions lead to an increased risk of high blood pressure, lipid levels, and abnormal glucose tolerance [3]. In the USA,studies have suggested that childrenwhobecome overweight at least once during infancy have a 5-fold higher risk being overweight by the age of 12 [4]. In the UK, reports have suggested that 40% of individuals who were obese in puberty remained obese into adulthood [5]. These studies show that childhoodobesity can be hugely influential onsubsequent growth in adulthood. Obesity prevention and solutions have become serious talking points in schools. Therefore, it is necessary to improve health and maintain a healthy weight as well as to promote physical activity [6].

In order to grasp the seriousness of the problem of obesity, Japanese national surveys have beenconducted toexamine the physical characteristics of children of both sexes from nursery to high school (aged 5‑18 years) [7]. The results of these surveys revealed that with in Japan, the Aomori prefecture has the highest number of obese children relative to the national average and that this has been a characteristic of the prefecture formany years [8]. The Shimokita Peninsula within the Aomori prefecture containsthe highest number of obese children and is therefore considered to have the highest number of childhood obesity cases in Japan [8]. However, the reason for this high obesity rate among children in this peninsula is unclear.

Obesity is the accumulation of fat due to energy intake that surpasses energy consumption. Childhood obesity results from eating habits, physical activitylevels, and environmental and hereditary factors that vary according to the region where the children reside.The National Health and Nutrition Survey (NHNS) conducted by the Japanese Ministry of Health, Labor, and Welfare [9] provided an account of Japanese school children's nutritional intakes [10]. The survey, however, utilized random sampling and didnot specifically evaluateobese or rural-dwelling children. In addition, these surveys wereonly conducted over a 1-weekday period. It is therefore difficult to assess food and nutrition intakes over multiple days, including the weekend, and consequently impossibleto evaluate how eating habits correlate with childhood obesity based on the NHNS data. Studies in the literature that evaluated children’s eating habits during the weekend have shown that regardless whether the environment was urban or rural, calcium and vegetable intakes were 70–80% lower than on weekdays when school lunches were eaten [11]-[13]; vitamin B1 intake was also reported to be deficient [14]. These studies suggest that weekday school lunches considerably influence food and nutrition intake. Weekday school lunches aim to give children a good balance of nutrition and food group variation but on the weekend, when school lunch is not eaten, there is a need to investigate the eating habits of children as opposed tomerely on week days with school lunches.

Research involving obese children in rural areas and investigations of their eating habits and lifestyles is not represented in the literature; this research, whichis an investigation of children’s eating and lifestyle habits in the Shimokita Peninsula of Aomori prefecture,aims to address that gap. First, the children’s meal and food group intakes will be assessed on week days and the weekend, followed by a discussion of how child obesity can be prevented. This research and the evaluation of the children’s nutritional intake and lifestyle habit characteristics could benefit health promotion in schools and assist house holds with obesity prevention.

2. RESEARCH METHOD

2.1. The target community

The population of Aomori has the shortest lifespan of all the 47 prefectures within Japan. Shimokitapeninsula, whichincludes 1city (Mutsu), 1 town (Ooma), and 3 villages (Sai, Kazamaura, and Higashidori), is an area of Aomori located in the remote northeastern cape of the prefecture on the main Japanese island of Honshū. The estimated population is approximately 78,000 people. Retail, wholesale, and administrative services account for the main industries within the region. Mutsu city within Shimokita has an average annual temperature of 9.4ºC with a maximum temperature of 27.5ºC in August and a minimum temperature of -5.4ºC in January. Annually, the city receives 1297.5 mm of rain, 70cm of snow, and 1675.6 daylight hours. Within the Shimokita area, there is a high percentage of obese childrenand obesity has become a particular problem among infants.

2.2. The subjects

With the aid of the Mutsu city Board of Education and the Shimokita Education Administration, cooperation was obtained from 5 elementary schools within the Shimokita peninsula. Upon the advice of these education administrations, fifth graders were selected as the best subjects because at 11 years of age, the students couldself-answer questionnaires; fourth graders were considered too young and sixth graders were in their final year before graduation and considered too busy to participate in the research. The surveys comprised aself-entry dietary and lifestyle survey based on the subjects’ lifestyles such the timesat which they get up and eatmeals. The survey also included physical status data such as weights and heights. A meal record diary where in subjects wrote down and took pictures of what they ate over a 3-day period (February to March, 2009) was also conducted.

Of the 151 surveys sent out as outlined above, only 77 guardians and their children signed the research consent form along with the completed dietary and lifestyle survey (a collection rate of 50.9%). Of these 77 participants, some only completed 1 or 2 days of the 3-day meal record diary. Therefore,only 42 subjects (20 boys and 22 girls) who completed both the self-entrydietary and lifestyle survey andthe full 3-day meal record diary were included for analysis within this study. This study was approved by the ethics committee of Aomori University Health and Welfare.

2.3. Participants' physical status

The physical conditions of the participants were as certained through self-evaluation reports conducted by the subjects. Items within the evaluation included sex, weight, and height. Body mass index (BMI) was calculated based oneach participant's height and weight. The obesity level was determined using criteria stipulated by the Ministry of Education, Culture, Sports, Science, and Technology in Japan, which were based on a school health statistical survey.The obesity classification or level was based on the formula below. Those with anobesity percentage of ≥20% were considered obese; those with a percentage below -20% were considered underweight.

Obesity level / percentage = Actual body weight (kg)-standard (ideal) body weight (kg) according to height ÷ standard (ideal) body weight criteria (kg) according to height×100.

Ideal body weight according to height = *a*×actual weight -*b*. Coefficients (for 11-year-old subjects): boys, a=0.782 and *b*=75.106; girls, a=0.803 and b=78.846

2.4. Subjects' lifestyles

The subjects' lifestyles were measured using a self-entry lifestyle survey that included items such as waking, sleeping, and meal times. Howand at what times the children attended school was also recorded. These times were divided according to the season. The children's activity was measured based on whether they exercised and if so, for how long. In addition, the duration of television viewing, whether they received sufficient sleep, and how often they ate breakfast were also measured. These measured items were similar to those found on physical fitness surveys.

2.5. Dietary survey (Meal record diary)

The dietary survey was conducted over a 3-day period. This included 1 week day when the children ate aschool lunch; the remaining 2 days were the weekend, when the children did not attend school or eata school lunch. In a meeting with the children'sguardians, we explained how we wanted the childrento document their 3-day meal records, which included asking them to photograph their meals. If filling out the meal record (of what and when they ate) was difficult for achild, we asked their guardian to help the child fill in everything.

During eachchild's homeroom period at school, the research was explained and research documents given to the children. These documents included the self-entry questionnaires and an explanation of how to write up the 3-day meal diary record as well asa photographic guidethat gave advice regarding the targeted amounts of food and seasoning.

The meal diary record asked the participants to record everything they ate, including snacks, over the 3-day period. An explanation and guide on how to complete the meal record diary was also included. Prior to the start of the study, a pilot test was conducted to help us confirm that a fifth grader would be able to understand and complete the questionnaires and meal diary record. Within the diary, thesubjectshad to fill in the following items: 1) Name of the dish, 2) Ingredients of the dish, 3) Weight of the dish, 4) How the dish was cooked (e.g., boiled, grilled, fried), and 5) The quantity of the uneaten amount (if applicable).

To prevent any omissions within the meal diary record, we asked participants to take photos of the meals (including snacks) that they ate. These photos included the placing of chopsticks and a spoon next to the dish/meal, which provided a scale from which to determine the size of the meal. Participants were asked to take photos of their meals before and after consumption, which allowed for estimations ofthe amount consumed. Forfood dishes that incorporatedseveral typesof ingredients or foods, the food name and weight were measured according to a food service industry guidebook. Altered food weight measurements (e.g., the weight changed after cooking) were corrected to the food weights before cooking. Fordeep fried food dishes, the amounts of absorbed oil were also based on a food service industry guidebook. As the 3-day meal diary record period asked subjects to record their eating habits on a weekday when at school, the school lunch menu was obtained from the school dietician on that day. Usingthe meal diaries and photographs, an estimate of the amount eaten could be obtained. Any leftovers were also recorded viaphotographs.

The nutritional value calculations based on the estimated nutrients, amountsconsumed, and food groupswere conducted using the software packageExcel *eiyou kun* version 6 (Kenpaku-sha, Tokyo, Japan),and the average intake per day was calculated from theoverall food intake overthe 3days.From the subjects'meal diaries and photographs, the names of the dishes were labeled in a meeting of 5 nationally registered dieticians (from the Aomori Dietetic Association,affiliated with the Nutrition Care Station) who specialized in calculatingnutritionalvalues. After this labeling, an experienced dietician conducted a complete data revision and reviewfollowed by revisions to the food weightsconsumed by the participants. This process was performed in order to prevent any typeof research bias towards the data.

3. DATA ANALYSIS

A descriptive statistical analysis ofthe participants' height, weight, BMI, and nutritional and food group intakes was performed. Nutritional and food group intakes were compared with the results for10–11-year-oldchildrenas determined by the NHNS. The NHNS is an annualinvestigation of the subjects' physical conditions, nutritional intakes, and lifestyle factors.

The normally distributed population of the NHNS was compared to the population of this study, and differences between the population mean and the sample mean of this study were also compared. The data in this study were z-transformed under the assumption that the NHNS data were normally distributed. The test-statistic value was calculated fromthe standard normal distribution table.

In addition, to compare and measure the dietary and food group intakes on a weekday, Saturday, and Sunday, a 1-way analysis of variance was conducted followed by a multiple comparisonaccording tothe Bonferroni method. In the complete data analysis we considered adifference to be significant when the null hypothesis was rejected at $p<0.05$.

4. RESULT AND DISCUSSION

4.1. Physical statuses and living conditions

In an analysis of the proportionsof the subjects' physical characteristics and obesity levels, anobesitylevel of ≥20% was observedin 5% of the boys and 13.6% of the girls, as illustrated in Table 1.In addition, 90% of the boys' meals were cooked by their mothers or grandmothers, compared with77.3% of thegirls' meals. All children walked to schoolin spring and summer andthe majority also walked in winter. Participants noted that it took 14–18 minutes to reach school, although in winter the number of students traveling by cars increased.

Table 1. Characteristics of the subjects

	Boys (n = 20)	Boys* (10 years, n = 780)	Girls (n = 22)	Girls* (10 years, n = 715)
Age (years)	10.9 ± 0.4	—	11.0 ± 0.2	—
Height (cm)	144.7 ± 7.5	139.7	148.8 ± 6.3	142
Weight (kg)	37.5 ± 7.0	36.1	44.2 ± 8.8	36.1
BMI (kg/m^2)	17.9 ± 2.9	—	19.9 ± 3.2	—
Obesity index				
Thin (≤-20%)	1 (5.0)	15 (1.9)	0 (0)	17 (2.4)
Normal	18 (90.0)	647 (83.0)	19 (86.4)	613 (85.7)
Obese (≥20%)	1 (5.0)	118 (15.1)	3 (13.6)	85 (11.9)

Data are shown as means ± standard deviations or n(%). *Aomori Prefecture School Health Survey, 2012.

Within the sample, only 1child did not eat breakfast every day. The sleeping durations were ≥6 h for both boys and girls, and approximately 40% of boys and 50% of girls reported television viewing durations≥3 h (Table 2).

4.2 Three-day average nutrition and food group intakes

The 3-day averages for the nutritional intake amounts werecompared to the NHNS results as illustrated in Table 3. There were no significant differences in the energy intake amounts between the boys and the girls in this study sample and those in the NHNS. However, among girls from the study sample, sodium intake was significantly different from that reported in the NHNS data ($p<0.05$). Statistical differences in the calcium intake between both sexes in the current study and the NHNS were minimal ($p<0.05$). However, among girls, therewere significant differences in the vitamin D and cholesterol intakes relative to the NHNS data ($p<0.01$).In addition, niacin intake wasfound to be significantly higher in both genders of the current study sample in comparison to the NHNS data ($p<0.01$).

Vitamin D intake was significantly higherwithin this study sample ($p<0.01$), and niacin intake was significantly higher within this sample when compared to male NHNS subjects ($p<0.05$). Water-soluble dietary fiber, insoluble dietary fiber, and total dietary fiber intakes were significantly higher within our sample in comparison to the NHNS ($p<0.05$, 0.01, and 0.05, respectively). Salt equivalent intakes differed significantly only between the girls in our study and the NHNS ($p<0.01$).

Tabel 2. Lifestyle

		Boys (n = 20)	Girls (n = 22)
Wake-up time		6:25 AM	6:08 AM
Bedtime		9:16 PM	9:15 PM
Main person who cooks			
Father		0 (0)	2 (9.1)
Mother		14 (70.0)	14 (63.6)
Grandfather		0 (0)	0 (0)
Grandmother		1 (5.0)	2 (9.1)
Mother & Grandmother		3 (15.0)	1 (4.5)
Oneself		0 (0)	0 (0)
Others		2 (10.0)	3 (13.6)
Attending school means			
Spring ~ Autum	On foot / minutes	12 (60.0) / 18.3 ± 10.1	18 (81.8) / 13.7 ± 8.5
	Bus / minutes	0 (0) / –	0 (0) / –
	Car / minutes	4 (20.0) / 8.8 ± 4.1	3 (13.6) / 5.3 ± 2.1
	Bicycle / minutes	0 (0) / –	0 (0) / –
	On foot & Car / minutes	4 (20.0) / 11.8 ± 9.5	1 (4.5) / 35.0
Winter	On foot / minutes	10 (50.0) / 18.0 ± 8.4	15 (68.2) / 14.9 ± 9.2
	Bus / minutes	0 (0) / –	0 (0) / –
	Car / minutes	5 (25.0) / 8.2 ± 4.2	6 (27.2) / 5.3 ± 2.2
	Bicycle / minutes	0 (0) / –	0 (0) / –
	On foot & Car / minutes	5 (25.0) / 12.6 ± 11.5	1 (4.5) / 45.0

	Boys	Boys * n = 780	Girls	Girls * n = 715
Extracurricular activities or sports clubs				
participation	18 (90.0)	(81.4)	17 (77.3)	(54.4)
nonparticipation	2 (10.0)	(18.6)	5 (22.7)	(45.6)
Exercise other than physical education (frequency)				
every day (more than 3days / week)	11 (55.0)	(75.9)	17 (77.3)	(54.7)
sometimes (1 ~ 2days / week)	7 (35.0)	(11.9)	2 (9.1)	(28.1)
often (1 ~ 3days / month)	1 (5.0)	(6.3)	3 (13.6)	(12.7)
never	1 (5.0)	(2.3)	0 (0)	(4.5)
Exercise other than physical education (duration)				
<30 minutes	2 (10.0)	(9.5)	6 (27.3)	(28.5)
≥30 minutes, <1 hour	3 (15.0)	(12.7)	1 (4.5)	(21.8)
≥1 hour, <2 hours	8 (40.0)	(25.6)	7 (31.8)	(20.4)
≥2 hours	7 (35.0)	(52.2)	8 (36.4)	(29.2)
Club activities				
Baseball	10 (55.6)	–	1 (5.3)	–
Basketball	4 (22.2)	–	6 (31.6)	–
Table tennis	1 (5.6)	–	10 (52.6)	–
others	3 (16.7)	–	2 (10.5)	–
Breakfast				
everyday	18 (90.0)	(92.4)	19 (86.4)	(90.5)
sometimes	2 (10.0)	(6.7)	2 (9.1)	(8.8)
never	0 (0)	(0.9)	1 (4.5)	(0.7)
Sleeping hours				
<6 hours	0 (0)	(3.6)	0 (0)	(4.5)
≥6 hours, <8 hours	3 (15.0)	(42.7)	11 (50.0)	(42.4)
≥8 hours	17 (85.0)	(53.7)	11 (50.0)	(53.1)
Watching television (hour / day)				
<1 hour	2 (10.0)	(13.8)	3 (13.6)	(19.0)
≥1 hour, <2 hours	6 (30.0)	(36.0)	4 (18.2)	(30.6)
≥2 hours, <3 hours	4 (20.0)	(24.4)	4 (18.2)	(24.3)
≥3 hours	8 (40.0)	(25.8)	11 (50.0)	(26.0)

Data are shown as n(%), (%), ormeans ± standard deviations.*Aomori Prefecture School Health Survey 2012.

A comparison of the average food group intake inthis study and the NHNS is shown in Table 4. Comparisons of potato and starch intake revealed small significant difference among the boys within the studies (p<0.05). In our sample, total vegetable intake (green vegetables) was low regardless of sex (p<0.01). In addition, the overall vegetable intake for both sexes was 150g, half of the recommended 350g. In our sample, green vegetable intake was low for both sexes, and the 3-day intake oflight-colored vegetables was low (p<0.05). The girls inour sample had a significantly higher intake of eggs (p<0.01). Milk intake was low amongst both sexes within our sample (p<0.01). The boys had a high intake of confectionary foods (p<0.01) and the girls had a low intake of beverages (all non-alcoholic beverages; p<0.01). Compared with the NHNS data, the girls in our studyhad a significantly higher pantothenic acid intake (p<0.05).

Table 3. Dietary intake over the 3-day period

		Boys n = 20	NHNS 2011 Male (10-11years, n = 100)	*p-value*	Girls n = 22	NHNS 2011 Female (10-11years, n = 93)	*p-value*
Energy	kcal	2097 ± 455	1967 ± 404	0.150	1910 ± 421	1801 ± 353	0.147
Protein	g	72.7 ± 20.1	70.1 ± 14.6	0.424	69.3 ± 17	66.7 ± 15.8	0.435
Fat	g	72.0 ± 27.5	64.4 ± 19.6	0.082	62.9 ± 23.1	60.2 ± 17.5	0.478
Carbohydrate	g	278.8 ± 60.0	269.1 ± 64.7	0.503	257.7 ± 55.6	241.8 ± 48.3	0.124
Sodium	mg	3970 ± 1061	3741 ± 1194	0.390	3951.5 ± 1112 **	3427 ± 914	0.007
Potassium	mg	2128 ± 690	2126 ± 566	0.984	2123 ± 489	2035 ± 481	0.390
Calcium	mg	560 ± 221	674 ± 252 *	0.043	501 ± 209 *	638 ± 200	0.013
Magnesium	mg	226 ± 70	213 ± 57	0.298	221 ± 54	211 ± 52	0.384
Phosphorus	mg	1055 ± 314	1062 ± 244	0.897	1030 ± 261	1015 ± 248	0.787
Iron	mg	7.2 ± 2.1	6.8 ± 3.0	0.529	7.1 ± 2.0	6.7 ± 2.1	0.347
Zinc	mg	8.2 ± 2.5	8.7 ± 2.0	0.234	7.8 ± 2.0	8.2 ± 2	0.317
Copper	mg	1.05 ± 0.26	1.04 ± 0.29	0.881	1.07 ± 0.29	1.01 ± 0.3	0.347
Manganese	mg	2.5 ± 0.9	– ± –	–	2.4 ± 1.0	– ± –	–
Vitamin A *1	μgRE	459 ± 452	526 ± 241	0.215	644 ± 928	534 ± 296	0.082
Vitamin D	μg	6.1 ± 6.3	4.9 ± 4.0	0.194	9.2 ± 10.1 **	5.8 ± 6.0	0.009
Vitamin E *2	mg	6.7 ± 2.4	6.3 ± 3.0	0.522	6.5 ± 2.5	5.7 ± 1.9	0.055
Vitamin K	μg	177 ± 144	187 ± 130	0.741	203 ± 158	184 ± 132	0.503
Vitamin B_1	mg	1.02 ± 0.36	1.08 ± 0.63	0.674	1.01 ± 0.43	0.93 ± 0.42	0.358
Vitamin B_2	mg	1.28 ± 0.54	1.29 ± 0.43	0.936	1.28 ± 0.51	1.19 ± 0.44	0.337
Niacin *3	mg	14.4 ± 6.4 **	11.5 ± 3.6	0.000	14.8 ± 7.0 **	11.1 ± 4.6	0.000
Vitamin B_6	mg	1.03 ± 0.46	1.08 ± 0.56	0.711	1.00 ± 0.33	0.98 ± 0.28	0.726
Vitamin B_{12}	μg	5.9 ± 4.8	4.8 ± 3.6	0.187	7.2 ± 6.6	5.3 ± 5.2	0.087
Folate	μg	225 ± 103	222 ± 79	0.881	238 ± 96	231 ± 73	0.660
Pantothenic acid	mg	6.05 ± 2.10	5.96 ± 1.49	0.779	6.04 ± 1.61 *	5.45 ± 1.29	0.032
Ascorbic acid	mg	77 ± 102	87 ± 159	0.787	63 ± 38	66 ± 36	0.741
Saturated Fatty acids	g	21.68 ± 11.62	20.87 ± 6.42	0.575	19.54 ± 8.60	19.50 ± 6.85	0.976
Monounsaturated	g	25.00 ± 10.94	21.70 ± 7.80	0.059	21.64 ± 8.60	19.79 ± 6.26	0.185
Polyunsaturated	g	14.14 ± 5.36	– ± –	–	12.56 ± 4.90	– ± –	–
Cholesterol	mg	379 ± 243	330 ± 171	0.201	389 ± 206 **	287 ± 145	0.001
Soluble Dietary Fibers	g	2.7 ± 1.0	3.2 ± 1.3	0.069	2.6 ± 1.3 *	3.1 ± 1.0	0.024
Insoluble Dietary Fibers	g	8.0 ± 2.9	9.2 ± 2.9	0.066	7.5 ± 2.2 **	9.3 ± 2.7	0.002
Total Dietary Fibers	g	11.4 ± 3.6	12.8 ± 4.0	0.112	11.1 ± 3.2 *	12.8 ± 3.7	0.027
Salt equivalents *4	g	10.1 ± 2.7	9.5 ± 3.0	0.384	10.0 ± 2.8 **	8.7 ± 2.3	0.006
Energy supplies from							
Protein *5	%	13.9 ± 2.6	– ± –	–	14.7 ± 2.6	– ± –	–
Carbohydrate *5	%	53.7 ± 7.7	56.2 ± 6.8	0.097	54.5 ± 6.7	55.3 ± 5.4	0.472
Fat *5	%	30.4 ± 7.0	29.4 ± 6.0	0.484	28.9 ± 6.6	29.9 ± 4.7	0.332

Data are shown as means ± standard deviations. NHNS,National Health and Nutrition Survey 2011, 10–11years. *p<0.05,**p<0.01;*1 RE: retinol equivalent,*2 α- tocopherol, *3 niacin, *4 sodium×2.54/100, *5 Averagedratio of a personal calculated value.

Table 4. Food group intake over the 3-day period

		Boys (n = 20)	NHNS 2011 Male (10-11years, n = 100)	*p-value*	Girls (n = 22)	NHNS 2011 Female (10-11years, n = 93)	*p-value*
Cereals	g	410.9 ± 104.7	440.3 ± 145.1	1.414	401.5 ± 114.4	390.6 ± 105.6	0.631
Potatoes and Starches	g	36.4 ± 31.3 *	57.7 ± 48.5	0.049	40.4 ± 43.3	58.6 ± 47.3	0.238
Sugars and Sweeteners	g	7.0 ± 10.2	4.9 ± 6.3	0.144	6.4 ± 11.1	5.9 ± 6.9	0.741
Nuts and Seeds	g	1.7 ± 4.5	2.0 ± 5.5	0.810	0.9 ± 3.8	1.4 ± 3.5	0.472
Vegetables	g	148.3 ± 107.8 **	237.6 ± 127.4	0.002	149.1 ± 72.2 **	242.6 ± 103.9	0.000
Green Vegetables	g	42.4 ± 39.2 *	70.5 ± 55.5	0.023	46.0 ± 39.2 *	67.9 ± 50.3	0.041
Light color Vegetables	g	105.9 ± 90.5 *	162.9 ± 112.0	0.023	103.1 ± 64.8 **	167.5 ± 82.7	0.003
Fruits	g	82.3 ± 133.4	91.6 ± 130.1	0.749	64.7 ± 96.8	72.8 ± 89.9	0.674
Mushrooms	g	7.1 ± 8.5	10.6 ± 19.0	0.407	7.0 ± 13.8	12.3 ± 18.8	0.184
Algae	g	5.0 ± 19.7	9.1 ± 19.0	0.177	5.7 ± 12.8	7.6 ± 15.5	0.555
Beans	g	29.5 ± 35.9	31.0 ± 39.9	0.857	33.7 ± 38.7	45.8 ± 57.7	0.327
Fishes and Shellfishes	g	60.6 ± 54.4	49.6 ± 55.4	0.373	62.7 ± 57.1	49.2 ± 53.2	0.234
Meats	g	94.9 ± 63.3	108.1 ± 54.5	0.276	73.5 ± 45.0	96.9 ± 60.5	0.070
Eggs	g	43.7 ± 42.4	34.6 ± 32.0	0.204	47.1 ± 37.7 **	25.5 ± 22.7	0.001
Milks	g	201.4 ± 148.1 **	323.1 ± 161.5	0.001	178.4 ± 157.2 **	281.5 ± 145.0	0.001
Fats and Oils	g	11.6 ± 9.1	11.2 ± 8.7	0.849	11.6 ± 7.4	9.1 ± 6.3	0.067
Confectioneries	g	65.3 ± 77.1 *	33.4 ± 46.8	0.002	36.4 ± 56.1	36.6 ± 47.4	0.984
Beverage	g	184.1 ± 239.2	290.6 ± 289.7	0.101	162.0 ± 206.8 **	334.8 ± 282.9	0.004
Seasonings	g	47.6 ± 38.5	82.0 ± 73.4	0.582	51.7 ± 28.5	57.3 ± 29.3	0.373

Data are shown as means ± standard deviations. NHNS, National Health and Nutrition Survey 2011. *p<0.05, **p<0.01.

Table 5. Boys'nutritional intakeson the weekday, Saturday, and Sunday

Boys (n = 20)		Weekday	Saturday	Sunday	*p-value*
Energy	kcal	2084 ± 344	2083 ± 533	2125 ± 499	n.s
Protein	g	74.4 ± 17.0	68.4 ± 18.8	75.0 ± 24.2	n.s
Fat	g	72.2 ± 20.9	69.5 ± 27.1	74.2 ± 34.3	n.s
Carbohydrate	g	275.5 ± 50.3	281.1 ± 74.3	280.3 ± 57.3	n.s
Sodium	mg	3709 ± 889	4211 ± 829	4017 ± 1369	n.s
Potassium	mg	2317 ± 655	1969 ± 613	2082 ± 778	n.s
Calcium	mg	596 ± 187	494 ± 198	585 ± 267	n.s
Magnesium	mg	240 ± 62	213 ± 73	225 ± 76	n.s
Phosphorus	mg	1137 ± 232	968 ± 293	1052 ± 391	n.s
Iron	mg	7.6 ± 1.9	6.6 ± 2.1	7.4 ± 2.3	n.s
Zinc	mg	8.8 ± 2.0	7.4 ± 2.7	8.3 ± 2.6	n.s
Copper	mg	1.12 ± 0.23	0.97 ± 0.28	1.06 ± 0.26	n.s
Manganese	mg	2.6 ± 0.6	2.5 ± 1.0	2.5 ± 1.0	n.s
Vitamin A *1	μgRE	542 ± 316	516 ± 705	318 ± 163	n.s
Vitamin D	μg	7.3 ± 6.2	4.8 ± 6.0	6.0 ± 6.7	n.s
Vitamin E *2	mg	7.2 ± 2.5	6.3 ± 2.1	6.7 ± 2.5	n.s
Vitamin K	μg	154 ± 100	159 ± 97	219 ± 205	n.s
Vitamin B_1	mg	1.05 ± 0.29	0.90 ± 0.40	1.10 ± 0.39	n.s
Vitamin B_2	mg	1.24 ± 0.28	1.14 ± 0.50	1.46 ± 0.74	n.s
Niacin *3	mg	14.3 ± 4.5	13.9 ± 7.2	14.9 ± 7.5	n.s
Vitamin B_6	mg	1.15 ± 0.37	0.90 ± 0.35	1.03 ± 0.61	n.s
Vitamin B_{12}	μg	5.9 ± 4.1	5.9 ± 5.2	5.8 ± 5.3	n.s
Folate	μg	240 ± 97	205 ± 97	227 ± 115	n.s
Pantothenic acid	mg	6.61 ± 1.49	5.31 ± 1.76	6.17 ± 2.74	n.s
Ascorbic acid	mg	92 ± 100	81 ± 139	59 ± 52	n.s
Saturated Fatty acids	g	21.50 ± 8.11	21.10 ± 11.38	22.41 ± 15.04	n.s
Monounsaturated	g	24.85 ± 8.49	24.22 ± 12.06	25.90 ± 12.50	n.s
Polyunsaturated	g	14.92 ± 4.94	12.58 ± 5.05	14.82 ± 6.00	n.s
Cholesterol	mg	423 ± 223	330 ± 207	379 ± 294	n.s
Soluble Dietary Fibers	g	2.4 ± 1.0	2.8 ± 1.1	2.8 ± 1.0	n.s
Insoluble Dietary Fibers	g	8.5 ± 3.1	7.4 ± 2.5	8.1 ± 2.9	n.s
Total Dietary Fibers	g	11.4 ± 4.0	11.3 ± 3.4	11.4 ± 3.6	n.s
Salt equivalents *4	g	9.4 ± 2.3	10.7 ± 2.1	10.2 ± 3.5	n.s
Energy supplies from					
Protein *5	%	14.3 ± 2.5	13.5 ± 3.1	14.0 ± 2.2	n.s
Carbohydrate *5	%	53.1 ± 6.6	54.3 ± 7.1	53.6 ± 9.4	n.s
Fat *5	%	30.9 ± 6.0	29.4 ± 7.2	30.7 ± 8.0	n.s

Data are shown as means ± standard deviations.*p<0.05, **p<0.01,n.s.: not significant.*1 RE: retinol equivalent, *2 α- tocopherol, *3 niacin, *4 sodium×2.54/100, *5 Averaged ratio of a personal calculated value.Weekday, Saturday,andSundayintakes were analyzed via1-wayanalysis of variance(multiple comparison,Bonferroni).

4.3 Comparison of food intakes on the weekday and the weekend

Comparisons of the nutritional intakes are shown in Table 5 (boys) and Table 6 (girls). Intakes according to food group on the weekday and the weekend are shown in Table 7. In each category, there was no statistical difference between the boys and girls. However, a tendency toward increased salt intake on the weekend relative to the week day was observed. Among boys, total vegetable and green and light-colored vegetable intakes were slightly significantly higher on Sunday than on the weekday ($p<0.05$). Among girls, fish and shellfish intake was slightly and significantly higher on Sunday than the weekday ($p<0.05$). Among boys, egg intake was lower on Saturday than on the weekday ($p<0.05$), and milk intake was lower on Sunday than on the weekday ($p<0.05$). Among girls, fat and oil intake increased significantly on Saturday compared withthat on the weekday ($p<0.05$). Although there was no difference between the boys and girls, there was a tendency toward increased beverage and confectionary intake on the weekend in comparison to the week day.

Table 6. Girls'nutritional intakeson the weekday, Saturday, and Sunday

Girls (n = 22)		weekday	Saturday	Sunday	*p-value*
Energy	kcal	1829 ± 354	1955 ± 455	1964 ± 464	n.s
Protein	g	72.2 ± 18.1	67.9 ± 16.1	67.2 ± 16.9	n.s
Fat	g	56.8 ± 18.2	68.2 ± 22.7	64.8 ± 28.0	n.s
Carbohydrate	g	247.7 ± 43.3	258.5 ± 66.3	269.3 ± 57.4	n.s
Sodium	mg	3668 ± 1027	3912 ± 1161	4347 ± 1098	n.s
Potassium	mg	2234 ± 543	1958 ± 486	2158 ± 387	n.s
Calcium	mg	565 ± 184	460 ± 209	465 ± 229	n.s
Magnesium	mg	226 ± 50	220 ± 71	215 ± 38	n.s
Phosphorus	mg	1097 ± 261	1001 ± 254	975 ± 262	n.s
Iron	mg	7.0 ± 1.7	6.9 ± 2.2	7.5 ± 2.2	n.s
Zinc	mg	8.2 ± 2.0	7.5 ± 1.9	7.6 ± 2.0	n.s
Copper	mg	1.13 ± 0.31	1.02 ± 0.25	1.05 ± 0.31	n.s
Manganese	mg	2.3 ± 0.6	2.6 ± 1.6	2.2 ± 0.6	n.s
Vitamin A *1	μgRE	821 ± 750	351 ± 165	729 ± 1437	n.s
Vitamin D	μg	12.8 ± 11.3	7.2 ± 9.9	6.7 ± 7.6	n.s
Vitamin E *2	mg	6.3 ± 2.7	6.3 ± 2.2	6.9 ± 2.8	n.s
Vitamin K	μg	226 ± 200	169 ± 128	209 ± 124	n.s
Vitamin B_1	mg	1.01 ± 0.43	0.92 ± 0.31	1.11 ± 0.53	n.s
Vitamin B_2	mg	1.34 ± 0.46	1.1 ± 0.37	1.36 ± 0.68	n.s
Niacin *3	mg	16.1 ± 9.6	13.7 ± 5.1	14.4 ± 4.6	n.s
Vitamin B_6	mg	1.08 ± 0.37	0.91 ± 0.28	1.02 ± 0.31	n.s
Vitamin B_{12}	μg	8.4 ± 5.5	7.6 ± 9.3	5.2 ± 3.7	n.s
Folate	μg	246 ± 94	223 ± 92	243 ± 105	n.s
Pantothenic acid	mg	6.55 ± 1.78	5.44 ± 1.13	6.03 ± 1.66	n.s
Ascorbic acid	mg	67 ± 35	56 ± 40	67 ± 41	n.s
Saturated Fatty acids	g	18.26 ± 6.04	21.05 ± 9.71	19.55 ± 10.21	n.s
Monounsaturated	g	19.06 ± 7.08	23.23 ± 8.36	23.19 ± 10.10	n.s
Polyunsaturated	g	11.29 ± 4.59	13.50 ± 4.95	13.17 ± 5.01	n.s
Cholesterol	mg	373 ± 183	371 ± 192	427 ± 248	n.s
Soluble Dietary Fibers	g	2.6 ± 1.7	2.4 ± 0.8	2.9 ± 1.1	n.s
Insoluble Dietary Fibers	g	7.5 ± 2.1	7.2 ± 2.3	8.0 ± 2.2	n.s
Total Dietary Fibers	g	10.9 ± 3.2	10.4 ± 3.0	12.0 ± 3.3	n.s
Salt equivalents *4	g	9.3 ± 2.6	9.9 ± 3.0	11.0 ± 2.8	n.s
Energy supplies from					
Protein *5	%	15.8 ± 2.1	14.2 ± 2.8	13.8 ± 2.7	n.s
Carbohydrate *5	%	54.6 ± 5.3	53.2 ± 6.6	55.7 ± 8.3	n.s
Fat *5	%	27.5 ± 4.8	30.8 ± 6.9	28.7 ± 7.9	n.s

Data are shown as mean± standard deviations. *$p<0.05$, **$p<0.01$,n.s.: not significant.*1 RE: retinol equivalent, *2 α- tocopherol, *3 niacin, *4 sodium×2.54/100, *5 Averaged ratio of a personal calculated value.Weekday, Saturday,andSunday intakes were analyzed via1-wayanalysis of variance(multiple comparison,Bonferroni).

Table 7. Intakes according to food groups on the weekday, Saturday, and Sunday

		Boys (n = 20)			
		weekday	Saturday	Sunday	*p-value*
Cereals	g	388.4 ± 102.1	442.2 ± 104.0	404.9 ± 105.9	n.s
Potatoes and Starches	g	49.9 ± 29.7	27.6 ± 31.0	30.6 ± 29.9	n.s
Sugars and Sweeteners	g	5.0 ± 4.7	8.4 ± 13.8	7.6 ± 10.7	n.s
Nuts and Seeds	g	1.7 ± 3.1	0.4 ± 0.8	3.0 ± 6.9	n.s
Vegetables	g	197.4 ± 110.3	137.2 ± 74.9	107.3 ± 115.9 *	0.020
Green Vegetables	g	61.7 ± 47.7	33.8 ± 33.8	30.2 ± 25.6 *	0.026
Light color Vegetables	g	135.7 ± 85.0	103.5 ± 63.4	77.1 ± 110.4	n.s
Fruits	g	90.0 ± 139.7	75.8 ± 114.6	80.3 ± 148.9	n.s
Mushrooms	g	10.0 ± 8.8	6.0 ± 8.6	5.1 ± 7.7	n.s
Algae	g	1.8 ± 3.3	12.4 ± 34.2	1.4 ± 2.3	n.s
Beans	g	31.8 ± 29.3	23.9 ± 19.6	32.3 ± 51.9	n.s
Fishes and Shellfishes	g	69.7 ± 55.7	61.1 ± 58.6	50.6 ± 49.9	n.s
Meats	g	94.1 ± 57.3	88.8 ± 63.6	101.4 ± 71.1	n.s
Eggs	g	52.3 ± 38.2	34.4 ± 39.0*	43.5 ± 49.3	0.033
Milks	g	270.0 ± 118.0	152.4 ± 112.0	176.1 ± 182.5	n.s
Fats and Oils	g	12.0 ± 7.7	9.6 ± 7.6	13.1 ± 11.5	n.s
Confectioneries	g	34.3 ± 42.2	74.2 ± 77.7	89.4 ± 95.4	n.s
Beverage	g	115.3 ± 156.9	229.9 ± 311.4	212.7 ± 227.2	n.s
Seasonings	g	52.6 ± 24.4	42.2 ± 19.9	47.5 ± 59.6	n.s
		Girls (n = 22)			
		weekday	Saturday	Sunday	*p-value*
Cereals	g	368.7 ± 123.6	403.8 ± 91.8	440.0 ± 116.9	n.s
Potatoes and Starches	g	53.3 ± 51.8	31.7 ± 29.5	33.3 ± 42.0	n.s
Sugars and Sweeteners	g	6.3 ± 6.1	9.1 ± 17.6	3.6 ± 6.0	n.s
Nuts and Seeds	g	0.2 ± 0.7	2.4 ± 6.5	0.1 ± 0.3	n.s
Vegetables	g	162.1 ± 79.4	127.3 ± 76.8	155.6 ± 53.6	n.s
Green Vegetables	g	55.7 ± 41.3	35.7 ± 33.6	44.5 ± 40.9	n.s
Light color Vagetables	g	106.4 ± 71.7	91.6 ± 67.0	111.1 ± 54.3	n.s
Fruits	g	59.6 ± 98.1	68.4 ± 93.1	67.3 ± 103.6	n.s
Mushrooms	g	8.1 ± 8.7	7.0 ± 18.0	5.6 ± 14.7	n.s
Algae	g	3.2 ± 6.1	7.6 ± 18.2	6.7 ± 12.3	n.s
Beans	g	36.2 ± 39.6	37.3 ± 46.9	26.9 ± 27.7	n.s
Fishes and Shellfishes	g	81.3 ± 46.3	63.9 ± 74.8	38.1 ± 38.4 *	0.034
Meats	g	67.1 ± 41.1	72.8 ± 46.0	82.3 ± 49.2	n.s
Eggs	g	39.9 ± 37.1	46.4 ± 33.4	56.8 ± 42.1	n.s
Milks	g	253.4 ± 139.9	146.9 ± 167.1	117.7 ± 134.2 **	0.009
Fats and Oils	g	8.3 ± 6.5	14.4 ± 6.6*	12.6 ± 8.0	0.013
Confectioneries	g	28.0 ± 48.7	29.5 ± 53.3	54.2 ± 65.6	n.s
Beverage	g	96.2 ± 160.2	217.0 ± 243.7	186.7 ± 204.1	n.s
Seasonings	g	48.7 ± 20.0	47.7 ± 27.2	59.8 ± 37.2	n.s

Data are shown as means ± standard deviations. *p<0.05, **p<0.01,n.s.: not significant.Weekday, Saturday, and Sunday intakes were compared via1-wayanalysis of variance(multiple comparison,Bonferroni).

This paper describes the first research to examine the rural Shimokita peninsula in Japan, where the childhood obesity rate is particularly high. The obesity rates were recorded at 13.6% for girls and 5% for boys. According to the annual report of School Health Statistics Research, among elementary school fifth graders, the obesity rates were 10.9% for boys and 8% for girls [8]; therefore, the rate for our sample of girls exceeded the national average. In addition, even when compared with the 11.9% overall obesity rate of children in the Aomori prefecture [10], the obesity rate of our sample of girls remained high.

Lifestyle is a contributing factor to obesity. Regarding the children's physical activity levels, most walked to school although the number of those traveling to school by car increased in winter. According to the literature, 50–80% of children who reside in rural areas use cars to attend school [12],[13] but within our sample, therate was 14–27%; therefore, we cannot say that the number of children traveling to school by car was particularly high. In addition, it took the children in our sample 14–18 minutes to walk to school but within rural areas where children are taken to school by car, the time required to walk that distance is 5 minutes [15] or approximately 15 minutes less than the children's commute in our study. According to the Japanese Society of School Health surveillance survey, the average duration for a 1-way journey on foot to school for elementary fifth and sixth graders was 16–17 minutes [16], which does not surpass the longest time of 18 minutes reported within the current study sample.

Gotet al. [17] showed that within large school districts, the commuting distances are long, resulting in the tendency to take children to school by car, which in turn leads to a higher obesity rate. Heelan et al.[18] reported that the main factor leading children to be driven to school as opposed to walking was the distance involved. Within this study, however, because the commuting distances and school district scales were not examined, it is not known whether the factors outlined byHeelan et al.[18] influenced the parents to take their children to school by car.

The data within this study and in surveys on children's physical activity in communities within southern Aomori prefecture showed that children walked less onthe weekend than on school weekdays. A previous survey reported that for 25% of children, their walking distances were reduced by>50% on weekends relative to week days [19].

The combination of reduced walking on the weekend and traveling to school by car can lead to lower levels of physical activity in children. To increase physical activity, we suggest that even if children are driven to school, when they are picked up, they should be made to walk to where their guardian will meet them rather than being picked up directly in front of the school. This would providethe child with a slight increase in physical activity.

Apart from comminuting to school, the children were also involved in other physical activities. The number of children who belonged to sports clubs and performed exercise on a regular basis outside of physical education classes was higher than the prefecture average; however, the television viewing duration exceeded 3 hours perday, a particularly high level. It has been suggested that long television viewing durations are associated with a higher obesity rate [20]; therefore, reducing the amount of television viewing is considered an effective measure for reducing obesity [21].

There were no great differences in nutritional intakes between the reported NHNS data for10–11-year-old and the data obtained during this study, but there were differences in calorie intake based on the national nutrition criteria that stipulate the necessary caloric intake for 10–11-year-olds. The intakes of children inthe current sample were below the standards of 2,250 calories for 10–11-year-oldboys and 2,000 calories for10–11-year-old girls.

The fat energy and carbohydrate energy ratios (%) were within the standard ranges. When compared with nutritional surveys of the energy intakes of elementary school fifth graders, our study sample reported the same energy intake levels; therefore, we cannot say that our sample's intake was particularly high. The lack of calcium intake within the sample is a reflection of nation wide calcium deficiency. Low calcium intake on non-school days when school lunch was not consumed has also been reflected in other studies [11],[12]. Calcium is essential for future bone growth and osteoporosis prevention, and its intake is strongly encouraged.

The salt intake levels ofour sample exceeded the recommended levels of 8g for boys and 7.5g for girls. 17of the boys (85%) and 19 of the girls (86.4%) were over the recommended levels. Taken together, 80% of the total sample exceeded the recommended salt intake. This high salt intake could be attributed to the frequency of instant noodle consumption. The salt contentsoffast food were also considered, but only 2 boys (10%) and 2 girls (9.1%) ate fast food during the study period and as only 4 participants ate fast food, it would be difficult to make assumptions. On the other hand, 7 boys (35%) and 5 girls (22.7%) reported instant noodle consumption. To change the custom of eating heavily seasoned, high-calorie food [22], the children's guardians must be instructed to initiate a new habit of serving children lightly seasoned dishes with low salt contents. According to the Aomori prefecture Community Survey, the salt intake levels of school children who reside in rural areas exceeded the national average. This finding was reflected in the current study, and it is felt that although salt intake was not considered a contributing factor to obesity in this study, this factor should be considered in future studies.

Within our sample, vegetable intake was very low; on the weekend when school lunch was not provided, the participants consumed 100–120g of vegetables, including30–40g of dark green and yellow vegetables. According to the literature, the non-school-lunch day vegetable intake is 200g [14]. According to the Aomori Prefecture Health and Nutrition Survey,the daily vegetable intake was 250g among 7–14-year-olds [10], which is 50% more than the vegetable intake of our study participants.Onereason for this low vegetable intake might be the fact the long-term average regional vegetable intake has always been low, and this fact influences younger generations [23]-[27]. We would like to see greater incorporation of vegetables in the meals preparedby the children's guardians and for increased vegetable intake to become a regular eating habit. In adults, vegetable consumption is known to reduce the risk of obesity, cancer, and chronic disease; however, the relationship between vegetable intake and obesity prevention among children remains largely unknown. Some studies have shown that when comparing obeseand non-obese children residing in rural areas, the obese children consume more vegetables [28]. Reports have shown that people who consume vegetables, fruits, fish, and cereals are more likely to have low blood pressure [29]. A balanced meal is therefore desirable.

The limitations ofthis study include the fact that the survey collection return rate was low, which might account for the low rate of obesity within this sample. Therefore, the evidence presented herein cannot be used to accurately predict obesity within this region. The reasons for this low collection return rate could include a failure of the children's guardians to acknowledge that their children were overweight or obese and consequently to avoid completing the questionnaires. Studies have shown that the self-entry survey participation rates are considerablylower among guardians of overweight children than amongguardiansof non-obese children [30]. Therefore, although the questionnaires were anonymous, the participants may not have had the confidence or willingness to allow their children to be perceived as obese or themselves to be perceived as failing to cook healthy meals. In hindsight, we also should have includeda second week day that included the child's school lunch for balance, along with the 2 weekend days.

This study has attempted to reportthe nutritional and food group intakes of children residing in the Shimokita Peninsula, Aomori prefecture, Japan. This area has the highest rate of childhood obesity, which until now has not been clarified within the literature. Obesity prevention in this area needs to be addressed, and we suggest that the children walk to school, increase their physical activity levels, and limit their television viewing. In terms of food intake, vegetable consumption should be increased and salt intake decreased.

5. CONCLUSION

The Shimokita Peninsula has the highest rate of child obesity in Japan, and this study aimed to examine the nutritional intakes of these children using questionnaires and self-documented meal record diaries.The viewing of ≥3 hours of television per day was a regular feature of these children's lifestyles. Compared with theNHNS data, the nutritional and energy intake levels in our sampledid not differ; however, when we examined the food group intakes, the vegetable intake in our sample was lower on weekends than on the weekday, when the children consumed a school lunch. Additionally, the salt intake level exceeded the recommended standard in>80% of the study sample. We suggest that the low vegetable intake juxtaposed with the high salt intake stems from childhood and comprises apattern that is repeated and passed down through the generations; therefore, nutritional guidance and education should be provided to the guardians of these children.

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